COMPLEXITY AND AESTHETIC PREFERENCE FOR DIVERSE VISUAL STIMULI

DOCTORAL THESIS

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Presentation

Even a superficial familiarity with the field of empirical aesthetics is enough to realize that there is a considerable amount of conceptual confusion. For instance, *aesthetic judgment* and *aesthetic preference* are often used with no prior explicit definition. Whereas some authors seem to consider that they are interchangeable, others consider that they should be used to designate different phenomena. In the present work I have chosen to follow McWhinnie's (1968) criterion of using *aesthetic preference* to refer to the degree with which people like a particular visual stimulus or not, how much they prefer it to another, or how they rate its beauty. Conversely, *aesthetic judgment* will be used to refer to the assessment someone does of the aesthetic or artistic value of a certain visual stimulus. Whereas the goodness of someone's aesthetic judgment can be gauged using external criteria provided by expert's appraisals –though these have certainly varied throughout history-, there can be no yardstick to determine how "good" someone's aesthetic preference is, given that it is an entirely subjective and personal matter. Finally, *aesthetic appreciation* will be used to refer to the human capacity to divide the world into beautiful and ugly things, to prefer a blue car to a red one, and to like blond men more than others. We believe that this capacity was present at least at the time of our species' birth, though it probably built on pre-existing cognitive and affective processes. It led the first *Homo sapiens* to decorate their bodies and to make necklaces, enabled our upper Palaeolithic ancestors to create breath-taking murals on cave walls, drove Michelangelo to sculpt *David*, and allows us to admire all of this. But it also allowed our ancestors to avoid settling in resourceless environments, feeling attracted by sick-looking people, and it allows us to avoid living in bare-walled houses, and wearing brown with red.

The work presented here, structured as a standard journal paper, is mostly concerned with aesthetic preference for visual stimuli, though there are many previous studies on aesthetic judgment and aesthetic appreciation which cast light on how people develop aesthetic preferences for visual stimuli. In fact, the question of the factors that govern these preferences is one of the oldest in the field of empirical aesthetics, and one of its chiefs objectives has been to articulate a sort of predictive mathematical formula that describes an underlying relation between certain attributes of visual stimuli and people's reaction to them. After briefly reviewing early attempts to formulate this relation, we will present Daniel Berlyne's framework, which stimulated research in the field since the 1970s. The main aim of our work is to explore the reasons behind the divergence of results obtained by studies attempting to verify Berlyne's predicted relation between complexity and aesthetic preference. We look at three main possibilities: (i) studies have varied as to the proportion of male and female participants, (ii) studies have used different kinds of stimuli (abstract, representational, artistic, geometric figures, and so on), (iii) studies have used different measures of complexity. As we mentioned, we are concerned solely with visual stimuli. Generalization of our results to auditory stimuli could be possible, though we have left this interesting issue for a later occasion.

Carrying out this project has been satisfying and thrilling most of the time, and disheartening at certain moments. However, I am sure it would not have been completed without the help and encouragement from my colleagues at the *Deparatment de Psicologia* and the *Departament de Filosofia i Treball Social* at the *Universitat de les Illes Balears*. To them I am deeply grateful. Thank you to my supervisors, Camilo José Cela Conde and Gisèle Marty, who I greatly admire and respect, for inspiring and enthusing me. Support, patience, and understanding from my friends and family were as essential as air, food, and water to me during this venture.

1

Introduction

1.1

The study of the determinants of aesthetic preference during the initial period of experimental aesthetics

Abstract

In this section we briefly review the early empirical approaches to aesthetic and artistic phenomena. We begin by presenting Fechner's work, which constitutes the foundation of the field of empirical aesthetics. Among many methodological and theoretical contributions, he formulated his principle of "unitary connection", which argues that pleasant stimuli achieve a balance between complexity and order. These two factors, complexity and order, were later considered by Birkhoff as the bases of the measure of the aesthetics of objects. From his point of view, this measure was greatest for ordered and simple stimuli, and decreased with disorder or complexity. However, Birkhoff's formulation received mixed empirical support. In fact, the results of Eysenck's experiments showed that both order and complexity were positively related with aesthetic preference. These early efforts to develop a predictive framework for aesthetic preference based on properties of the stimuli paved the way for Berlyne's integrative approach, which we review in section 1.2.

1.1.1. The birth of a new field: The work of Gustav Fechner

As many other intellectual issues, the questions related with art and aesthetics have been continuously debated since they were initially asked by ancient Greek philosophers. Until relatively recently the answers to these questions, as well as those concerning other psychological phenomena, were mostly based on the experiences of the authors themselves. In this case, the experiences were their own reactions when viewing artworks and the daily observation of other people. These are extremely poor bases to ground explanatory theories, and leave a great amount of issues unaddressed, which in many occasions are not detected until new and more rigorous research methods are used.

It is usually considered that experimental means of testing insights and hypotheses regarding art and aesthetics began in 1879 with the work Gustav Fechner, who also founded the field of psychophysics (Cupchik, 1986). Although aesthetic and artistic phenomena are probably among the most complex within the domain of psychology, they were among the first to be addressed by experimental psychology, more than a century ago, giving birth to the field of empirical aesthetics (Carreras, 1998; Marty, 1997). The first serious empirical study of reactions to artworks was performed in 1871, when two versions of Holbein's (1497–1543) painting *Madonna with Burgomaster Meyer* were exhibited at the Dresden Museum. At the time there was certain controversy regarding the authenticity of these two versions. Experimental and other empirical methods had proven unable to resolve the question, but Fechner realized he could study a different matter. Specifically, he designed a method to determine which of the two paintings was valued best by spectators, which involved asking the museum visitors to write down their impressions. Ultimately, the experiment did not reach its goal. In fact, only a small part of the visitors accepted the invitation to participate, many of which were unable to correctly carry out the instructions, and their answers were not taken into account. He later carried out a series of empirical studies designed to determine which types of form, proportions, and colours were considered the most beautiful or pleasant (Carreras, 1998).

In spite of the fact that some authors have noted that the methods used by Fechner in experimental aesthetics were less elaborate than those used in psychophysics (Pratt, 1961), there is a broad agreement that his greatest innovation was a methodological one. He introduced the practice of addressing psychological questions related with art by means of the registration of reactions of a sample of subjects representing a certain population. His book *Elements of Aesthetics*, published in 1876, included reports of various experiments carried out in more rigorous conditions than the Dresden experiment. Fechner (1876) characterized the new experimental aesthetics he was proposing as a kind of aesthetics from below. He meant that it had to begin with particular facts and then gradually grow towards generalization, which contrasted with the type of aesthetics carried out by philosophers. The reflections of a single individual were substituted by averaged responses given by a group of participants. Instead of studying a single artwork in depth, large numbers of objects were used to determine collective attributes of classes of stimuli (Cupchik, 1986). In fact, Fechner's work is considered as the beginning of the transition from traditional humanist perspectives towards a scientific and experimental approach.

Fechner developed three methods to be used in empirical aesthetics, all of which have been used ever since. First, the choice method consisted in asking various participants to compare the pleasingness of a number of objects. Different variants of this method have dominated experimental psychology of aesthetics since its first implementation. Second, in the method of production participants were required to produce, by means of drawing or the manipulation of certain devices, an object conforming to their own taste or liking. Third, the method of use consisted in the examination of artworks or other objects under the premise that the features that appear most frequently are preferred by the society which originated them.

Since the publication of Fechner's book, many experiments have sought to elicit indicative responses of the preferences of samples of participants. Artistic materials, such as reproductions of paintings, photographs of sculptures or façades, and musical excerpts have been used on some occasions. Most of the times, however, researchers have used much simpler materials: colours, geometric forms, or isolated sounds. The first kind of stimuli has the advantage of enabling the study of the reactions to true art, but the disadvantage that any two artworks may differ in any number of features, such that it becomes difficult to identify the factor that is truly responsible for any differences in the reactions to them. The use of simple artificial materials overcomes this problem because it allows manipulating a single dimension. Nonetheless, this kind of material has been criticised for being very far from anything like art and, hence, could prevent the identification of essential components of the true aesthetic behaviour.

In time, the procedures designed to obtain and register participants' preferences have multiplied and have become more varied. For instance, later studies have used the ordering method, which requires participants to order a series of objects according to their preference for them. Another popular method is known as paired comparisons, in which the objects to be rated are presented in pairs. Participants are asked to indicate which of the two elements they prefer. Finally, one of the most common methods used in empirical aesthetics is to ask participants to choose a number that represents their degree of preference or liking for each object in the presented set.

As Cupchik (1986) noted, the kind of approach to aesthetic phenomena initiated by Fechner is eminently empirical, quantitative, determinist, and reductionist. This tradition has been criticised from other perspectives precisely because of these biases. The Gestalt psychologists, for instance, noted the extreme limitation of the phenomena addressed by Fechner's approach, as well as the restriction of the methods he applied. Philosophers have often made similar criticisms, related mainly with these methodological restrictions and the fact that cultural and historical aspects are usually left aside. We will further develop these criticisms in subsection 1.2.3.

Despite these limitations, Fechner's work anticipated many of the elements that characterize the motivational and cognitive traditions in modern psychology. He expressed this motivational aspect in the belief that the search for pleasure is an important element in the aesthetic response. He also studied, as we just mentioned, the mental processes that could be associated with aesthetic responses, including the effects of relative similarity, intensity, context, and sequence. Relative similarity between stimuli and their intensity are two important parameters taken into account by modern experimental aesthetics. They are an essential part of Berlyne's model, and, more generally, they are consistent with the widespread approach within the field of addressing aesthetic phenomena through isolated traits or dimensions of experimental stimuli. The effects of context and sequence have been central to the approach of Gestalt psychologists. These factors emphasize the holistic and global perspective of the aesthetic stimuli.

Fechner must also be credited for developing a series of theoretical concepts to account for aesthetic preferences. For instance, his principle of the aesthetic centre states that people will tolerate an intermediate degree of activation more frequently and for a longer time than a very high or very low degree. This leads them to feel neither over-stimulated nor unsatisfied by a lack of stimulation. As we will soon see, this principle was reformulated by Berlyne, and constitutes the explanatory mechanism of his model of aesthetic preference. Fechner's principle of unitary connection suggests that pleasant stimuli must provide an adequate balance between complexity -a multiplicity of fixation points- and order - unitary connection- (Cupchik, 1986). Again, this is another of the pillars of modern experimental aesthetics.

One of the most important questions that have been addressed by experimental aesthetics is how to measure the relation between an object's features and its aesthetic value. The focus of Fechner's initial proposals was almost exclusively based on studies of rectangle proportions. However, this issue was dealt in a novel and revolutionary way during the 1930s.

1.1.2. Birkhoff's aesthetic measure

According to a very old belief, which was reformulated by Fechner, beauty is a function of two distinct factors. One of these is usually associated with such concepts as order, unity, or harmony. The other is usually understood as a synonym of complexity, multiplicity, or diversity. Since the Greek philosophers, most authors have believed beauty to result from the balance of these two factors, a notion expressed in the principle of unity in variety (Boselie & Leeuwenberg, 1985). However, it was George Birkhoff (1932) who first transformed this intuition into a mathematical formula. He proposed a means to compare, in a rational fashion, diverse aesthetic objects. From his perspective, the aesthetic value of an object is given by the relation between its order and its complexity, such that ordered and simple objects, including artworks, have the highest aesthetic measures. He based his formula on the hypothesis that the effort made by someone to attend to a certain configuration grows proportionally to the amount of complexity of the visual details of the object. The measure of the aesthetic value refers to the feeling that reinforces this attentional effort.

Hence, features related with order (O) contribute positively to his aesthetic measure (M), while aspects related with complexity (C) contribute negatively. He supported this formulation with an analogy from economics: any business requires a certain investment and provides a certain benefit. The relation between one and the other determines the success of the business. Likewise, the perception of any object requires an attentional effort, measured by C, which is rewarded by the object's resulting order, measured by O. In this case, the invested effort should also be compensated by the reward. Hence, the best estimation of the aesthetic measure is the relation between order and complexity. This is the reasoning behind Birkhoff's (1932) well-known formula:

$$M = \frac{O}{C}$$

Birkhoff was very specific with his definition of the terms order and complexity for various classes of objects, such as polygonal figures, or vase contours, the rhythmical structure of poetry or musical melodies. Among the elements of order for polygonal figures Birkhoff included vertical symmetry, balance, radial symmetry, relation to a vertical-horizontal grid, and unsatisfactory form (small distances between vertices, angles too close to 0º or 180º and other ambiguities). He defined complexity as the number of independent straight lines that contain all the sides of the polygon. Additionally, he specified a protocol to assign numerical values for each of the elements of order and complexity, and published a series of 90 polygons, each with its M values.

Birkhoff himself did not carry out any rigorous study to contrast the predictions of his model with the ratings made by different groups of participants. However, his formula has been tested by other authors. These efforts yielded contradictory results. For instance, Brighouse (1939) and Meier's (1942) conclusions supported Birkhoff's predicted relation between complexity and order. Conversely, the results of the studies performed by Weber (1927), Beebe-Center and Pratt (1930), Davis (1936) and Eysenck (1942) did not conform to the predicted values. In any case, as noted by McWhinnie (1968), although correlations between scores awarded by participants and the predicted values was usually positive, the truth is that they were considerably low. The broadest study aimed at contrasting Birkhoff's measure was carried out by Eysenck and Castle (1970b), who showed a series of polygons to more that 1100 participants, including art students and people without art education, and asked them to rate their preference for the figures. The correlation of scores awarded by both groups of participants with Birkhoff's M was r = .28 for art students and r = .04 for laypeople.

1.1.3. Eysenck's measure of aesthetic preference

The fact that there was a great deal of variation in the results of studies that had been carried out to determine whether Birkhoff's (1932) aesthetic measure could in actual fact predict the preference of humans for simple polygons, and that most of the correlations were quite low, led Eysenck (1941b) to develop an empirical aesthetic formula. In order to do so he used 64 of Birkhoff's original polygons, trying to include at least one of the different classes and avoiding those that had very obvious associations, such as the swastika or the Jewish star, divided into two equivalent samples. He thereafter asked seven men and seven women, which included artists, students, professionals, teachers and psychologists, to rank the stimuli in each set in order of preference. The rankings for each of the two sets of polygons were correlated subjected to statistical analysis. Two factors were extracted from each table of correlations: a general factor with positive loadings throughout, and a bipolar factor with roughly equal positive and negative loadings. The structure of these factors will be commented in a different section below. Eysenck (1941b) studied the features of the polygons that had strong correlations with the general factor. These included vertical or horizontal symmetry, rotational symmetry, angles close to 90 or 180 degrees, and number of non-parallel sides of the polygon. Using the squares of the correlations as weights in a regression equation, he derived an empirical formula that could predict preference for simple geometrical forms:

$$M = 20x_1 + 24x_2 + 8x_3 + 7x_4 + 5x_5 + 3x_6 + 3x_7 + 2x_8 + 1x_9 - 2x_{10} - 8x_{11} - 15x_{12}$$

In this formula, x_1 is "vertical or horizontal symmetry", x_2 is "rotational symmetry", x_3 is "equilibrium", x_4 is "repetition", x_5 is "compact figure", x_6 is "more than 6 non-parallel sides", x_7 is "both vertical and horizontal symmetry", x_8 is "pointed top and/or base", x_9 is "between three and six non-parallel sides", x_{10}

is “two non-parallel sides”, x_{11} is “re-entrant angles”, x_{12} is “angles close to 90 or 180 degrees” (Eysenck, 1941b).

He tested the accuracy of this formula by correlating the average orders received by the polygons in each of the sets and their expected values given by the formula. This procedure showed that the formula accounted for over 80% of the factors influencing preference judgments for polygons. An additional validation of the formula with different participants and different polygons from Birkhoff's work revealed that, again, 80% of the variance is accounted for by the formula.

The terms in Eysenck's (1941b) formula seemed to be different manifestations of order and complexity. These are the same two principles Gestalt psychologists considered to be the determinants of aesthetic appreciation, as well as the two terms that Birkhoff included in his mathematical measure of aesthetic preference. However, contrary to what Birkhoff had predicted, the terms in Eysenck's (1941b) formula associated with complexity showed positive, and not negative, correlations with liking for polygons. As a first approximation, Eysenck (1942) suggested that the following formula would be a better predictor of human preferences for polygons:

$$M = O \cdot C$$

He also noted that the final formula would probably be much more complicated, because it would have to accommodate different kinds of objects, as well as the relations between the fundamental elements of those objects and the whole. Nevertheless, this represented the first serious effort to quantify the “good Gestalt”. Goodness is thus defined as a combination of order and complexity. But the precise definition of the terms of order and complexity was left for future studies.

Eysenck (1968) addressed this issue by asking 160 male industrial apprentices to rank Birkhoff's 90 polygons, divided in two sets, in order of preference. The comparison of the mean ranking for each polygons and the predictive value using Birkhoff's formula yielded a positive, albeit non-significant correlation. The analysis of the results allowed Eysenck (1968) to ratify the simplification of his original formula (Eysenck, 1941b) to his more manageable prediction of $M = O \cdot C$ (Eysenck 1942) by reducing order elements down to some form of symmetry (vertical, horizontal, rotational), and complexity to the number of sides and the presence of angles other than 90º. Eysenck believed that this conception of order and complexity refers specifically to polygons, and that the specific elements contributing to the order and complexity of other kinds of visual materials should be determined empirically. However, he predicted that the presence of elements of order and complexity would both contribute positively to aesthetic preference in any set of visual stimuli. This prediction was supported by his analysis of the preference ratings for geometrical designs and devices other than polygons (Eysenck, 1968), which suggested that $M = O \cdot C$ was a much better predictor than $M = \frac{O}{C}$

1.2

The study of the determinants of aesthetic preference since the "new experimental aesthetics"

Abstract

In this section we review Berlyne's contribution to the study of the relation between complexity and aesthetic preference. His view is usually summarized as the prediction that preference for intermediately complex stimuli will be greater than for simple or highly complex ones. However, studies that have tested this prediction using non-artistic and artistic stimuli have not always yielded results supporting it. In fact, a great number of them have found a linear relation between complexity and aesthetic preference. We have devoted better part of this section to give an overview of these studies, and to offer a sample of studies that have attempted to clarify the nature of the concept of complexity. We finally review some of the criticisms made to Berlyne's theoretical and methodological approach.

1.2.1. The framework created by Daniel Berlyne

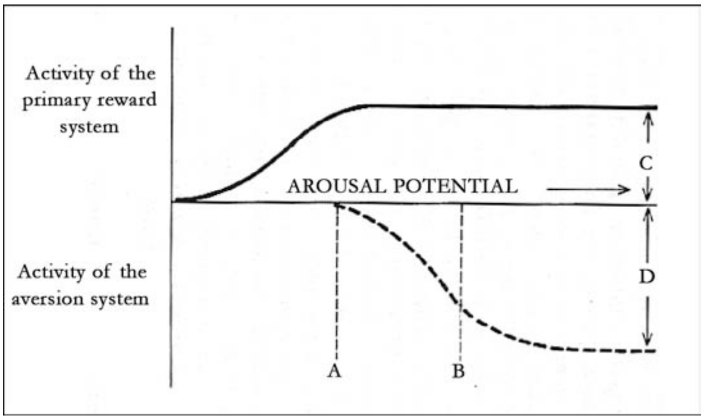
We owe Daniel Berlyne the current framing of most the questions addressed by Fechner. Berlyne is undoubtedly one of the most prominent figures contributing to the revitalization of the study of psychological phenomena related with art and aesthetics. During the 1960s and 1970s, he developed a broad research program, known as Psychobiological Aesthetics, which became the starting point for contemporary experimental aesthetics. Its main objective was to detail a set of hedonic laws that could explain the preference of people, as well as other animals, for certain kinds of stimuli.

Berlyne's work is mainly a theoretical integration of several different perspectives of his time (Konecni, 1978). His efforts were driven by the will to develop an explanation for a broad range of human and animal behaviours in terms of a reduced number of motivational principles. Many authors have considered him as a motivational psychologist because his main interest was to understand why organisms show curiosity and explore their environment, why they seek knowledge and information, and why some of them like looking at paintings and listening to music. He approached these question from the framework constituted by the collative theory of motivation, which focused on the hedonic effects of changes in the organisms' arousal as a result of their exposure to stimuli varying in such features as novelty, complexity, surprise, and so on. These stimulus dimensions were called collative properties because their effects are related with operations that include the comparison of current stimuli with past ones, and the comparison of current stimuli with the expected ones.

His book *Conflict, Arousal and Curiosity*, published in 1960, is usually considered his most important contribution (Konecni, 1978). It is there where he integrated his own work related with exploratory behaviour, arousal, and curiosity, with classical behaviourist approaches. Berlyne (1960) laid down the bases of his motivational theories and anticipated some aspects of its application to art, humour, and intellectual processes, which he developed later. The book is a serious attempt to integrate collative motivation theory, the latest advances in neurophysiology, and the very young information theory. Towards the end of the 1960s his interest shifted to the application of collative motivation to aesthetic phenomena, and in 1971 he published *Aesthetics and Psychobiology*, which had a capital role in the articulation of an empirically-oriented psychology of art (Konecni, 1978). This was followed in 1974 by *Studies in the New Experimental Aesthetics*, a collection of studies carried out by himself and his colleagues that explored different possible applications of motivation theory to aesthetics.

There is no question that Berlyne's work still influences contemporary research in empirical aesthetics and the psychology of art (Jacobsen, 2006). Silvia (2005) wrote that "Modern research on experimental aesthetics still take inspiration from Berlyne's ideas about how collative variables affect arousal, interest, and preference. The influence of the Berlyne tradition may be best seen in the intensity of debates about alternative theories of aesthetic response" (Silvia, 2005, p. 119). Databases afford more of a quantitative assessment. For instance, a search of the ISI Web of Knowledge on may 12th 2007 revealed that, during the last five years, *Aesthetics and Psychobiology* (Berlyne, 1971) has been cited an average 21 times each year in journals with impact factor, *Studies in the New Experimental Aesthetics,* (Berlyne, 1974) has been cited an average 12 times, and his paper *Novelty, complexity, and hedonic value* (Berlyne, 1970), has been cited an average 9 times each year. Hence, it seems clear that Berlyne's work is still highly regarded by researchers publishing in high-profile journals. We now briefly review his model of aesthetic preference, which is the starting point of the present work.

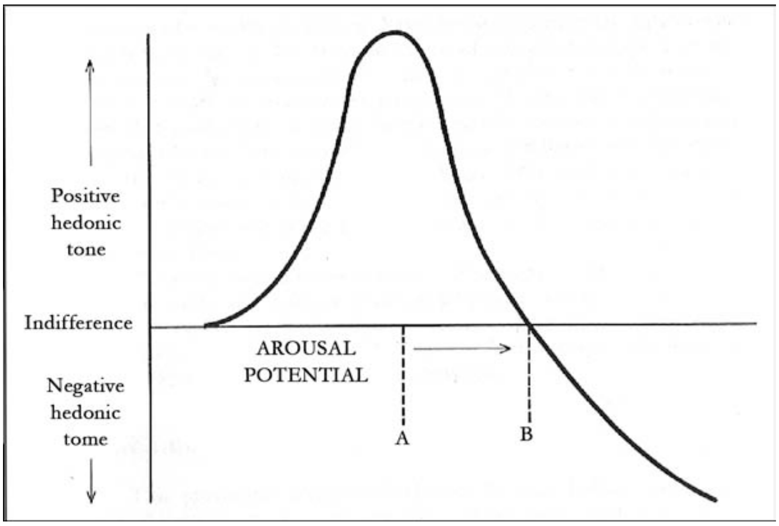
On the grounds of neurobiological findings on motivational and emotional systems Berlyne (1971) argued that the motivational state of an organism is the product of the activity of three neural systems: (i) a primary reward system, (ii) an aversion system, and (iii) a secondary reward system, whose activity inhibits the aversion system. The activity of the three systems depends on the organism's degree of arousal (see figure 1.1), which in turn depends, among other factors, on the configuration of stimuli from the environment. The degree in which a given stimulus can increase arousal is known as arousal potential.



Adapted from Berlyne (1971)

Figure 1.1. Activity of the primary reward and aversion systems as a function of arousal potential

Given that the primary reward system is the most sensitive to the organism's arousal, moderate increases of arousal during a relatively low arousal state are usually pleasant. The aversion system's threshold is somewhat higher (A), such that if arousal continues to grow it becomes active, counteracting the effects of the primary reward system. If the arousal becomes very high, the activity of the aversion system can exceed that of the primary reward system (D>C). For each degree of arousal the resultant hedonic tone can be calculated by means of the algebraic sum of the activity curves of the primary reward and aversion systems. Hence, moderate increases of arousal in a resting organism increase its positive hedonic tone up to a given point, beyond which additional increases in arousal potential do not modify the activity of the primary reward system. At a certain point (A), and because of the initiation of the activity of the aversion system, increases in arousal produce a decrease of the overall hedonic tone. This can even lead to a negative hedonic state if arousal pushes the activity of the aversion system beyond a given threshold that corresponds to the maximum level of activity of the primary reward system (B). This is illustrated in figure 1.2:



Adapted from Berlyne (1971)

Figure 1.2. Resulting hedonic tone as a function of arousal potential

From this point of view, the hedonic tone induced by a stimulus, defined as the capacity to reward an operant response and to generate preference or pleasure expressed through verbal assessments (Berlyne, 1971), depends on the level of arousal that it is capable of eliciting and the organism's current arousal level. Given that organisms tend to search for the optimal hedonic value, they will tend to expose themselves to different stimuli as a function of their arousal potential. Berlyne (1971) noted three classes of variables that determine a given stimulus' arousal potential, mainly through the amount of information transmitted to the organism. These are: (i) psychophysical variables, such as brightness, saturation, predominant wavelength, and so on; (ii) ecological variables, including those elements that might have acquired associations with biologically relevant events or activities; (iii) collative variables, such as novelty, surprise, complexity, ambiguity, or asymmetry.

In relation to aesthetics and art, Berlyne suggested that interest and preference for an image depend primarily on how complex such a stimulus appears to the viewer (Berlyne, 1963; Berlyne, Ogilvie, & Parham, 1968). Perceived complexity, in turn, is related with such factors as the regularity of the pattern, the amount of elements that form the scene, their heterogeneity, or the irregularity of the forms (Berlyne, 1970). Thus, in normal conditions, that is to say, with an intermediate level of arousal, people are expected to prefer intermediately complex artworks over highly complex or very simple ones.

There has been a great amount of subsequent attempts to test the predictions derived from this framework. We next review some of these studies, a number of which have used non-artistic, decorative, or artificially generated stimuli, whereas others have used artistic stimuli. Their contradictory results constitute the grounds for the hypotheses tested in the present work.

1.2.2. Testing Berlyne's hypothesis

1.2.2.1. The use of non-artistic stimuli

As mentioned above, Berlyne (1963) noted that the concept of complexity, as commonly used, included different aspects: the irregularity of the arrangement of elements, the amount of elements, their heterogeneity, the irregularity of the shapes, the degree with which the different elements are perceived as a unit, asymmetry, and incongruence of the elements. In order to determine whether these variables influence exploratory behaviour, the judgments of pleasingness, and the judgments of interest, and to clarify the relation between pleasingness and interest, Berlyne (1963) presented four groups of participants with pairs of slides illustrating the aforementioned dimensions. One of the stimulus in each pair was high in a complexity dimension, while the other was low in the same complexity dimension. The four groups of participants viewed the same slides, though for different time intervals: .5, 1, 3, and 4 seconds. In a first experiment, participants were asked to choose one of the two stimuli in each slide to see again. Results showed that the stimuli participants chose most often to see again were the high complexity ones. This tendency was significantly greater for the two groups of participants with the shorter exposure times than for the two groups of participants with greater exposure times.

In the second experiment, the same stimuli were shown to two different groups of participants. One of the groups was asked to rate the interest of each of the stimuli on a 7-point Likert scale, whereas the second group was asked to rate the pleasingness of the stimuli on the same kind of scale. Highly complex stimuli received higher scores on the interest scale, while low complexity stimuli received the greatest scores on pleasingness.

From both sets of results Berlyne (1963) concluded that the collative properties of the stimuli patterns influenced the level of arousal, independently of the content. Arousal increased with the initial contact with a stimulus, and this increase was driven further by the features that distinguished the least complex patterns from the most complex patterns used in the experiment. Such features as an orderly spatial arrangement of the elements, their coherent grouping, repetition, and redundancy reduce the level arousal and allow a faster recovery. The results of the second experiment suggest that the scores awarded by participants on the interest scales reflect processes related with properties that increase arousal, while scores awarded on the pleasingness scale reflect processes related with arousal reducing properties.

Berlyne (1963) explained these results in accordance with theories of exploratory behaviour. When participants were presented with stimuli for very short intervals, they exhibited a type of exploratory behaviour known as *specific* exploration, which is seen in situations in which there is an increase in arousal because of conflicts arising from the reception of incomplete information. In these cases, arousal is conceived as perceptual curiosity. The continued or repeated exposure to the stimulus that produced this curiosity reduces arousal, with a consequent reinforcing effect, which is proportional to the magnitude of the reduction. Participants who were presented with stimuli for a longer time exhibited a different kind of exploratory behaviour, known as *diversive* exploration. This kind of exploration is not directed towards any particular source of stimulation. It is driven by stimuli with optimal collative properties, independently of the source or the content. Berlyne (1963) argued that most forms of aesthetic behaviour could be considered as instances of *diversive* exploration. Given that long initial exposure times would have afforded participants to satisfy their levels of perceptual curiosity, they should tend to choose the least complex patterns. These were, as described above, the results obtained by Berlyne (1963).

Based on Berlyne's framework, Munsinger and Kessen (1964) carried out a series of experiments to study the relation between preference and complexity of visual stimuli. They predicted that participants would award higher preference scores to intermediately complex stimuli than to very simple or highly complex ones. They noted in their predictions that the perceived complexity of the stimuli depends on features of the stimuli themselves, such as the number of independent turns in a polygon, and on the cognitive structure of the viewer. In fact, they expected that for random shapes, such as those used in their experiments, such features of the stimuli would be the greatest determinants. The authors also predicted that the point of maximal preference could be shifted by changing the features of the stimuli that contributed to its perceived complexity or by helping participants to code the stimuli. In order to test these predictions, the authors created two sets of random shapes to be used as stimuli in their experiments, one of asymmetrical figures and the other of symmetrical ones. They did so using a variation of Attneave's (1957) method. Ten thousand holes were drilled on a $1m^2$ square-shaped board at the intersections of 100 vertical and 100 horizontal lines drawn at 1 cm intervals. Thereafter, points were randomly connected to form a polygon containing a specified number of independent turns, which varied from 3 to 40. The stimuli included in the symmetric set required and additional step. The authors reflected the polygon on a vertical axis had passed through the centre of the board. This did not change the total number of turns in the shape, but it substantially reduced the number of independent turns. The resultant shapes were traced on paper and then photographed for their projection to the participants. To test the hypothesis that participants, 92 men and 44 women, would prefer intermediate levels of complexity they used the asymmetrical shapes, including 12 levels varying from 3 to 40 turns. Results show that preferences of both men and women increased from low scores given to polygons with five turns to a maximum score for polygons with about 10 turns, and then decreased again as the number of turns increased to about 20 (Munsinger & Kessen, 1964).

However, there were two departures from this inverted-U-like trend. Shapes with three and four turns were more preferred than shapes with five turns, and preference seemed to increase with the number of turns for shapes beyond 20 turns. In order to analyse the reasons behind these two departures, the authors designed to additional experiments. First, they hypothesised that the high scores received by the three and four sided shapes were due to the fact that they were easily classified as triangles and quadrilaterals. In order to test this explanation, the authors asked 20 participants to rate their preference for a set of 3-, 4-, and 5-turn regular and random polygons presented in a variety of orientations. Results showed no significant differences between the preferences of the participants for the regular and random three and four sided shapes. However, there were very large differences between preference for the regular and random shapes with five turns. The authors believed that this showed that the departure from the inverted-U-like trend observed for the preference ratings given to shapes with very few sides was, indeed, due to the ease with which 3- and 4-turn shapes are classified as triangles or quadrilaterals, whereas shapes with more turns are not as easily classified (Munsinger & Kessen, 1964).

Second, they wished to verify whether the increasing preference for polygons with more than 20 turns owed to the increasing meaningfulness of the shapes. Forty-eight male participants were asked to judge the meaningfulness of the shapes ranging from 5 to 40 turns used in the previous experiment by indicating the amount of things each of the shapes reminded them of. Results showed that the meaningfulness ratings for the shapes with 25, 31 and 40 was much higher than those given to the intermediate range of shapes. This suggests that the departure from the inverted-U-like trend for the shapes with the most sides is the result of meaningfulness of the shapes reducing the amount of perceived complexity. The authors concluded that the results show that preference for stimuli varying in complexity is determined by the number of independent features of the stimuli and meaningfulness, that is to say, a factor related with the number and variability of the elements, and a factor related with the overall structure of the elements.

Munsinger and Kessen (1964) also wished to assess the impact of symmetry on preference for this kind of stimuli. They constructed asymmetrical figures, varying from eight to 46 turns, according to the method described above and asked 40 female and 8 male participants to rate their preference for these stimuli, as well as the number of ideas or things they remind them of, that is, their meaningfulness. The results of this experiment showed that preference for symmetric random shapes increased monotonically with the number of turns, and that symmetrical shapes were rated much more meaningful than asymmetrical shapes. Thus, perceived complexity was reduced by decreasing the number independent units, and by increasing meaningfulness. Hence, overall, these results show that there is an inverted U-like relation between preference and complexity of random shapes. This trend is disrupted by the ease with which 3- and 4-sided shapes are seen as triangles and quadrilaterals, by the meaningfulness of very complex polygons, and by the reduction of complexity by symmetry (Munsinger & Kessen, 1964).

Day (1967) designed a different study to uncover the relations between perceived complexity, interestingness, and pleasingness at different levels of objective complexity. He used black solid polygons varying in number of sides presented on a white background, which were created by using a similar method to that used by Attneave (1957). In his first study he asked 245 students to rate seven polygons varying from four to 40 sides on one of three dimensions: complexity, interestingness, and pleasingness. A third part of the participants rated subjective complexity, another third rated interest, and the rest rated pleasingness. A paired-comparison method was used, so each possible combination of two polygons was presented to each participant.

Results show that the relation between the number of sides of the polygons and their perceived complexity is an increasing linear one (Day, 1967). However, there were two deviations from linearity: the 6-sided figure seemed less complex than the 4-sided one, and the 40-sided figure was rated as complex as the 28-sided one. The ratings of interest raised up to the 28-sided figure and then dropped slightly, whereas pleasingness ratings showed great fluctuations and a small tendency to decrease with increasing complexity. These two tendencies were interrupted by a very low score awarded to the 20-sided figure. Additional studies were carried out with the intention of clarifying these anomalous instances. They showed that the plateau that had appeared at the 40-side level was a peculiarity of the specific figure used in the first study. When the figure was substituted for another one, and further figures with up to 90 sides were added, ratings for complexity continued to rise monotonically. When the number of sides was increased to 160, results showed that subjective complexity continued to rise with number of sides, whereas interestingness and pleasingness reached a peak at 28 sides and then gradually decreased. On the other hand, when the scores for pleasingness and interestingness were laid over the scores for subjective complexity, interestingness seemed to increase gradually and pleasingness showed an inverted-U pattern, although both trends exhibited great fluctuations, suggesting they were susceptible to factors other than complexity (Day, 1967).

Based on these findings that supported the notion that people reject very complex stimuli in aesthetic preference tasks, Eisenman (1967) carried out a study to assess the relation between complexity and symmetry in determining people's preference for visual stimuli. In order to test the hypothesis of a greater preference for symmetry and rejection of complexity he created a set of twelve geometric figures which varied in symmetry and complexity, measured by the number of vertices of the polygons. In the first part of his experiment Eisenman (1967) asked a group of 58 men and women without formal art training to choose their three most and the three least preferred figures. The results showed that participants mostly preferred symmetric figures to the asymmetric ones.

In the second part of the experiment, for which he recruited 28 different participants, he eliminated the symmetric figures and repeated the procedure with the 9 asymmetric figures. These results showed that most of the high preference scores were awarded to simple and intermediately complex figures. Eisenman (1967) concluded that when people are offered a choice between symmetric and asymmetric figures they tend to choose the former, whereas when they are not given the chance to choose symmetry, they express their preference for simplicity by rejecting complexity. However, we believe that an important limitation of this study is that symmetric and asymmetric figures were taken from different studies, specifically from Birkhoff (1932) and Vanderplas and Garvin (1959), respectively.

These results called for an additional experiment in which the materials included stimuli which varied simultaneously in complexity and symmetry. Eisenman and Gillens (1968) created a slide with four rows of three geometric figures each. Crossing the simple-complex and symmetric-asymmetric dimensions produced four kinds of figures presented in each of the four lines in the slide: complex symmetric, complex asymmetric, simple symmetric, and simple asymmetric. Here, complexity was calculated on the grounds of the number of vertices of the figures: the complex ones had 24 vertices, while the simple ones had 3 or 9. Participants were asked to choose the three figures they preferred the most. Results showed a strong tendency to prefer the complex symmetric figures. This result was unexpected in the light of Eisenman's (1967) previous study, which suggested people had a strong preference for simplicity. Eisenman and Gillens (1968) concluded that symmetry had acted by reducing the complexity introduced by the number of vertices of the figures.

Nicki (1972) carried out a series of experiments aimed to uncover the relations between an objective measure of complexity (uncertainty), arousal, preference, and EEG desychronization. In the first experiment, he asked 120 female students to press one of two switches, which projected two possible stimuli. Participants were divided into six groups. Three of them carried out the procedure wearing earphones that delivered white noise, known to increase arousal, while the other three groups were delivered no sound. Within each of the two sound levels, one group would be shown medium or low complexity visual stimuli (checkerboard-like displays), depending on the switch pressed by the participant. The second group in each sound level would have to choose between medium or high complexity visual stimuli, while the third could choose between seeing stimuli with low or high complexity. Here complexity was defined on the basis of the grain of the checkerboards, which were randomly filled with about 50% of black squares: low complexity stimuli were 2 x 2 checkerboards, medium complexity stimuli were 6 x 6 checkerboards, and high complexity stimuli were 30 x 30 checkerboards. The advantage of using this kind of material is that it allowed a very precise measure of complexity in terms of information. Low, medium and high complexity slides had 4, 36 and 900 bits, respectively. The aim of this first experiment was to ascertain whether arousal level and complexity would influence participants' choice of the stimuli they wished to see. Results showed that participants preferred to view medium rather than high, and medium rather than low complexity stimuli. There was no trend apparent in the choices made by participants offered low or high complexity stimuli. Furthermore, there was no appreciable effect of arousal on the responses of the participants. Nicki (1972) attributed this to the possible inadequacy of the design and of the measure of arousal used in this experiment (GSR). In order to determine whether this was the case, he carried out an additional experiment.

In the second experiment Nicki (1972) asked 60 male and female to look at some of the stimuli used in the previous experiment (10 low, 10 medium, and 10 highly complex images), while their brain activity was recorded by means of an electroencephalograph. Berlyne's model predicted a linear relation between complexity and arousal, specified here as EEG desychronization. However, the results showed that this was not the case. There was an inverted U relation between both variables, with EEG desychronization reaching a peak with intermediate levels of complexity, whereas both low and high complexity stimuli were associated with low EEG desychronization (Nicki, 1972).

Another attempt to clarify the influence of the complexity of visual stimuli on ratings of their pleasingness and interest, as well as the relation between these two scales, was carried out by Aitken (1974). The author created 5 sets of 10 random polygons generated using the procedure described by Attneave (1957), corresponding to 10 levels of complexity. These levels were defined in accordance with the number of sides of the polygons, which varied between 4 and 40. Each complexity level included polygons with 4 more sides than the level immediately below. Participants were asked to order the 10 stimuli in each set from those they found least pleasing to those they found the most pleasing. The procedure was then repeated, but participants were instead asked to order the stimuli based on the interest of the figures. The order in which the sets of stimuli were presented and the task participants performed was counterbalanced.

The results of Aitken's (1974) study suggests that scores on pleasingness and interest increase with complexity to a certain asymptotic limit. Scores on the pleasingness scale reach this limit before the interest scale. However, Aitken (1974) reported that results at the group level masked several particular scoring tendencies in which scores on pleasingness and interest decreased with complexity. Besides this small number of participants, the scores of most of the participants increased monotonically or had an inverted u shape.

On the other hand, the highest scores awarded on the pleasingness scale correspond to stimuli that are less complex than those receiving the highest scores on the interest scale. This finding is compatible with Berlyne's (1966) view that stimuli that are somewhat more complex than those that produce the maximum level of hedonic value can seem interesting because they hold the promise of arousal reduction through their assimilation. There was, however, no support for an inverted U distribution of preference. Additionally, Aitken (1974) made an interesting finding in the interviews carried out after the participants had performed all the tasks. They revealed that the criteria that participants used to order the stimuli according to pleasingness and interest included other aspects in addition to the number of sides. Some of the participants had based their responses on the associations between the polygons and common objects, whereas others based their answers on organizational aspects of the overall aspect of the stimulus, such as how cutting or compact they seemed.

Grounded on the firm conviction that complexity cannot be reduced to a single dimension, Kreitler, Zigler, and Kreitler (1974) drew on Berlyne, Ogilvie, and Parham's (1968) work and attempted to clarify the relations between different forms of complexity and aesthetic preference. Kreitler *et al.* (1974) asked 42 boys and 42 girls between 6 and 8 years old to look at Berlyne's figures (Berlyne, 1963, 1974a, 1974c; Berlyne & Ogilvie, 1974; Berlyne *et al.*, 1968; Berlyne & Peckham, 1966). This set varied in five complexity dimensions: heterogeneity of elements, irregularity of the disposition of the elements, the amount of elements, irregularity of the shape, and incongruence of the juxtaposition of the elements. The authors recorded the time participants spent observing each stimuli and their stated preference for them. Their results revealed no clear relation between any of the complexity dimensions and the two measures of aesthetic preference. In fact, the authors found no differences in the responses given by participants to simple and complex stimuli for most of the pairs, and no prevalent trend when differences did exist (Kreitler *et al.*, 1974).

Building on these authors' strategy, Francès (1976) designed a study intended to clarify the relations between aesthetic preference and complexity, albeit not just one measure of complexity, but several different dimensions. In order to do so he carried out two experiments involving two groups of participants with different educational levels, and materials varying in six different kinds of complexity. These were: number of elements, heterogeneity of elements, regularity and symmetry of the designs, regularity of the disposition of the elements, incongruity, and incongruous juxtaposition. Materials were presented as pairs of designs which varied only in one of these six dimensions. In the first experiment, he asked 36 university students and 36 manual workers to indicate their preferred design in each pair and the one they found most interesting. The second experiment involved the same procedure, but instead of designs, photographs were used. Results of both experiments were identical. They revealed that both groups of participants showed a greater *interest* in the most complex designs. However, whereas students also *preferred* the complex designs, manual workers tended to *prefer* the simple designs. The results of this experiment showed that these forms of complexity were tolerated best, or more preferred by university students than by manual workers, who clearly rejected them (Francès, 1976).

Thomas Jacobsen and Lea Höfel (2002) recently performed a study to verify whether the main structural dimensions of visual stimuli predict ratings on aesthetic preference tasks, as suggested by Berlyne (1970, 1971) and to disentangle the roles of symmetry and complexity in the determination of aesthetic preference. In order to do so, they created graphic material that varied in two dimensions: symmetry and complexity, understood as the number of elements that conform the pattern. Beginning from a fixed pattern with a black circle in which there was an empty square placed like a rhombus, Jacobsen and Höfel (2002) created 252 different stimuli. The different patterns were created within the empty square by means of arranging between 86 and 88 small black triangles. Half of the stimuli were symmetric. The complexity of the stimuli was measured by counting the amount of geometric elements constructed by means of triangle combinations. Fifty-five participants without artistic education, of which 15 were men, were asked to classify each of the stimuli in three categories: beautiful, ugly, and indifferent. Their initial hypothesis was that participants would award higher preference scores to symmetric stimuli than to the asymmetric ones, and that complex stimuli would receive higher preference scores than the simple ones.

Jacobsen and Höfel's (2002) results showed that symmetry was the best predictor of the aesthetic preference of participants, who, overall, tended to classify symmetric stimuli as beautiful more often than asymmetric figures. The complexity of the stimuli was the second predictor of aesthetic preference. Stimuli which were generally classified as beautiful were constituted by more distinct elements than those generally classified as ugly. The authors note, however, that these tendencies are by no means representative of the whole sample. Specifically, symmetry was used as the sole criterion of aesthetic preference by 22 of the participants, 4 of which consistently preferred asymmetric stimuli. Twenty of the participants exclusively based their responses on complexity, 3 of which preferred the simple figures. In light of these results, Jacobsen and Höfel (2002) argued that there are substantial individual differences among aesthetic preference, and that ignoring them by averaging participants' results is to loose a very valuable information, as well as an overestimation of within-group agreement.

Vitz (1966) carried out two experiments to determine whether the preference for certain visual stimuli rises with complexity to a certain point after which it decreases. However, Vitz's (1966) approach to the relation between visual complexity and aesthetic preference differs slightly in posited the causal mechanism. From his point of view, the ease with which perceptual experience can be processed is inversely related to a stimulus' complexity or uncertainty. And given that the processing and organization of stimuli is reinforcing, people are motivated to process stimuli that are close to the maximum limit of our perceptual system.

The two experiments reported by Vitz (1966) were very similar in all aspects, except that he used different kinds of randomly generated geometrical stimuli, and that he used 8 stimuli in the first experiment and 6 in the second. The complexity of each stimulus was calculated based on the ratings by 6 and 5 participants in the first and second experiments, respectively. Participants –fifty six and 48, respectively- were asked to perform two tasks. First, they were required to order the set of stimuli along a dimension of decreasing preference. Second, they were asked to select the stimuli they most preferred in a pairwise comparison presentation. The general results of both experiments are quite similar, so we will comment them jointly. Overall, the simplest and most complex stimuli received lower scores than the intermediately complex stimuli. This was true for the majority of participants –close to 60%-, but there were also other individual preference patterns. Vitz (1966) attributed these deviations from the expected distribution to the influence of variables related with the meaning participants attributed to the stimuli. For some participants these interpretative processes seem to have been more salient than the perceived complexity in the determination of their preference.

Chevrier and Delorme (1980) carried on this exploration of the mediating role of perceptual ability between the complexity of visual stimuli and people's aesthetic preference for them. They designed an experiment aimed at determining whether there is any relation between the level of complexity preferred by participants and their perceptual abilities. This experiment was grounded on the belief that aesthetic preferences are based, at least in part, on the pleasure obtained from the quality in the functioning of perceptual abilities during the viewing of aesthetic stimuli. Aesthetic pleasure would be caused by an easy functioning of perceptual processes, whereas displeasure would be caused by their difficult functioning. At the same time, they took a developmental point of view and examined how this relation changes with age. The participants that took part in this experiment were 40 boys and 40 girls equally distributed in four age groups (average 6, 8, 11, and 14 years old). The authors created five stimuli varying in complexity, created from the same 6 transparent rectangles. The only variable aspect was the number of intersections among them. Aesthetic preference was recorded by means of a paired comparisons ranking procedure. Perceptual ability was measured using an overlapping figures test and an embedded figures test. They both involve the same kind of perceptual difficulty as the aesthetic preference task, that is to say, isolating figures within a complex general structure.

Results showed that participants seemed to use the activity of their perceptual system as a criterion to guide their aesthetic preferences. Chevrier and Delorme (1980) suggested that children felt well when they were able to isolate the figures that composed each stimulus. When the task got harder due to the increase in the number of intersections, that is to say, the increase of the stimulus' complexity, it was only pleasurable for those participants whose perceptual abilities were mature enough to isolate the components of those stimuli. For those participants whose abilities had not developed to that point, elevated complexity levels reduced the task's pleasure and the stimulus was seen as less pleasing. However, there was a great variability in relation to the figure preferred by participants with low perceptual abilities. Chevrier and Delorme (1980) suggested that, given that their capability to manage the complexity of the stimuli, small children base their preference solely on numerousness, and only later will they attend to organizational aspects.

1.2.2.2. The use of artistic stimuli

In this subsection we review studies that have used artistic to test Berlyne's hypothesized relation between aesthetic preference and complexity. As formulated by Berlyne (1971), the predicted inverted U function of aesthetic preference over complexity should hold for artistic stimuli as well as for simple geometric forms and random shapes, as those we reviewed in the previous subsection. As we mentioned before, the challenge with this new kind of stimuli is to adequately control such variables as complexity, familiarity, or style.

One of the earliest attempts was carried out by Wohlwill (1968), whose main objective was to determine whether the influence of complexity on aesthetic preference for artworks is similar to what was reported in similar studies to those we reviewed in the previous subsection. Five judges were asked to rate 48 initial reproductions of landscape paintings on a 1 to 7 scale on five complexity dimensions: colour, form, direction of dominant lines, texture, and natural-artificial. Complexity was defined as the degree of variation on each of the dimensions. The same procedure was followed for a set of abstract art reproductions, except that the natural-artificial dimension was not included. Thereafter, 14 stimuli of each kind were selected, which were pairs belonging to each of the 7 complexity levels. Aesthetic preference was measured by two dependent variables: the amount of voluntary exploration and scores awarded by participants on a semantic judgment scale. The 28 stimuli were first presented to 28 participants by means of a tachistoscope for half a second. Participants were asked to press a button as many times as they wanted to see each of the slides. In the second phase, participants were asked to rate the extent to which they liked each of the slides on a 1 to 7 scale.

Results revealed that, for both landscape and abstract artworks, both preference measures had different relations with complexity. The number of times participant chose to expose themselves to each stimulus grew monotonically with their complexity. Wohlwill (1968) interpreted this as a reflection of the interest elicited by the stimuli, and related this result with Berlyne's specific exploration. Preference scores awarded by participants to the stimuli increase with complexity to a certain extent, after which they decrease somewhat. Wohlwill (1968) suggested that, according to the perspective of diversive exploration, after that point, the effort required to process information reduces the interest, which leads to a decrease in preference.

Osborne and Farley (1970) were also interested in examining the relation between aesthetic preference and the complexity of abstract works of art, as well as the influence of other variables, such as gender, formal art education, and certain personality traits, including extroversion and sensation seeking. Twenty participants, half psychology students and half art students (5 men and 5 women in each group), rated the complexity of 62 reproductions of very well known abstract artworks. Complexity was defined in this study as the way in which the formal elements of line, direction, form, size, colour, tone, and texture, had been used to achieve harmony, contrast, dominance, rhythm, and balance. These ratings were used to create three complexity levels –high, intermediate, and low complexity- with five stimuli in each of them. Thereafter, 15 psychology students and 15 art students (8 male and 7 female participants in each) were asked to assign a high, intermediate, or low aesthetic preference to each of the stimuli.

Osborne and Farley's (1970) results revealed that there were no differences relating to the participants' sex, personality, or training in art. On the other hand, participants tended to assign the highest preference scores to the most complex stimuli. However, the greatest difference appeared between intermediate and low complexity stimuli, with the latter receiving very low preference scores. These results support Eysenck (1941b) and Taylor and Eisenman's (1964) predictions of a linear relation between complexity and aesthetic preference, though given the celebrity of the paintings used as materials, it is difficult to say to what extent subjects' familiarity with the stimuli influenced these results.

Saklofske (1975) asked 30 female infirmary students to rate the complexity of a series of portraits. Based on these ratings the author selected 5 simple stimuli, 5 intermediately complex stimuli, and 5 highly complex ones, such that the average complexity of each level was significantly different from that of the other two. These portraits were then presented to 60 different women, also infirmary students, who were able to view them as long as they wanted to. They were asked to rate their pleasingness, interest and liking for each of the stimuli on a 7-point Likert scale. This experiment's results revealed that complexity has a significant effect on ratings of pleasingness, interest, and liking. Interest scores increased with the complexity of the paintings, whereas scores on liking and pleasingness were significantly greater for intermediately complex stimuli than for simple or highly complex ones. Portraits of intermediate complexity were also those which participants chose to view for a longer time. These results, hence, support

Berlyne's model. They come to show, according to Saklofske (1975), that when people are presented with visual stimuli for a long enough time as to alleviate perceptual curiosity and uncertainty, they seek to extent their exposure to stimuli with an optimal arousal potential –a case of diverse exploration.

In addition to examining the relation between three different measures of complexity, which we will review in the following subsection, Nicki and Moss (1975) carried out a study aimed at clarifying the influence of these measures on three dependent variables related with aesthetic preference. The first of the complexity measures, which the authors named judged complexity, was obtained by averaging the ratings awarded by 12 participants to 30 abstract artworks on four 7-point Likert scales ranging from "little or no variation" to "much variation": colour, form, texture, and direction of the dominant lines. Based on these ratings the authors selected 18 of the original stimuli with the highest degree of agreement among participants and which represented a balanced distribution of complexity. The second complexity measure referred to redundancy. It was calculated with the aid of 24 different participants and the 18 selected stimuli. Participants were presented with the stimuli missing two square regions and they were asked to fill-in the missing areas. Thereafter, five additional participants judged, as a percentage, the accuracy of the participants' responses. The average of the five accuracy ratings for each stimulus was considered as the measure of its redundancy. The third measure of complexity, considered by Nicki and Moss (1975) as subjective complexity, was calculated on the basis of the number of answers given when participants were asked to write down the names of objects they associated with each of the stimuli.

As we just mentioned, aesthetic preference was measured by means of three dependent variables: the number of times participants chose to expose themselves to .5 second presentations of each stimulus, the rating of interest on a 7-point Likert scale, and the rating of liking on a 7-point Likert scale. These tasks were carried out by 12 male and 12 female participants for each of the 18 reproductions of abstract artworks. The results of the analysis of variance revealed that the three complexity measures had significant effects on the three measures of aesthetic preference. In all three cases, there was a linear relation between complexity and aesthetic preference, such that as complexity increased, so did aesthetic preference (Nicki & Moss, 1975). However, in the case of pleasingness, there was also a significant curvilinear relation with the three complexity measures. These results are in general agreement with those obtained by Wohlwill (1968).

Nonetheless, only the linear relation between measures of pleasingness and interest and several complexity indicators was confirmed by a subsequent experiment (Nicki & Gale, 1977). In this case, the authors included a measure of physiologic activity: the abundance of alpha waves in the electroencephalogram. They asked 34 participants (male and female students, housewives, children, and so on) aged between 12 and 46 to view each of the 18 stimuli used in the previous experiment. Stimuli were presented for 27 seconds, with a 3 second interstimuli interval, while electroencephalographic activity was being registered. In a different experimental session, the stimuli were presented again to the participants with the instruction of rating their complexity, liking and interest. As we advanced, their results support an increasing linear relation between complexity and liking and interest. On the other hand, and contrary to Berlyne's model, the abundance of alpha waves showed a decreasing relation with the complexity of the artworks, as measured by means of judged complexity and redundancy (Nicki & Gale, 1977).

Later, Nicki, Lee, and Moss (1981) carried out a series of experiments to determine the influence of ambiguity on aesthetic preference. The materials they used in these experiments were 20 reproductions of cubist artworks by Picasso, Braque, and Gris. A numerical value for ambiguity had been previously obtained from the word associations elicited by the stimuli in 40 students. Ambiguity was high for those stimuli eliciting the greatest variety of associations, and low for those stimuli which were associated with few items. Stimuli were thereafter divided in two sets: low ambiguity and high ambiguity. Subjects were sat in front of the screen and instructed to press the 'view' button if they wanted to see the picture again, which was presented for 1 second, and to press the 'change' button if they wanted to go on to the next image. The aim of this experiment was to ascertain whether participants would prefer to expose themselves to images of low ambiguity or high ambiguity. Results showed that participants pressed the 'view' button more often for the high ambiguity images than the low ambiguity ones, though the difference was not significant. The division of images into more levels of ambiguity yielded no significant effects either (Nicki, Lee, & Moss, 1981).

In the second experiment, 30 male and female students were asked to carry out the same task, only that half of them were asked to guess what the main object depicted in the artwork was. In this case, participants who had to guess chose to expose themselves to each stimulus much more than participants who did not have to guess. This difference was much greater for highly ambiguous stimuli. Specifically, participants who were guessing chose to view highly ambiguous stimuli significantly more than paintings with low ambiguity. In the last experiment, 43 male and 57 female participants were asked to rate the interest and pleasingness of the 20 stimuli. Results show that low ambiguity images were rated as more pleasing and interesting than the highly ambiguous artworks. Nicki and colleagues (1981) believe that the lack of an inverted U function of the verbal ratings over ambiguity owes to the fact that images of extremely low ambiguity were not included in the materials, and they speculate that doing so might have produced low interest and pleasingness ratings for these barely ambiguous stimuli, rendering a possible preference peak for the intermediate ambiguity stimuli (the ones they referred to as low ambiguity artworks in their actual experiments).

Farley and Weinstock (1980) conducted an experiment to study the influence of complexity on children's aesthetic preferences. They divided the sample of 18 girls and 21 boys –aged around 8- into four groups. Each group was asked to carry out a different task: rating the complexity of original woodcuts, rating their liking for original woodcuts, rating the complexity of photographs of the woodcuts, rating their liking for photographs of the woodcuts. Results revealed that greater preferences scores were awarded to stimuli of intermediate complexity, for original works as well as their photographs. Very complex and very simple originals and reproductions received lower scores (Farley & Weinstock, 1980).

Neperud and Marschalek (1988) conducted an experiment aimed at assessing the influence of amount of information contained in an artwork and aesthetic preference for it. Materials included two unaltered early 20th century black and white artworks by Pankok and Gris, as well as two modified versions of each obtained by removing different amounts of elements (black lines and shapes). The authors asked 26 college students with no formal art training or experience to rate the six stimuli on a semantic differential including the following adjective pairs: pleasing-annoying, beautiful-ugly, weak-strong, powerful-powerless, active-passive, noisy-quiet. The first two scales represented the evaluative dimension, and were equated with hedonic value, the third and fourth scales represented the potency dimension and were interpreted as measures of arousal, and the final two scales represent the activity dimension, and were considered as measures of uncertainty. Additional adjective pairs included complex-simple, dense-sparse, cohesive-diffuse, and pleasant-unpleasant.

Results revealed that, with the exception of the cohesion scale, scores on all other variables were influenced by the information levels created by the alterations to the original artworks (Neperud & Marschalek, 1988). Specifically, a linear relation was found between arousal (potency scales) and level of information. Ratings for the two higher information levels on uncertainty was higher than for the modified versions of lower information level. Scores on the evaluative scales were higher for the two modified versions (low and intermediate information levels) than for the unaltered (high information level). Finally, preference ratings were greatest for low levels of uncertainty and equally low for the unaltered and the intermediate information level (Neperud & Marschalek, 1988). Thus, these results provide very limited support for Berlyne's general framework. Although measures of arousal did consistently grow with the amount of information, preference ratings seem to decrease with stimuli density. One possible explanation for the failure to support Berlyne's expected inverted U distribution of preference is that the removal of structural elements, such as lines and shapes, might have increased semantic uncertainty. If this assumption is true, Neperud and Marschalek's (1988) attempt to manipulate one complexity factor by reducing the amount of elements resulted in the inadvertent modification of another: the increase of unintelligibility of the overall painting.

Krupinski and Locher (1988) aimed to clarify the relation between complexity, arousal, and aesthetic judgment. The aspect of complexity they focused on was symmetry. Their materials included 15 unaltered non-representational artworks by Vasarely, Rothko, Braque, Matisse, Mondrian, Kandinsky, and so on, as well as 4 similar artworks by Hoffman, Duchamp, Klee, and Pollock that had been subjected to two modifications by applying two symmetrical transformations: reflecting one half of the picture to create a representation with perfect vertical symmetry, and then, subjecting this version to a further horizontal symmetry transformation. Thus, from each of these four originals two altered versions were created, one by means of a single symmetry transformation, and the other by means of a double symmetry transformation. The non-redundant elements contained by the symmetrical versions were fewer and less varied than the originals, though the authors felt that rather than variety, it was the reduction in overall elements that contributed to the reduction in complexity of the altered versions. Eight female and 5 male participants were asked to examine each painting carefully and to rate it for inclusion in an art show from 1 (definitively not to be included in the show) to 5 (definitively to be included in the show), based on composition, complexity, and creativity. Skin conductance levels were measured while participants carried out this task

The results of Krupinski and Locher's (1988) experiment revealed significant differences in the skin conductance levels when participants were viewing the unaltered reproductions, the single-axis symmetry versions, and the double-axis versions. Contrasts suggested that the arousal induced by unaltered artworks, this is, the most complex stimuli, was greater than that induced by versions produced by the single symmetry transformation, with intermediate complexity, and that these induced more arousal than the double-symmetry versions. On the other hand, the ratings made by the participants also followed this trend. Ratings were significantly greater for the unaltered than for the two kinds of transformations, and ratings for the single symmetry versions were greater than for the double symmetry versions. Krupinski and Locher (1988) interpreted these results as a support for Berlyne's model, in spite of the fact that their results showed preference to be a linear function of arousal and complexity. They believe their stimuli represent only a low to intermediate range of complexity, and thus, their results would only reflect the ascending trend of Berlyne's predicted inverted U relation between complexity/arousal and preference (Krupinski & Locher, 1988).

Messinger (1998) carried out an experiment to determine the relations between perceived complexity, pleasure and interest in artworks. The author asked 92 participants to view 6 paintings varying in era (ranging from the fourteen-hundreds to the nineteen fifties), style, and genre, by Hans Memling (*The Annunciation*), George Tooker (*The subway*), Diego Rivera (*Zapata, the Peasant Leader*), Pablo Picasso (*Les Demoiselles d'Avignon*), Georges de la Tour (*The Fortune Teller*), and Salvador Dalí (*The Persistence of Memory*). Additionally, participants were asked to fill out a semantic differential adapted from Berlyne's (1974) work that measured perceived complexity, pleasure, and interest. Messinger's (1998) results showed an inverted U function of pleasure over interest. However, there was no appreciable relationship whatsoever between perceived complexity and pleasure. The author suggested that these results might be due to the fact that the ratings of complexity might actually reflect an inability to process the material, and not the process that was taking place, and concluded that interest might be a better measure of involvement with the stimuli. However, besides the small number of stimuli, we believe that the absence of a relation between complexity and pleasure is due to the interference of a variable the author did not take into account: the familiarity with the materials included in this study, a necessary precaution pointed out by Eysenck (1940) and Berlyne (1970, 1971) himself. Most of the works (Messinger, 1998) included are by authors with a very conspicuous style, and, furthermore, the particular artworks are probably among their best known productions.

More recent studies that have assessed the relation between aesthetic preference and complexity have been carried out in applied settings, such as architecture or landscape design. For instance, Imamoglu (2000) carried out an experiment designed to test Berlyne's (1971) prediction of an inverted U function of preference over complexity in the realm of architecture. The author produced two series of drawings of facades of two-storey buildings which varied from the very simple to the very complex. One series represented traditional Turkish façades, while the other represented modern facades. The simplest items in each set render only the most basic elements of the façades, such as the windows, windowsills, and chimneys. Complexity was increased by adding additional elements, such as shutters, wooden lining, and different degrees of tiling detail. Fifteen male and 19 female architect students, and 21 male and 17 female students without architectural or artistic training were asked to rate each stimulus, in addition to five buffer items which were not taken into account for the analysis, on a series of 7-point scales. These included three scales to measure preference (beautiful-ugly, pleasant-unpleasant, like-did not like), two measuring complexity (simple-complex, plain-ornate) and one to assess familiarity (familiar-unfamiliar).

With regards to the ratings on complexity, scores were collapsed into three complexity levels. Imamoglu's (2000) results showed that the ratings of all groups of participants followed a linear relation with the level of complexity, that is, they rated the highly complex façades as more complex than the intermediate ones, and these as more complex than the simple ones. This was true for both styles of houses (traditional and modern). Regarding the preference ratings, the combined measure of the three scales was greater for the intermediately complex houses than for the highly complex or very simple ones. This was true for men and women, and architecture students and other students, as well as for modern and traditional façades (Imamoglu, 2000). This result clearly supports Berlyne's prediction of an inverted U function of preference across levels of complexity.

Nasar (2002) designed a study to assess the influence of factors such as complexity, order, historical significance, and prototypicality on preferences for presidential libraries. The author selected six colour photographs of different buildings from a large sample, two of which had conspicuous historical elements, such as arches, ornaments and a roof typical of older buildings. The stimuli represented several architectural styles and their size were just about right to pass as a presidential library. Before the main study was carried out, the author asked eight graduate students in city planning to judge the complexity, order, prototypicality, and historical significance of the six buildings. The analysis of their responses indicated a high reliability of the scales. In the main experiment, 130 participants were included, varying in political views, education, and occupation. There were just about the same amount of men and women, and they were all interviewed in their homes. Half of them were asked to pick the building they liked most and then the one they liked least. For the other half this order was reversed. Thereafter, they were all asked to rate how attractive, expensive, public, complex, ordered, and impressive they felt each of the buildings was on a 7-point scale.

The analysis of the data collected by Nasar (2002) revealed that two factors accounted for a large portion of the variance. The first one received high loadings from attractive, expensive, impressive, and public, while the second factor received high loadings only from complexity. The analysis of the relation between attractiveness and complexity revealed that people had tended to rate intermediately complex buildings as the most attractive, and that they had rated simple and highly complex buildings as less attractive. On the other hand, there was a surprising result concerning the relation between attractiveness and order. The most attractive buildings had received an intermediate score for order, while the most orderly and disorderly buildings had both received low attractiveness ratings. This result is contrary to views that preference is a linear function of order (Birkhoff, 1932; Eysenck, 1942). Nasar (2002) concluded that these results support Berlyne's prediction concerning the relation between preference and complexity, and suggested that the unexpected result for order might be due to participants confounding order with simplicity. However, we believe the confounding effect might already be present in the stimuli, given that order and complexity were not manipulated independently of each other. Another of the limitations of Nasar's (2002) study is that materials were not controlled for factors such as shades, size of the building in relation to the photograph, perspective, amount of the building appearing in the photograph, and other features of the surroundings, such as vegetation or fountains. Because these aspects have not been controlled, the extent to which participants responded to features of the buildings themselves, or the photographs, is uncertain.

However, other studies of preference for architectural designs within Berlyne's framework have failed to produce the expected inverted U distribution of preference over complexity. Heath, Smith and Lim (2000) also framed their research into architectural aesthetics within Berlyne's framework. Their main objective was to study the impact of skyline complexity on aesthetic preference. They considered two dimensions of the skyline complexity, one related with the building silhouette, and the other with the articulation of the building surface, or the façade detail. Given that photographs of skylines of actual cities presented many disadvantages, such as difficulty to control many variables or their familiarity, the materials used in this study were designed and constructed by the authors according to the two dimensions of complexity they considered. Heath and colleagues (2000) generated nine monochrome images based on a common scene of several tall buildings rising above a common baseline of low waterfront buildings. The generated stimuli varied in three levels of each of the two complexity dimensions. Before the main study was performed, the authors made sure that perceived complexity as rated by a test group correlated highly with the objective levels of complexity. Thereafter, Heath and colleagues (2000) asked 32 women and 28 men, all psychology students, to look at the set of nine images and complete an affect grid with the two crossing dimensions of arousal and pleasure. Additionally, half of the participants were asked to rate the images' complexity (after having been instructed to attend the complexity of the silhouette and the façades) and the other half to rate their preference for each of the stimulus.

Results revealed a significant effect of silhouette complexity and façade complexity on perceived complexity. Highly complex silhouettes were rated as more complex than the simpler silhouettes, and highly and intermediately complex façades were rated as more complex than the simpler façades. There were also significant effects of silhouette, but not façade, complexity on preference ratings. Highly complex silhouettes were more preferred than intermediate or simple silhouettes. Arousal and pleasure also showed this monotonic increasing relation with complexity levels of silhouette, but not façade. Heath *et al.* (2000) concluded that, concerning distant views of skylines, architects should work on silhouette development rather than the façade in order to generate acceptance for the buildings, and that increasing silhouette complexity would lead to greater positive attitudes. The authors acknowledge that these conclusions are limited by several factors, including their non-applicability to close views. But there is an additional limitation which is more interesting to our purposes. It concerns the stimuli used in this study. Inspection of this material suggests that, as noted by Heath *et al.* (2000), the range of complexity is rather limited. Expanding the upper range, as well as increasing the differences between complexity levels, might reveal a decrease in preference ratings, producing the inverted U distribution.

Stamps (2002) designed a study with the purpose of clarifying the relations between the entropy of visual stimuli and ratings for pleasure and diversity. Results were intended to add to the field architectural aesthetics and contribute to its regulation. An important aspect of this study was the use of entropy as an independent variable. The concept of entropy, developed initially as a measure of physical disorder, was redefined by information theoreticians as a measure of information disorder. His design addressed to main issues: whether visual entropy is a good predictor of subjective ratings of visual diversity, and whether preference is an inverted U-like function of visual entropy. Thirty female and 27 male participants were asked to view a series of scenes portraying a line of houses and rate each scene on two semantic differentials: pleasant-unpleasant and uniform-diverse. The scenes were all composed of 7 aligned houses, and varied in the amount of colours, the variation in the size of the houses, and the variation in the shape of the houses. The resultant measure of entropy ranged from 0.0 bits for the scene with houses the same colour, size, and shape, to 5.6 bits, for the scene with all houses different in colour, size and shape.

Stamps' (2002) results revealed that the data relating entropy and preference, as well as entropy and rated diversity, could be best accommodated by either a linear or asymptotic function. Hence, entropy as defined in this study seems to be a good predictor of rated diversity. The author suggests that these results support building policies that depart from total uniformity towards greater amounts of diversity. On the other hand, there was no support for an inverted U relation between preference and entropy. This is interpreted by Stamps (2002) as the result of using stimuli with low entropy measures, and suggests the possibility that the use of stimuli with greater entropy might produce the expected inverted U function. There are three reasons why we believe this might not be the case. First, if entropy is a measure of disorder, Berlyne's (1971) predictions do not necessarily apply, because complexity is not just random chaos (Sambrook & Whiten, 1997). Second, the expected inverted U distribution of preference was posited to be a function of subjective or perceived complexity, not an objective measure of information. Third, variety is only one form of increasing complexity. When Berlyne (1963) developed his model he referred to other additional forms of complexity, such as the irregularity of arrangement, or the amount of elements, to name only two. These factors were kept constant in Stamps' (2002) experiment, which precludes clarifying whether other forms of complexity, or any combination of them, could have produced the expected distribution

1.2.3. The concept of complexity and its measure

In this section we will review the ways in which the concept of complexity has been defined and used to test Berlyne's predicted relation between complexity and aesthetic preference. A general review of the development of the study of visual complexity throughout the 20th century from Gestalt psychologists to current approaches was provided by Donderi (2006), which complemented by Sambrook & Whiten's (1997) thoughtful conceptual discussion on complexity and its role in cognitive and behavioural sciences. These general issues will not be repeated here, given that our focus is much narrower.

1.2.3.1. The relation between objective and subjective complexity

Berlyne (1971) explicitly asserted that the hedonic value of a stimulus was not directly determined by objective complexity features, but by subjective complexity. The latter is undoubtedly related with the former (Attneave, 1957; Chipman, 1977; Chipman & Mendelson, 1979; Hall, 1969), in that it varies, to a certain extent, with such aspects as the number of elements or the redundancy in visual stimuli. However, the complexity perceived by each individual depends on the way he or she perceptually organizes the scene:

> The collative variables are actually subjective, in the sense that they depend on the relations between physical and statistical properties of stimulus objects and processes within the organism. A pattern can be more novel, complex, or ambiguous for one person than for another or, for the same person, at one time than at another. Nevertheless, many experiments, using rating scales and other techniques, have confirmed that collative properties and subjective informational variables tend, as one would expect, to vary concomitantly with the corresponding objective measures of classical information theory (Berlyne, 1974b, p.19).

Other contemporary researchers realized the importance of distinguishing objective from subjective measures of complexity. Heckhausen (1964), for instance, argued that the attempts to relate complexity, as conceived from information theory and based on elemental aspects of the stimulus, such as the number, size, or location of the elements, and aesthetic preference are inherently flawed. Heckhausen (1964) stated that the behaviour of experimental participants, and people in general, does not depend on the complexity of the stimulus itself, but the way complexity is perceived: "Only what is perceived –the perceptual object- can have activating or motivating effects upon behaviour" (Heckhausen, 1964, p. 168). He suggested that instead of considering the smallest isolatable elements, researchers should focus on "natural parts", that is to say, those that encompass elements as they are perceived, as observed, for instance, in the relations between figure and ground. Additionally, the informational content of an image would also contain the different relations between these "natural parts", which is to say, the grouping of parts into sets. Unexpected and surprising reorganizations can result from these phenomenal processes. Heckhausen (1964) believed that what was required was a multidimensional phenomenology of complexity.

Recent experimental studies have actually demonstrated that subjective complexity, as Berlyne (1971) had argued, does not only depend on the amount of elements, or their heterogeneity. It also depends on how people organize those elements to form a coherent scene (Hogeboom & van Leeuwen, 1997; Strother & Kubovy, 2003). This process of construction of a global and meaningful scene based on the interaction of different perceptual elements, such as lines, angles, or surfaces, is known as perceptual organization.

Phenomena related with perceptual organization were initially studied by Gestalt psychologists, who concluded that the overall organization of the scene is not reducible to the combination of its parts. They proposed a series of principles that were thought to promote the performance of different cognitive operations, such as figure-ground segregation and grouping, which would contribute to perceptual organization. Some of these proposals include the principles of proximity, similarity, common destiny, orientation, continuity, closure, common region, or connectivity. Additionally, a general guiding principle was posited, known as the principle of figural goodness. This principle maintains that "out of all possible organizations for a given stimulus, the simplest will be perceived, that which minimizes its complexity" (Crespo León, 1999). This simplest organization is known as *good form*. Later studies have revealed some interesting details about perceptual organization, such as the fact that it cannot be explained in virtue of a single discrete processing stage. Instead, as suggested by results from psychological studies (Palmer, Brooks, & Nelson, 2003), neuroimaging experiments (Altmann & Bülthoff, 2003; Murray, Schrater, & Kersten, 2004), and neuropsychological tests (Behrmann & Kimchi, 2003), the assembling of distinct elements into an organized scene occurs at different levels of perceptual processing.

Not many studies have addressed questions related with perceptual organization using artworks. The closest approximation is the work of Paul Locher (2003a; 2003b; 2004; Locher, Smith, & Smith, 2001), who has developed several procedures to study the influence of such features as balance and the disposition of the elements on the perception of works of art. However, the question of how the processes postulated by Gestalt psychologists lead to perceptual organization has not been directly addressed from this perspective. For instance, the possible differential role of the different Gestalt principles on the perceptual organization of abstract and representational artworks has not been explored.

Most of the studies that have explored phenomena related with perceptual organization in the last fifty years have taken the principle of figural goodness as the starting point. The main difficulty they have found lies in the absence of a clear and non-circular definition of terms such as *simple* or *complex*, given that, as we mentioned above, the properties that make a stimulus simple or complex do not completely reside in that stimulus (Pomerantz & Kubovy, 1981). The definition of good form has also been a source of discussion. For instance, Garner (1970) defined it as that organization of elements that offers the least alternatives of perception. Attneave (1981) has conceived it as the most economic form in terms of information required to describe the stimulus. Palmer (1982, 1991) has argued that the good form is that organization which remains invariant in spite of the different transformations to which it may be subjected.

Given that the present study is concerned with the influence of complexity on aesthetic preference, we can leave the debates surrounding the most adequate way in which to conceive figural goodness to one side. However, we do need to review how prior studies have conceived and measured *complexity* and *simplicity*. We explore this question in the remainder of this section, and we will deal with aesthetic preference and the cognitive and affective processes it involves further below.

Within a broad effort to explore the applications of information theory in psychology, Attneave (1957) explored the relation between different physical attributes of non-representational figures and subjective judgments people made about their complexity. He constructed a series of figures by randomly joining different marks in several matrices. He used matrices formed by 8, 16, 32, and 64 marks. In addition to this variable, which he referred to as the grain of the matrices, he included others, such as the curvature, symmetry, or the number of turns (vertices or curves). His results showed that close to 80% of the variance of people's judgments of the complexity a given polygon was explained by its number of turns. Conversely, the remaining variables hardly had any predictive value of the subjective judgments of complexity.

In addition to revealing that the number of vertices of a non-representational figure determines to a great extent the complexity people attribute to that figure, Attneave's (1957) study is of great importance to the present work for pointing out that the judgment of the complexity of a visual stimulus is not completely determined by the amount of information contained in it. This is illustrated by two findings. First, although figures constructed from matrices with 64 marks contain a greater amount of information than those constructed from matrices with 8 marks, this variable had no appreciable influence on complexity judgments. Second, the kind of turn had also no effect on complexity ratings. This is true despite the fact that in order to create a vertex of α degrees only two numbers are required to place it in a bidimensional space, whereas the creation of a curve of α degrees, in addition to the spatial coordinates, requires a measure of the curvature radius. Hence, curved turns contain more information that vertices, but the complexity of curved, angular, and mixed figures was rated very similarly. These findings led the author to conclude that "the amount of information contained in a stimulus (from the experimenter's point of view) may be varied greatly without changing the apparent complexity of the stimulus" (Attneave, 1957, p. 225).

Berlyne, Ogilvie and Parham (1968) carried out another study to attempt to clarify the conceptual structure of complexity ratings. They created stimuli varying in several objective measures of complexity and designed a study to assess the way in which each of these variables contributed to subjective judgments of complexity. Twenty participants were presented with 16 figures varying in the following complexity dimensions: irregularity of the disposition of the elements, amount of elements, their heterogeneity, irregularity of the shapes, degree with which the different elements were perceived as a unity, asymmetry, and incongruence. Their results revealed that two factors explained most of the variance. The first factor was the number of independent elements. This dimension accounts for between 70 and 90% of the variance (Berlyne *et al.*, 1968). The second factor was more difficult to conceptualize, but the authors defined it as unity versus articulation of easily recognizable parts.

Hall's (1969) attempt to validate physical variables related with geometrical figures as measures of subjective complexity was the first to examine the role of colour. He created 30 random geometrical figures that varied in the number of segments used to construct them, from 4 to 20. Ten female participants were asked to rate the "visual complexity" of each of the figures, and ten other women were asked to perform the same task with the same stimuli whose lines had been coloured with different pairs of colours. The results showed that colours did not represent an important factor in the complexity judgments. On the other hand, the author found that the correlation between the complexity ratings awarded by the participants to the stimuli and the number of intersections of the segments was very high (.98), as was the correlation between the ratings and the number of vertices of the contour (.85) (Hall, 1969).

Nicki (1972) carried out a series of experiments aimed to uncover the relations between an objective measure of complexity, arousal, preference, and EEG desychronization, and subjective complexity. The results concerning the relation between complexity, arousal, and preference were commented in the previous section. Here we will concentrate on the results that bear on the relation between objective and subjective complexity. Let us recall that Nicki (1972) defined complexity on the basis of the grain of the checkerboards, which were randomly filled with about 50% of black squares: low complexity stimuli were 2 x 2 checkerboards, medium complexity stimuli were 6 x 6 checkerboards, and high complexity stimuli were 30 x 30 checkerboards. The advantage of using this kind of material is that it allowed a very precise measure of complexity in terms of information. Low, medium and high complexity slides had 4, 36 and 900 bits, respectively. Conversely, subjective complexity was measured by the number of free associations elicited by a pattern and the strength of those associations. Thirty-six male and female participants were asked to look and 30 checkerboard-like patterns (10 low, 10 medium, and 10 high in complexity) and to say all the names of things he or she was reminded of. Thereafter, participants were asked to rate the strength of those associations. Results showed a U-shaped relation between objective and subjective complexity, with 4- and 900-bit images eliciting the greatest amount and strongest associations, while 36-bit images received the lowest subjective complexity scores (Nicki, 1972).

1.2.3.2. Visual complexity: a multidimensional concept

Most of the studies exploring the relation between complexity and aesthetic preference that we reviewed in the previous section created a set of materials by manipulating only one aspect of the visual stimuli, such as the number of polygon sides or symmetry (Aitken, 1974; Day, 1967; Eisenman, 1967; Eisenman & Gillens, 1968; Imamoglu, 2000; Jacobsen & Höfel, 2002; Krupinski & Locher, 1988; Munsinger & Kessen, 1964; Nicki, 1972). Others quantified the complexity of their stimuli by asking participants to rate them on a general complexity scale (Farley & Weinstock, 1980; Messinger, 1998; Nasar, 2002; Saklofske, 1975). Yet others gathered ratings from participants on different dimensions of complexity and then collapsed them into a single measure (Osborne & Farley, 1970; Stamps, 2002; Wohlwill, 1968). However, there is reason to believe that not all aspects of a visual stimulus, such as number of elements, variety of colours, asymmetry, and so forth, contribute equally to subjective complexity. Hence, general ratings of complexity, might mask the effects of different contributing features.

Rump (1968) empirically examined the assumption that different aspects of visual complexity are intercorrelated. He compared people's preference for stimuli varying in asymmetry, multiplicity, and heterogeneity, using different materials for each test, designed to vary in only one of the dimensions. He registered the preference scores awarded to the stimuli by 66 women and 45 men and found that there was no correlation between the three scores. That is, people that preferred asymmetrical figures did not necessarily prefer pictures with many elements, nor figures with different elements. The author interpreted these results as an indication that a general concept of complexity is meaningless. Instead, researchers should specify the specific dimension of complexity manipulated in the study. Moreover, Rump (1968) suggested that people's assessment of the complexity of an image may differ depending on the feature they focus on primarily.

Kreitler, Zigler and Kreitler (1974) were very critical with previous attempts to measure visual complexity in terms of a single dimension reflecting uncertainty. They pointed three main inadequacies of these attempts, some of which are still applicable to the current state of the matter. In the first place, researchers have not agreed on the single adequate measure to reflect the complexity of visual patterns. This point was also emphasized by Siebold (1972) when comparing his results with those from previous studies:

> Since no clear definition of complexity (applicable to all the stimuli in question) is presently available, the relative complexity levels of the stimuli employed by Berlyne and those used in the present study cannot be assessed. It seems, therefore, that until a general means of scaling complexity is devised, no definitive statement regarding the relationship of preference to stimulus complexity and familiarity can be made (Siebold, 1972, p. 263).

Second, Kreitler, Zigler and Kreitler (1974) argued that despite efforts to design patterns to vary along certain measure of complexity, they often end up varying on other features that may affect several dependent measures, such as preference ratings or exploration time, which was also noted by Long and Wurst (1984). Third, it has been shown that complexity judgments performed by participants in different experiments correspond to several features of the stimuli and not to a single dimension (Attneave, 1957; Berlyne et al., 1968; Day, 1967).

In view of these issues, Kreitler, Zigler, and Kreitler (1974) argued that visual complexity is best conceived as a multidimensional concept. In order to begin characterizing the structure of this concept they designed a study which picked up on the work carried out by Berlyne and colleagues (1968). They asked 42 boys and 42 girls between 6 and 8 years old to look at Berlyne's figures (Berlyne, 1963, 1974a, 1974c; Berlyne & Ogilvie, 1974; Berlyne *et al.*, 1968; Berlyne & Peckham, 1966). This set varied in five complexity dimensions: heterogeneity of elements, irregularity of the disposition of the elements, the amount of elements, irregularity of the shape, and incongruence of the juxtaposition of the elements. Two measures of preference were recorded: looking time and numerical rating.

The analysis of their results led Kreitler and colleagues (1974) to conclude that the stimuli, which had been designed to reflect variation in a certain complexity dimension, varied in other features which had a serious impact on the dependent variables. These other features most often referred to the global structure of the stimulus, mainly its organization. They argued that a stimulus which facilitates the organization of its meaning and its forms into an overall structure can be rated as simpler than a stimulus with fewer elements, or more homogeneous, but which are harder to integrate or organize into a coherent whole. Hence, the first great implication of this study was the need to revise the concept of complexity to reflect the degree of organization of the stimuli's patterns. Another important implication derived from the finding that the relations between the five complexity dimensions that were taken into account in this study were very low. Kreitler and colleagues (1974) suggested this could be evidence that the dimensions could refer to very different aspects of the stimuli, some of which, or even all, could be unrelated to complexity as defined in previous studies. Another possibility suggested by the authors is that the five dimensions are related with five complementary, but different, aspects of complexity. If this were finally the case, the authors argue that subsequent studies need to separately take into account the five dimensions, and not in combination.

Most of the subsequent studies that addressed the question of the relation between objective and subjective measures of complexity did in actual fact consider the multidimensional nature of complexity. However, there is a wide variation in the procedures, materials, and participants they selected to explore this relation and the specific dimensions they studied.

For instance, Nicki and Moss (1975) examined the relation between three different measures of the visual complexity of abstract works of art and the effects that each of them had on the time participants need to reconstruct puzzles representing those paintings. The first of the complexity measures, which the authors named judged complexity, was obtained by averaging the ratings awarded by 12 participants to 30 abstract artworks on four 7-point Likert scales ranging from "little or no variation" to "much variation": colour, form, texture, and direction of the dominant lines. Based on these ratings the authors selected 18 of the original stimuli with the highest degree of agreement among participants and which represented a balanced distribution of complexity. The second complexity measure referred to redundancy. It was calculated with the aid of 24 different participants and the 18 selected stimuli. Participants were presented with the stimuli missing two square regions and they were asked to fill-in the missing areas. Thereafer, five additional participants judged, as a percentage, the accuracy of the participants' responses. The average of the five accuracy ratings for each stimulus was considered as the measure of its redundancy. The third measure of complexity, what the authors considered as subjective complexity was calculated on the basis of the number of answers given when participants were asked to write down the names of objects they associated with each of the stimuli. In a second part of the experiment the authors presented the stimuli in the form of puzzles to 24 new participants and measured the time they took to complete them.

Results showed there was a significant positive correlation between the stimuli's judged complexity and subjective complexity. Redundancy correlated significantly, though negatively, with the other two measures of complexity. Regarding the effects of the different measures of complexity on the time participants took to make the puzzles, results showed that the three measures had significant effects. However, whereas completion time was linearly related with redundancy and judged complexity, there was a curvilinear relation between time and subjective complexity. Specifically, the puzzles of intermediate complexity artworks took participants longer to make than puzzles of low complexity (those which reminded of few objects) and those of high complexity (that had received many associations). Nicki and Moss (1975) suggested these results indicated the existence of two complexity factors: a perceptual kind, related with the number and variety of elements, and a cognitive kind of complexity, related with the amount of associations or cognitive tags elicited by visual stimuli.

Chipman (1977) adopted quite a different approach to the same issue. In a series of seven experiments she explored the determinants of the perceived complexity of visual patterns. The materials she used in all the experiments was composed by a series of 45 stimuli from a 6 x 6 black and white square matrix. Each stimulus contained 12 black squares. Some of the stimuli were randomly created, whereas other were created by the author by arranging the black squares to form a variety of patterns and symmetries. The subjective complexity of each of the stimulus was gathered by means of verbally expressed scores. Each participant was asked to estimate the complexity of a sample of the stimuli. On the other hand, computer programs calculated a series of complexity measures for each stimulus. These measures included the number of corners, $(\text{perimeter})^2/\text{area}$, horizontal symmetry, diagonal symmetry, opposition symmetry (opposite colours), repetitions, and rotations. Overall, the results reveal that there are two important components in relation to the subjective determination of the visual complexity of a stimulus. The first one has a marked quantitative character, and it corresponds mainly to the number of turns in the stimuli, in this case, the number of corners. The second component refers to structural aspects, and it is related with symmetry, rotation, and the repetition of motifs. The analysis of her results led Chipman (1977) to conclude that the first component fixes an upper limit for the complexity of a given pattern, and that the different structural aspects of the second component act by reducing perceived complexity. This conclusion is similar to what Eisenman and Gillens (1968) had noted for the number of vertices and symmetry. It is interesting to note, however, that by selecting a broader range of organizational processes, Chipman's (1977) study allowed her to determine that the relation between structural aspects of the second component need not be additive, they can function as alternatives.

Chipman and Mendelson (1979) gathered additional evidence supporting the notion of two distinct complexity components. Additionally, they showed that the sensibility to the different kinds of structure of the second complexity component develop at different rates. The complexity reducing effects exerted by double symmetry and vertical symmetry appear first throughout development, around the age of five. The effects of horizontal symmetry, diagonal symmetry, and chequered patterns appear at later ages, between seven and eight. The sensibility to the organization created by the rotation of the stimulus' elements seemed to be incompletely developed even in the oldest participants in this study, which were eleven years old (Chipman & Mendelson, 1979). Thus, as children grow they gradually become able to use all structures to assess the complexity of visual stimuli. These results were supported by a later study in which Mendelson (1984) asked 8, 10, and 12 year old children, as well as young adults with an average age of 23, to order a series of visual patterns according to any property they wished. These figures varied in the amount of contour and visual organization (unstructured, simple symmetries, multiple symmetries, and so on). The results of this study again showed that small children attend to the amount of contour, and that attention to structural aspects increases with age. This suggests that quantitative aspects of complexity perception may be associated with different underlying cognitive processes which are different to those involved in the detection of structural relations and their contribution to the perception of visual complexity. This is in complete agreement with Chevrier and Delorme's (1980) suggestion that children's capability to manage the complexity of visual stimuli has a deep impact on their perception of complexity. Small children base their preference solely on numerousness, and only later will they attend to organizational aspects of the stimuli.

Additional evidence for different cognitive processes involved in different kinds of complexity was offered by Francès' (1976) study we mentioned above. The author designed a study intended to clarify the relations between aesthetic preference and complexity, albeit not just one measure of complexity, but several different dimensions. In order to do so he recruited two groups of participants with different educational levels, and materials varying in six different kinds of complexity. These were: number of elements, heterogeneity of elements, regularity and symmetry of the designs, regularity of the disposition of the elements, incongruity, and incongruous juxtaposition. Materials were presented as pairs of designs or photographs which varied only in one of these six dimensions. The author asked 36 university students and 36 manual workers to indicate their preferred design in each pair. Results revealed that whereas students preferred the complex designs, manual workers tended to prefer the simple designs. When responses were analyzed separately for each complexity dimension, it was found that the number of elements and their heterogeneity had an identical impact on both groups' preferences. However, the effects of aesthetic preference of regularity of the elements, the regularity of their disposition, incongruity, and incongruous juxtaposition seem to be mediated by educational level. The fact that some forms of complexity are sensitive to educational level, and, thus, familiarity with such materials, while other are not, suggests that they are not all processed in the same manner (Francès, 1976).

Additional evidence for this dual nature of visual complexity was obtained by Ichikawa (1985), who designed a study to determine the quantitative and qualitative variables that affect judgments of the complexity of visual patterns. The results of this study indicated that general ratings of complexity could be explained by the number of the figure's turns (quantitative variable) and its degree of symmetry (structural variable). Ichikawa (1985) hypothesized that the effects of the structural and quantitative factors are the result of two different kinds of processing. A primary processing would be responsible for the estimation of quantitative features, and a higher-order processing is assumed to be involved in the discovery of structure. The results suggest that only quantitative aspects play a role in very short complexity judgments, whereas both quantitative and qualitative aspects play a role when there is no time limit for the judgment. The author proposed that both processes are carried out in parallel, but the one related with structural features lasts longer than the other. Due to this, short exposures lead to the interruption of the assessment of the structural aspect. These results are compatible, and can be seen as an extension of Chipman's (1977) work.

1.2.3.3. Summary

In this section we have reviewed studies that show subjective complexity cannot be directly equated with objective measures of complexity (Attneave, 1957). However, there have been several attempts to derive objective measures of complexity that could predict subjective ratings. These measures include Berlyne and colleagues' (1968) irregularity of element disposition, amount of elements, their heterogeneity, irregularity of the shapes, unity, asymmetry, and incongruence, Hall's (1969) number of segments constituting random polygons, Nicki's (1972) checkerboard grain, and so on. However, we have also reviewed evidence that cast doubts on the validity of a unitary and general concept of complexity. In fact, several studies have shown that different measures of objective complexity may refer to completely different aspects of complexity, and that they might even be independent. Hence, it is possible that the divergence among the results yielded by studies of the relation between complexity and aesthetic preference owes to the use and manipulation of different forms of complexity. However, at present this possibility remains to be tested.

1.2.4. Criticisms to Berlyne's framework

Several problems with Daniel Berlyne's framework have been noted from empirical and theoretical points of view. In this section we will briefly review three kinds criticisms: (i) those that have questioned the validity of the concept of arousal, (ii) those that have questioned the special relevance awarded to complexity in aesthetic preference for visual stimuli, and (iii) those that have focused on the shortcomings of the general approach of empirical aesthetics.

The concept of arousal

Neiss (1988) reviewed the history of the concept of arousal and its application to research in motor performance. He pointed out that the reason for the initial success of the concept of arousal was that it substituted the traditional concepts of emotion, drive, and motivation, whose definition and relations were much more complex. However, psychophysiological and neurophysiological research has shown that arousal can no longer be conceived as a one-dimensional construct. It became apparent that there were different forms of arousal. Some proposals distinguished input-related arousal from preparatory activation and effort. Other proposals distinguished between externally and internally directed arousal. Yet others drew a distinction between appetitive and aversive arousal. Additionally, we now know that there are multiple arousal mechanisms (Mong, Easton, Kow, & Pfaff, 2003), related with different neural nuclei (Jones, 2003).

Furthermore, the indicators used to measure arousal do not consistently show correlated activity, they seem to function independently, a phenomenon known as directional fractionation (Lacey, 1967), and they show idiosyncratic patterns in different people (Lacey & Lacey, 1958). In fact, they exhibit different patterns in relation to different affective states (Lang, Greenwald, Bradley, & Hamm, 1993) and are related to different neural structures which interact in complex ways (Derryberry & Tucker, 1992).

Berlyne's conceived arousal as an intervening variable, which was defined based on its relations with antecedents and consequents. Due to this, arousal has not been manipulated as an independent variable, and thus, its effects on performance have not been directly tested. In fact Neiss (1988) has suggested that although the inverted-U hypothesis is refutable in principle, it has become immune to falsification. As we saw in the studies reviewed above, on finding that preference increased in a linear fashion with complexity, some researchers believed this was evidence for the ascending part of the curve, and that their stimuli were insufficiently complex to produce the expected curve (Krupinski & Locher, 1988; Nicki, Lee, & Moss, 1981; Stamps, 2002).

In light of these issues, Neiss (1988) suggested substituting arousal-based explanations for others grounded on current knowledge of cognition and affect. Silvia (2005) has began this task of reformulating and testing hypotheses in empirical aesthetics based on recent theories explaining the dynamics of emotional responses, such as appraisal-based models of emotion.

> One of Berlyne's legacies is a narrow view of the possible responses to art. Research to date has emphasized ratings of enjoyment and interest (…), the responses that figured in Berlyne's research. But there are a lot of emotions, and the emotions evoked by art extend beyond interest and enjoyment. An appraisal model can make predictions about other "epistemological emotions" (…), such as wonder and awe, as well as emotions like anxiety, shame, confusion, disgust, and anger (…). The traditional psychobiological model, in contrast, has little to say about the broader set of emotions that can be experienced in the context of art. (Silvia, 2005, p. 128).

These recent approaches suggest that the explanatory role Berlyne awarded the concept of arousal in the mediation between complexity and aesthetic preference was inadequate. However, as we saw in our review, the fact is that visual complexity has been repeatedly shown to influence aesthetic preference, presumably by virtue of other underlying processes, such as those outlined in section 1.3, below. A different question, the one we are exploring in the present work, is that different studies have found different relations between complexity and aesthetic preference, and this lack of congruence requires an explanation.

Complexity or prototypicality?

One of the most important alternatives to Berlyne's framework was elaborated by Colin Martindale (1984, 1988). He and his colleagues carried out a number of experiments designed to test predictions derived from Berlyne's framework. Some of this work questioned the role of arousal in aesthetic preference (Martindale, Moore, & Anderson, 2005), but as we mentioned before, we will not concentrate on this aspect of Berlyne's work. In any case, the bulk of Martindale's criticism is directed towards the influence of complexity and other collative variables on aesthetic preference. For instance, Martindale, Moore and West (1988) compared the importance of novelty, one of Berlyne's collative variables, and prototypicality, the core of Martindale's framework, in determining aesthetic preference. In order to do so, the authors asked a group of female participants to rate their liking for each word in a set of 171 items, which were controlled for typicality and usage frequency, on a +10 to -10 scale. The results showed that when the effects of frequency were removed, typicality explained 43% of the variance in preference ratings. Conversely, when the effects of typicality were removed, usage frequency accounted only for 8.1 of the variance. Furthermore, there was no trace of an inverted U function of aesthetic preference and novelty, as predicted by Berlyne's (1971) model.

Martindale, Moore and Borkum (1990) carried out a series of seven experiments designed to assess the relative importance of collative, ecological and psychophysical variables, and meaningfulness. In the first of these experiments, they asked 33 male participants to rate on a +10 to -10 scale their liking for a series of random polygons varying in size (14 levels) and number of turns (5, 8, 10, 13, and 20). Their results showed that participants preferred polygons with 10 turns over the rest, and that size had no appreciable effect on preference. Hence, this result seemed to support Berlyne's (1971) prediction. However, when the same experiment was repeated with a larger range of size and complexity levels, preference was linearly related to complexity. Martindale and colleagues (1990) concluded that this questioned the ecological validity and generalizability of Berlyne's model. Additionally, despite the fact that in both instances complexity was more important than size in determining aesthetic preference, it only explained 15.8 and 10.7% of the variance in preference ratings awarded during the first and second experiments, respectively.

In the third experiment, Martindale and colleagues (1990) explored the possibility that the effect of the number of turns might actually be confounded with that of meaningfulness. They asked 40 women to rate 14 random polygons varying in turns on four 7-point scales: like-dislike, meaningless-meaningful, orderly-disorderly, and complex-simple. Their results showed that although preference was related with complexity, the relation between preference and meaningfulness was stronger. Moreover, the authors suggested that the relation between number of turns and preference was artifactual, and that, in fact, it arised because of the way participants found meaning in random polygons varying in the number of turns. Hence, the authors claimed that, contrary to Berlyne's proposal, collative properties are not the strongest determinant of aesthetic preference. These conclusions were validated by an additional experiment with random polygons, another using drawings, and another one using representational paintings. However, when the materials included abstract and representational paintings, complexity turned out to be a better predictor of preference than meaningfulness (Martindale, *et al.*, 1990, p. 73), although preference was not an inverted U function of either complexity or meaningfulness.

Martindale considered that these results raised serious questions regarding Berlyne's framework and that they were congruent with his own model of aesthetic preference (Martindale, 1984, 1988). The main pillar of his model is the assumption that the mind can be adequately modelled as a large network of interconnected cognitive units, segregated into a number of so-called analyzers. This theory posits a sensory analyzer for each of the senses, whose output constitutes the input for a number of perceptual or gnostic analyzers. It is believed that there is a distinct perceptual analyzer for each class of recognizable objects. These perceptual analyzers include a series of cognitive units at the lower levels which code the distinctive features. Specific excitement patterns of feature units define units in the next level, and so on up the hierarchy in the perceptual analyzers. Hence, a reduced number of feature units are able to define a vast amount of unitary percepts. The output from perceptual analyzers enter the semantic analyzer, where it is hypothesized that there is one cognitive unit for each concept a person has. Activity from here is passed on to the episodic analyzer, which contains memories. This analyzer produces outputs which correspond to events coded propositionally. Whereas sensory and perceptual analyzers are modality-specific, the others are conceptual.

When using this general model of cognition to explain aesthetic appreciation, Martindale noted that it addresses only "disinterested or aesthetic pleasure" (Martindale, 1988, p. 26). When the arousal or limbic systems become unusually active, pleasure and displeasure is mainly determined by the activity of these systems. Conversely, under conditions of "disinterested pleasure", usually associated with aesthetic experiences, preference is determined by the cognitive system we just summarized:

> Apprehension of a work of art of any sort will involve activation of cognitive units in sensory, gnostic, semantic, and episodic analyzers. (…) the pleasure engendered by a work of art will be a positive monotonic function of how activated this entire ensemble of cognitive units is. The more activated the ensemble of units, the more pleasurable an observer will find the stimulus to be. (Martindale, 1988, p. 26).

Martindale (1984, 1988) hypothesized that prototypical stimuli are encoded by stronger cognitive units. And given that aesthetic pleasure is a function of the activation level of cognitive units, prototypical and meaningful stimuli are predicted to be associated with higher levels of aesthetic preference than stimuli which are atypical. Hence, Martindale, Moore and West (1988) and Martindale, Moore and Borkum's (1990) results are considered to represent strong support for this model.

However, Martindale's work has not gone without criticisms either. North and Hargreaves (2000) suggested that the results which Martindale uses to ground his rejection of Berlyne's framework and the proposal of meaningfulness and prototypicality as central to aesthetic preference may be biased by the use of materials that varied more on typicality than on complexity. This would explain the different percentages of variance accounted for by complexity and typicality. But North and Hargreaves (2000) pointed out another problem related with the materials. They argued that the manipulation of typicality cannot be done without confounding other aspects, including complexity, and thus, the contribution of both presumed determinants cannot be disentangled. Boselie (1991) noted several methodological problems with Martindale's approach. For instance, given that Martindale's studies have primarily been correlational, there has been no way to show that prototypicality has a causal role in aesthetic preference. Boselie (1991) even cites evidence supporting the notion that preference might influence typicality ratings. Boselie (1991) also pointed out some problems with the interpretation of the data in Martindale and Moore (1988) and Martindale and colleagues' (1988). Prototypicality cannot be such a great determinant of aesthetic preference when it explains such a little amount of the variance in the results reported in those studies. On the other hand, Boselie (1991) also questioned that the task Martindale *et al.* (1988) asked their participants to perform was actually an aesthetic preference task. And in relation with this, Boselie (1991) also noted that it is not clear what feature of the stimuli participants are responding to. Are they rating the prototypicality of the object as a painting, as a cubist artwork, or as the depicted object?

From a very different perspective, Humphrey (1973) also came to conclude that the key to explaining why people find certain objects or representations more beautiful than other was more closely related with prototypicality than other features. In exploring the natural origin of humans' ability to find beauty in things, and its possible biological adaptiveness, he identified a quality which beautiful things have in common and suggested a reason why we feel attracted to the presence of that quality:

> Considered as a biological phenomenon, aesthetic preferences stem from a predisposition among animals and men to seek out experiences through which they may *learn to classify* the objects in the world about them. Beautiful 'structures' in nature or in art are those which facilitate the task of classification by presenting evidence of the 'taxonomic' relations between things in a way which is informative and easy to grasp (Humphrey, 1973, p. 432).

He reasoned that an effective classification, the organization of sensory information as an economical description of the world, must divide entities into discrete categories according to a series of criteria "which make an object's membership of any particular class a relevant datum for guiding behaviour" (Humphrey, 1973, p. 433). Just as other vital functions, Humphrey reasoned that classification became a source of pleasure throughout evolution. This pleasure is minimal with repetitive examples of the same object, or with exemplars which are so different from everything else that lie beyond the scope of the classification. Pleasure is greatest for objects that, while resembling others in the classification system, show certain peculiarities, and act as "sources of new insight into how things are related and divided" (Humphrey, 1973, p. 434).

Hence, from this point of view, it seems that we should find that people prefer viewing intermediately typical representations. This prediction was supported by Hekkert, Snelders, and van Wieringen's (2003) study of the relation between typicality and novelty, that showed people's preference is greatest for novel objects, providing they are typical, and for typical objects, providing they are reasonably novel. Hence, this study reconciles the importance of meaningfulness and collative properties in the determination of aesthetic preference, a view advocated by Hekkert and van Wieringen (1990) and North and Hargreaves (2000).

The shortcomings of empirical aesthetics

Cupchik (1986) has reviewed some of the criticisms made to the general strategy of empirical aesthetics. George Dickie (1962), for instance, considers aesthetics as a discipline in which philosophers deal with logical consideration that encompasses the meaning of critical concepts and the truth of descriptive and evaluative critical statements. According to this author, the psychological approach could be useful to address questions related with behavioural or cognitive aspects involved in the creative experience or the perception of artworks. However, Dickie (1962) believes these issues are irrelevant for aesthetics.

Margolis (1980) has been a little more specific in his arguments against some of the bases and procedures of empirical aesthetics. Margolis (1980) believes that it is problematic to reduce aesthetic materials to mere physical elements or the transmission of information without reference to its content. This leads to the loss of a fundamental quality related with cultural and intentional aspects of the materials. A true science of aesthetics cannot be reductionist in any sense, including informational, neurophysiological, and behavioural. He argued that the roots of aesthetic comprehension should be cultural relativism, conventionalism, and the influences of history and language on perception and learning. Styles and ways of producing and appreciating art are strongly influenced by cultural particularities and historical moments. Margolis (1980) believes that artists and spectators are not restricted by their nervous systems to interpret or produce art in specific ways.

On a different note, Cupchik (1986) and Cupchik and Heinrichs (1981) have criticised the passive role assigned to the spectator and the artist, as well as the fractionation of an artwork into a collection of elements in order to ease the quantification of informational content. Cupchik (1986) noted that this approach does not take into account the decisional and organizing role of the artist. Furthermore, denies the viewer an active role, "stressing instead the competition among 'bits' of information for the attention of a passive viewer" (Cupchik, 1986, p. 353). This distortion, introduced by experimental procedures moves the researcher away from the natural processes of creation and appreciation. The fact that the impact of an artwork is produced by the structuring of component elements diminishes the validity of the conclusions reached through these strategies. Appreciating art cannot be conceived as a passive observation of the accumulation of visual contents. Instead, people actively organize those contents searching for an aesthetic and personal meaning. The strategies developed by Fechner and Berlyne emphasize those elemental aspects of aesthetic appreciation. However, there are many other kinds of cognitive and affective processes related with this search for meaning.

One of Arnheim's (1966) most noted achievements was to apply the viewpoint of Gestalt psychology to the realm of art and aesthetics, countering Fechner and Berlyne's atomism. One of the issues Arnheim (1966) strongly criticised was Fechner and Berlyne's conception of art as a source of pleasure and the hedonistic perspective that has shaped research in aesthetics. He objected to the reduction of the complicated processes that occur when people perceive, organize, and understand artworks to a single quantitative variable measured by means of a pleasant-unpleasant scale. However, according to this author, the emphasis on pleasure has prevented realizing that there are differences between aesthetic pleasure and pleasure related with other kinds of stimuli, such as food or sex. Another of Arnheim's criticisms refers to the belief that concepts used to research in empirical aesthetics can be isolated and have a precise meaning. Such terms as interest, complexity, and pleasure are examples of multidimensional concepts, as we already mentioned above.

Cupchik (1986) has underlined the need for creating a broad framework that reconciles the approach of empirical aesthetics, as created by Fechner and reformulated by Berlyne, and the historical and sociological perspectives advocated by Margolis (1980) and Cupchik (1986; Cupchik & Heinrichs, 1981). Cupchik (1986) suggested considering, within this broad frame, the meeting of spectator and artwork as a search for meaning based on the application of perceptual and cognitive schemes. He considers these schemes to be hierarchically organized at two poles. Culturally and historically specified schemes, related with artistic styles and rules are at one of them. They allow viewers to understand artistic innovations and conventions. These schemes change with time, gradually or suddenly. Spectators familiarized with artistic culture have acquired an aesthetic competence by means of these schemes that allow them to understand the meaning of an artwork, to understand its message completely. Innate psychobiological restrictions that guide the processing of visual information from the world would be at the opposite pole. These processes are general and they are involved in the perception of aesthetic and non-aesthetic objects. These innate schemes would be the reflection of the structure of the nervous system, they operate automatically, without the involvement of the spectators' attention. These lower processes are related with the psychophysical properties of the stimulus, and they can also reflect gestalt-like processes.

This point of view conceives that comprehending the meaning of an artwork requires the interaction of schemes operating at both levels. Hence, it considers that both divergent perspectives mentioned above as parts of the same process. In the next section we will review recent models that have developed this integrated perspective. They consider that aesthetic preference involves a number of affective and cognitive processes and that it is closely related with other personal, cultural, and historical factors.

1.3

Aesthetic preference

Abstract

Although complexity, among other variables, has been shown to have a great influence on aesthetic preference, the psychobiological mechanisms proposed by Berlyne (1971) are now known to be too simplistic. A great deal of current research in the field of empirical aesthetics is aimed at determining the cognitive and affective processes involved in aesthetic preference. In this section, we review two recent approaches to this issue and discuss their differences and similarities. We then turn to the question of the dimensional structure of aesthetic preference, trying to ascertain whether the complexity of this phenomenon can be reduced to a simple but meaningful measure. This framework will serve us to present studies that evidenced the influence of several variables on aesthetic preference. Specifically, we present evidence suggesting several personality traits and cognitive styles have a very small role in determining aesthetic preferences. Conversely, there is strong support for the notion that art education plays a pivotal role in aesthetic preference. Finally, the extent to which sex and aesthetic preference are related is unclear.

1.3.1. Cognitive processes involved in aesthetic preference

Thirty years ago Hardiman and Zernich (1977) performed a review of 20 studies that had explored people's preference for artistic visual stimuli. These authors showed that although some of the reviewed studies attempted to relate their results with some kind of theoretical framework, most of them did not present explanations that went beyond simple intuition. Hardiman and Zernich (1977) concluded that preference for visual arts should be considered as an unresolved question. They also pointed out three issues that were not adequately taken into account by most of the studies. First, they lacked and adequate control over the properties of the stimuli, including reproductions of images belonging to different artistic styles, with a different degree of abstraction, and ignoring differences related with the emotional content of the artworks, their popularity or the presence of human figures. Second, the authors noted the lack of a common method of registering the responses of the participants. Whereas some studies used questionnaires to record their answers, others used paired comparisons, and others used Likert scales. Finally, Hardiman and Zernich (1977) underlined the little generalizability of the results of these studies, given that all the samples of participants were strictly composed of university students.

The authors suggested two courses of action for the future. The first one was to closely examine the meaningful dimensions related with the appreciation of artworks to ground future studies. Their second proposal was to frame research into aesthetic preference within a theoretical structure that can serve as the base for the interpretation of the results (Hardiman & Zernich, 1977). As we noted in previous sections, although many of the studies that were carried out subsequently show the same shortcomings that they pointed out about previous work, there have been significant contributions to clarify the cognitive and affective processes involved in aesthetic preference, as well as the relations among them.

Leder *et al.* (2004) have recently proposed a comprehensive model of visual aesthetic judgment and perception. It includes five processing stages that might run in parallel or in series. The first of them, perceptual analysis of the visual stimulus, includes operations related with perceptual organization, such as grouping, the analysis of symmetry and complexity, and other perceptual features that influence aesthetic judgment. The second stage, implicit memory integration, encompasses the effects of familiarity, prototypicality and meaningfulness. The third stage, explicit classification, includes cognitive operations related with the style and content of the stimulus. The following stage, cognitive mastering, includes art-specific and self-related interpretations. Finally, the last stage sees the emergence of a cognitive state, resulting from previous stages, and an affective state, that results from the continuous interactions between previous stages and affective systems in the brain. The cognitive state is the source of aesthetic judgment, while aesthetic emotion is grounded on the affective state.

Chatterjee's (2003) model of visual aesthetics represents a recent neuroscientific framework for investigating aesthetic experience. Chatterjee (2003) has suggested that aesthetic experiences related to visual objects involve three visual processing stages common to the perception of any visual stimulus, as well as an emotional response, a decision, and the modulating effect of attention. In the first stage early visual processes break the stimulus down into simple components, such as colour, shape, and so on, which are extracted and analyzed in different brain areas. The second stage, intermediate vision, includes a series of operations that segregate some elements and group others, forming coherent representations. In late visual stages, included under the representational domain in this model, certain regions of the object are selected for further scrutiny. At this moment, memories are activated, and objects are recognized and associated with meanings. This visual analysis leads to emotions associated with the aesthetic experience, and it grounds decisions about the stimulus. However, this is not a strictly linear model. In fact, it posits an important feedback flow of information via attentional processes, from higher visual and emotional levels towards early visual processing.

A comparison of the models proposed by Leder and colleagues (2004) and Chatterjee (2003) reveals similarities and differences. Both models acknowledge the importance of early and late visual processes in the generation of an emotional response and the elaboration of a decision. They also take into consideration the influence of complexity, order, grouping, and many other variables familiar to experimental aestheticians, as well as the interaction between affective and cognitive processes such as the activation of memories and the search for meaning. Additionally, both models suggest two different outputs: an emotional response or aesthetic emotion versus a decision or aesthetic judgment. However, at a more specific level, these models have emphasized different aspects of aesthetic experience. Chatterjee's (2003) model deals extensively with perceptual processes, but makes little mention of higher cognitive processes, such as interpretation or classification. In contrast, Leder and colleagues (2004) subsumed all perceptual processes in a single stage and did not explicitly consider a function for attention, instead specifying higher cognitive processes in detail, and awarding them a central role in the aesthetic experience. Figure 1.3 shows a combined representation of both models, illustrating their similarities and differences.

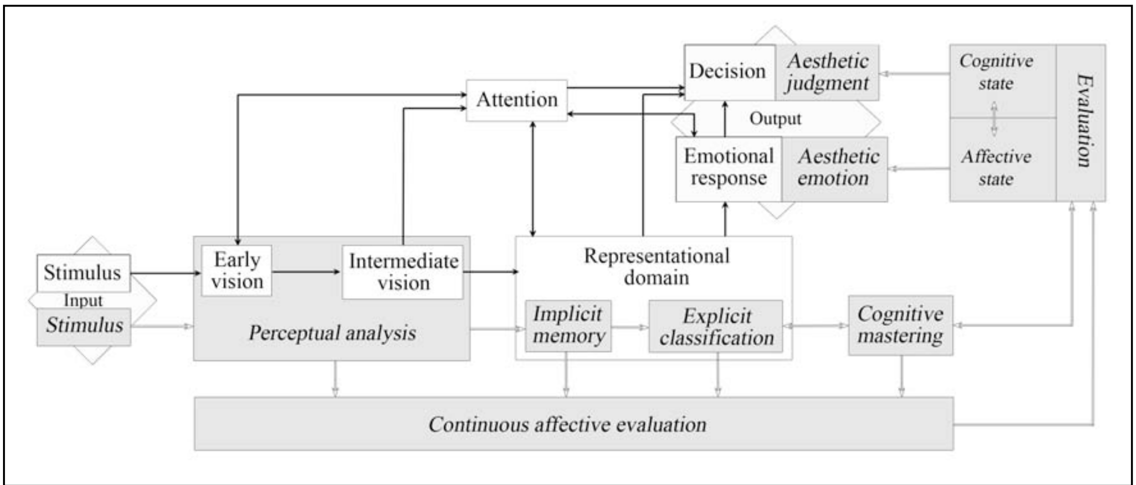


Figure 1.3. Combined representation of Leder and colleagues' (2004) and Chatterjee's (2003) models of aesthetic appreciation. Grey boxes, white arrows and italic text correspond to the stages suggested by Leder et al. (2004), and white boxes, black arrows and regular text correspond to Chatterjee's (2003) stages.

There could be several reasons behind the differences between Chatterjee's and Leder and colleagues' models. First, Chatterjee's (2003) objective was to create a framework for neuroaesthetics that was firmly based on findings from visual neuroscience. In his model, the processes involved in visual object recognition constitute the starting point for visual aesthetics, so it is not surprising that they figure so prominently in his model. This is also the reason why attention is awarded a central role: It is known to exert top-down modulation of early visual processing. On the other hand, Leder and colleagues (2004) aimed to present an information-processing model of the stages involved in the aesthetic processing of visual artistic stimuli. In this sense, the starting point of the model was their analysis of modern art (Leder *et al.*, 2004, p. 491). They believe that understanding plays a critical role in the aesthetic experience of modern art, in the sense that comprehending an artwork alters the way in which it is experienced.

However, there is also a deeper difference between the two models, and it refers to the way in which they conceive of the aesthetic experience itself. Chatterjee (2003) believes the notion of disinterested interest adequately captures the aesthetic experience such that "the viewer experiences pleasure without obvious utilitarian consequences of this pleasure" (Chatterjee, 2003, p.55). From this perspective "judgments about an aesthetic object might be considered outside the core aesthetic experience" (Chatterjee, 2003, p. 56). In fact, the model seems to include a decision phase only as an approach to laboratory settings, where participants are usually asked to state their preferences or make decisions about a certain aspect of the stimulus. Conversely, Leder and colleagues (2004) believe aesthetic experiences arise when "exposure to art provides the perceiver with a challenging situation to classify, understand and cognitively master the artwork successfully" (Leder *et al.*, 2004, p. 493). This successful mastering of the artwork involves, especially in relation to modern art, style-related processing, which results from the acquisition of expertise. In this model, the judgment of the aesthetic object is an important element; in fact, together with aesthetic emotion, it is the main output of the model. In sum, whereas Chatterjee's (2003) proposal can be considered as a *neuroscientific* model of *aesthetic preference* for *a broad range of visual objects*, Leder and colleagues' (2004) proposal is an *information-processing* model of *aesthetic judgment* of visual *works of art*.

In any case, there is currently a broad agreement among researchers that aesthetic preference involves a number of cognitive and affective processes. Some of these are related with perceptual analysis, others with recognition and other mnemonic processes, others with decision-making, and other with analyzing the affective value of the stimulus. In the remainder of this section we will use this general framework to address two issues. First, if aesthetic preference involves such a complex interplay of cognitive and affective operations, can it be adequately studied in laboratory conditions which require simple responses from participants? Second, what are the main personal variables that influence these cognitive and affective processes, and therefore, the performance on aesthetic preference tasks?

1.3.2. The dimensional nature of aesthetic preference

Research of aesthetic preference usually entails the recording of participants' responses to different kinds of objects. However, these responses may refer to a broad variety of aspects of the material used in the experiment or the response scales, such as novelty, originality, pleasantness, complexity, interestingness, order, liking, or beauty, among many other possibilities. However, when the aesthetic experience of participants is studied in an experimental setting with the objective of relating it with different variables, such experience must be reduced to a manageable, and preferably quantifiable, magnitude. In spite of the need to simplify this admittedly complex human experience, and accepting the loss of information in the process, researchers need to make sure that the resulting measure is not completely devoid of meaning, that is to say, that it is representative of the phenomenon being studied. Hence, we need to ask participants to communicate their aesthetic experience in a meaningful but simple way.

The issue of whether there is a simple rating scale that might best represent the aesthetic experience was initially addressed by researchers during the early twentieth century and has been carried on to the present using different experimental and statistical approaches. This line of research was born from the need of art schools and vocational psychologists for a valid and reliable test of artistic capacity that could be used as an entrance examination or as a tool for estimating a candidate's suitability for an artistic career. The following paragraph by one of the pioneers in this endeavour clearly illustrates the parallels existing between the aims of these vocational psychologists and empirical aestheticians:

> If we are to seek a single test-measurement for 'artistic appreciation', whatever that may be, it is important first of all to inquire whether any single central factor exists which mainly determines the artistic judgments of different persons

(…). There may be, too, and almost certainly are, many other specific factors, each of them perhaps influencing certain persons or certain groups. The chief questions, therefore, are: do these irrelevant factors have sufficient weight to obscure and overlay any general or universal tendency that may operate, and do the standards and criteria differ so completely from one competent judge to another that no single test is conceivable? (Dewar, 1938; p 32).

1.3.2.1. A general factor of aesthetic preference?

The first empirical attempts at determining the existence of a general factor underlying aesthetic preference were based on Cyril Burt's (1924, 1933) work on the creation of adequate instruments to select pupils for art schools. Burt arranged a sample of 50 postcards including "reproductions from classical masters, second-rate pictures by second-rate painters, every variety and type down to the crudest and the most flashy birthday-card that I could find at a paper-shop in the slums" (Burt, 1933, p. 290). His first objective was to establish a standard for comparison by asking competent artists and art critics to arrange the cards in order of preference. Burt (1933) recounts the experience in the following words:

> Nearly all of them began by protesting that such a standard was impossible. The Royal Academician declared that the modernist would completely reverse his order; and both were quite sure that any approach to agreement was wholly out of the question. To my amazement, their actual orders were much the same throughout. The average correlation was nearly .9. All that happened was that the Royal Academician would put a landscape by Leader rather near the top, whereas the modernist might put it tenth or fifteenth –but well above the commercial horrors of the stationer's shop. Some put Raphael first, and the primitives fourth or fifth; others put the primitives first, yet Raphael was never far down. It became clear that the differences in their taste and judgment were far smaller than their warm disputes and discussions would lead one to suppose. The conclusion, in short, was irresistible: that there was something fundamental guiding their general choice, although their special theories or private points of view might produce a few minor divergences (Burt, 1933, p. 290).

He thereafter asked children and untrained adults to rate their liking for each of the postcards in the set. He observed that the preferences of these participants were much more influenced by "irrelevant factors", such as the subject matter of the pictures. He correlated the order preferred by each of these participants with the standard order suggested by the art experts, and took this as the measure for each individual's taste. Two observations were critical. First, that scores increased with age, though untrained adults still fell short of the experts' standard. Second, despite the difference regarding experts, "the coefficients were almost invariably positive: thus there seemed to be some one, general, underlying factor influencing the artistic judgments of all" (Burt, 1933, p. 292). As Pickford (1955) noted, this was the first time such a factor was mentioned. Subsequent studies including older participants confirmed this finding. The use of new factor analysis techniques suggested the existence of bipolar factors related with certain kinds of artistic appreciation. The same kind of results were obtained from studying the aesthetic preference of men and women with different social backgrounds using a broad range of test materials, including several different objects with aesthetic value, such as furniture, vases and china, dressing complements, and so on.

Heather Dewar (1938) followed this line of research with her study of the responses to several artistic tests given by both laymen and experts. She asked her participants to complete *The Meier Seashore Art Judgment Test*, *The McAdory Art Test,* which measured appreciation of form, colour and distribution of light and shade, as well as modified versions of two of the tests used by Burt (1933), one of which was the aforementioned *Picture Postcard Test.* Her results showed that her participants had tended to place the pictures varying in aesthetic merit in approximately the same order of liking in the four tests they performed. The factorial analysis of the data revealed that, even eliminating the influence of intelligence, a single general factor accounted for over 70% of the variance in the responses of the participants to the tests. Additionally, as previously suggested by Burt (1933), there was indication of some factors that seemed to be specific of different kinds of aesthetic appreciation (objective or classical versus subjective or romantic). Hence, the arrangement of the cards of the different tests afforded information about the general degree of taste individuals had and the direction in which his or her preference tend. An interesting issue raised by this study was that the second factor seemed to be different for experts and non-experts. This factor separated the former group of participants into those with a higher appreciation for classical art from those preferring romantic art. But when the general factor was eliminated from the scores given by laymen, the bipolar factor seemed to indicate the extent to which untrained people were influenced by subjective associations in their judgment. Two types of persons were distinguished: those who based their judgments on the stimuli actually shown and exhibited a critical stance, and those who based their judgements on the effects of the object on themselves –emotions, associations and memories elicited by the test stimuli. In a footnote, Dewar (1938) pointed out the resemblance between this division and the Jungian distinction between extroverts and introverts.

It must be noted that at this early research period the appreciation of pictorial art was not the only area to be explored with factorial techniques. Williams, Winter and Woods (1938) carried out a similar investigation to the aforementioned studies using literary materials. Their results revealed a general factor underlying literary appreciation and a bipolar factor which distinguished romantic from classical writing styles. Furthermore, they also reported that there was a correlation between the appreciation for literary, musical and pictorial materials. Overall, thus, as early as the beginning of the nineteen forties there were several studies that suggested the existence of a general factor underlying the appreciation of pictorial arts, and possibly musical and literary, as well as some indications of bipolar factors associated with specific styles or kinds of artistic expression.

However, Hans Eysenck (1940) was not completely convinced by the procedures of the studies we have just summarized. Specifically, he believed that the materials used by the researchers did not meet relevant criteria for factor analyses. Eysenck's (1940) concerns were mainly related with three issues. First, the influence of culture –meaning teaching, traditions and so on- had not been completely controlled. Second, some of the material sets varied in the technical merit of the stimuli. Third, familiarity was also not taken into account, which would lead to greater preference for familiar pictures, artists or art schools. Thus, in order to carry out a diligent study of the factorial structure of aesthetic preference, researchers should avoid materials for which preference might be susceptible to teaching or tradition, materials including stimuli of uneven execution, and which might stand out as familiar.

Taking these criteria into account Eysenck (1940) asked eighteen participants with a variety of social and educational background (typists, students, painters, teachers, bank clerks, psychologists and a professor of Aesthetics) to rank the pictures in each one of eighteen sets of stimuli. These sets, which included an average of fifteen elements were: portraits, reproductions of statues of Roman emperors, reproductions of book bindings, pencil drawings by the same artist, pictures used in advertising, photographs of vases, reproductions of Malayan masks, Japanese paintings, photographs of steamships, Japanese landscape paintings, picture sets, reproductions of pieces of embroidery, curves of mathematical functions, reproductions of modern statues, coloured photographs of flowers, coloured reproductions of Eastern pottery, reproductions of silver plate, and pictures of medieval clocks. The results showed that for each of the stimuli sets, the order preferred by each participant was significantly correlated with the average order, which suggests that a general factor underlies the responses to each of the tests. In order to make sure that in effect it was the same factor for all of the eighteen tests, Eysenck ran a correlation between the tests, and found another very statistically significant value. This, he believed, was evidence for the existence a general objective factor of aesthetic appreciation. He referred to this factor as "general" because it seemed to cover a broad range of visual stimuli, just as Spearman's "*g*" covers at least most cognitive tests, and "objective" because it had been shown to be largely independent of individual taste. He named this factor *T*, because he believed this factor was behind what is usually known as "good taste". This factor exhibited insignificant correlations with measures of intelligence, which suggested that *T* could not be explained entirely in terms of general cognitive ability. On the other hand, the fact that this general factor correlates with the ranks awarded to odoriferous substances, several colours and a variety of polygonal figures led Eysenck to "surmise that we are dealing here with a perceptual factor that derives directly from the nature of the nervous system" (Eysenck, 1940). Most importantly for the present research, Eysenck stated that "as related to pictures, [*T*] accounts for what we call 'beauty'" (Eysenck, 1940, p100).

The nature of the bipolar factor was studied in detail in a subsequent paper (Eysenck, 1941c) aimed at reducing the relevance of the general factor by eliminating better part of the variation in artistic merit among the stimuli included in the materials. Thus, the stimuli in each of the five sets used in that study were characterized by a similar artistic merit. Materials included two sets of 51 landscape paintings, a set of 51 black and white landscape photographs, a set of 32 portrait paintings, and a set of 32 photographs of statues. Fifteen participants, seven men and eight women, including artists, university students, teachers, bank clerks, and typists, were asked to rank the pictures in each one of the five sets in order of liking, using a grouping strategy which created a normal-like distribution. The results of this study confirmed that standardizing the artistic merit of the stimuli used as material favoured the emergence of bipolar factors for each of the stimuli sets. This factor separated participants preferring modern, impressionistic, colourful pictures of landscapes and portraits, and those who preferred the older, more conventional, less colourful ones. In relation to photographs, the factor distinguished participants who preferred sunny, bright, happy landscapes with trees and clear skies from those preferring dark landscapes with overcast and cloudy skies. Finally, it opposed those who liked sculptures with perfect forms from those emphasizing character or content. The correlation of the five bipolar factors suggested that there is one factor running through all the five tests. Eysenck (1941c) named it the *K* factor, and suggested that it might have a significant relation with education and temperamental qualities, which we will examine in the following sections of this chapter.

What is the relation between the *T* and *K* factors? Eysenck and Hawker, (1994) asked art-trained and untrained participants to complete two visual preference tests. The first test, VAST (Götz, Borisy, Lynn, & Eysenck, 1979), had been designed to measure the *T*-factor, and consists of a series of high aesthetic quality non-representational pictures paired with a very similar altered version which is aesthetically flawed. The task of the participant is to identify the correct version of each picture. The second test, designed to measure preference for complexity, and thus, closely related to the *K* factor, was the Barron-Welsh Art Scale (Barron & Welsh, 1952). The results showed no significant correlations for either group of participants, which suggests the two factors are independent of each other, and that art training does not alter this fact.

To what extent do these two factors underlying aesthetic preference generalize to other kinds of stimuli? There is evidence that these results may be generalized to quite a broad range of visual stimuli, including colours and geometrical designs. Eysenck (1941a) asked 6 men and 6 women to rank 10 colours in order of preference and to respond to a test of the *T* factor. His results showed a considerable agreement in the preferences for colours, and furthermore, two factors were extracted from the table of correlations. The first of these, with positive saturations throughout, accounted for 34% of the total variance, while the second factor, which was bipolar, accounted for only 4%. The correlation between the saturation of the ratings awarded by these 12 participants with their scores on the *T* factor test was .53, which led him to conclude that the first factor of colour appreciation could be a manifestation of the underlying general factor of aesthetic appreciation we mentioned above. The second factor simply divided those participants who preferred saturated colours from those who preferred unsaturated colours. Eysenck's (1941a) study also included the assessment of sex differences. He repeated the procedure with a different sample of 15 men and 15 women, to find the preferences among these participants were virtually identical, and coincident with those of the smaller group of participants.

Eysenck (1971a) also provided evidence to support the involvement of the general factor when people are asked to express their preferences for geometrical designs. He asked 179 participants with no specific art training to rate their liking for a series of 131 geometrical designs on a 5-point scale, which ranged from "Don't like" to "Like very much indeed". The stimuli were a broad range of designs representing elaborate variations of geometrical forms, such as squares, triangles, circles, hexagons, and so on. Factor analysis revealed three major kinds of factors across which stimuli could be distinguished. The first kind of factors separated stimuli according to their shape into circles, rings, squares, stars, and so on. The second type of factors was related to the presentation of the stimuli and included shadings, and three-dimensional appearance, among others. The last type of factor separated simple designs from complex ones. In addition to this, and closer to our present interests, Eysenck's (1971a) participants showed a great agreement, which suggested the involvement, yet again, of the general factor of aesthetic preference. In order to verify this, he had his participants rate their liking for 135 Birkhoff-like polygons, as a sort of *T* test. For each participant two scores were obtained, one which represented their agreement with the mean average of designs, and the other their agreement with the mean average of polygons. The correlation between both scores was .525, which "demonstrates at a high level of statistical significance that a person showing 'conformity' or 'taste' on one test does so also on the other, while a person lacking in this quality on one test is also found lacking on the other" (Eysenck, 1971a, p. 163.). Hence, it seems that the general factor underlies, to a certain extent, aesthetic preferences for a wide range of visual stimuli.

The notion that the coincident ordering by participants of diverse visual stimuli on preference scales might actually represent the aesthetic value of those stimuli was questioned by Child (1962). He asked two groups of 22 participants with no artistic training to order each of the 60 pictures in each of 12 sets according to how much they liked or disliked them. The picture sets included still lifes, pictures of animals, landscapes, religious themes, abstract pictures, depictions of single men, depictions of single women, and so on. A third group of participants, art students in this case, was asked to perform a different task in order to obtain a criterion for aesthetic value of the pictures. They had to "judge the aesthetic merit of the pictures (i.e., how good they are as works of art)" (Child, 1962, p. 499). According to the author, the results from his study question that group preference reflects aesthetic value and that the proximity of individual agreement with that group preference can be considered as a measure of aesthetic sensitivity. However, Eysenck (1971b) noted three reasons why Child's (1962) results do not represent actual criticisms of his previous work (Eysenck, 1940). First, the group of art students were asked to perform a different judgment to the other two groups of participants. Eysenck (1971) argued that there was no reason to assume that preference and aesthetic judgment would coincide even for a single group of participants, and thus, that Child's results might merely show that different instructions lead to different results. Second, the stimuli used by Child do not meet the three criteria established by Eysenck (1940). Thus, the kinds of interfering effects mentioned above cannot be discarded. Finally, whereas Child (1962) assumed the existence of an external criterion of aesthetic value provided by experts, Eysenck (1971) was not willing to accept this in the absence of empirical proof. Eysenck naturally agreed that experts, such as those included in Child's (1962) third group of participants, possess knowledge of criteria used to assess artworks, but he stressed that agreement on these criteria does not necessarily amount to good taste or aesthetic sensitivity.

Together with other works, the literature reviewed above led Pickford (1955) to feel that it was well established at the time that there is a general factor of aesthetic appreciation. This factor, as stated by Eysenck (1940) is closely related with the appreciation of beauty. This would suggest that beauty represents an adequate scale to summarize aesthetic experiences of participants carrying out experimental procedures in laboratory settings. This early conclusion has been ratified by recent studies using different approaches. One of these studies was carried out by Marty, Cela-Conde, Munar, Rosselló, Roca and Escudero (2003), who were faced with a similar issue we are dealing with here: to find a simple way of recording the aesthetic experience of participants in neuroimaging procedures. They asked 100 university students to rate 96 images on four semantic differentials: *beautiful-ugly*, *interesting-uninteresting*, *original-common*, and *pleasant-unpleasant*. Their set of materials included black and white High Art and Popular Art images, both abstract and representational, and were selected according to Eysenck's (1940) criteria. The factorial analysis they carried out revealed the existence of a general factor explaining 62.3% of the whole variance, with the *beauty* scale having the greatest loadings. The authors concluded that these results are in agreement with Eysenck's (1940) characterization of a general factor underlying aesthetic appreciation, and allow the reduction of aesthetic appreciation to relatively simple questions about the beauty of the stimuli presented in neuroimaging and cognitive experiments.

Jacobsen, Buchta, Köler, and Schröger (2004) carried out another recent study aimed at disclosing the most representative dimension of aesthetic appreciation, although they used quite a different approach from those reviewed above. In contrast to the other studies, they moved away from theoretical perspectives of what constitutes aesthetic experiences and focused on what people's ordinary idea of aesthetics was. They asked the people participating in their study -84 male and 227 female non-art undergraduate students- to write down adjectives that could be used to describe the aesthetics of objects for two minutes. The analysis of the 590 different words produced by the participants revealed that "beautiful" was clearly the most frequent answer to the questionnaire, written by 91.6% of them. The second most frequent answer was "ugly", appearing in 42% of the answer sheets. The remaining responses were much less common, and included such adjectives as pretty (27%), elegant (23%), small (18%), repulsive (12%), stylish (10%), interesting (7%), and so on. The authors correlated the frequency with which these words appeared in the responses of their participants and the frequency with which they appeared in common language use. This showed that general use accounted for less than 6%

of the answers to the questionnaire, excluding the possibility that they had responded based on the common usage of the adjectives. These results show that "a bipolar beautiful-ugly dimension clearly appears to be the primary and prototypical descriptive dimension for the aesthetics of objects" (Jacobsen, Buchta, Köler, & Schröger, 2004, p.1258).

In sum, experimental results support the notion of a general underlying capability of aesthetic preference. Beauty ratings have been shown to adequately represent this general factor in experimental settings using a broad diversity of stimuli. However, to show that this general factor is a biological property of our species is a different question. This issue has been traditionally studied by attempting to determine whether there are aesthetic universals by means of cross-cultural research methods.

1.3.2.2. Cross-cultural research

The anthropologist Robert Lowie (1921) was the among the first to carry out a quantitative research aimed at establishing whether aesthetic preferences are universal. Stimulated by the results obtained by contemporary psychologists showing that occidental participants tended to prefer rectangles with proportions close to the golden section, Lowie (1921) studied the distribution of rectangular forms in the decorative art of a tribe of North American Indians, the Crow. He also compared some of these elements with similar ones created by another tribe, the Shoshoni, expecting to find a mix of common features, resulting from a putative universal aesthetic norm, and distinctive motives in each tradition. The measurements of the proportions of 20 Crow and 20 Shoshoni items revealed that the former tribe seemed to prefer somewhat thinner rectangles that the latter. Furthermore, his results revealed that the dimensions of the most prevalent rectangular figures in Indian art did not conform to those established by the golden section. In fact, the Crow's norm was below this proportion, whereas the Shoshoni's was above it (Lowie, 1921).

A possible explanation for this failure in finding common aesthetic values in different cultures may reside in the use of extremely simple materials. At around the mid nineteenth century researchers began using other kinds of materials, such as those collected by Eysenck (1940), and with participants from cultures with very little mutual contact and with notoriously different beauty criteria. The objective of these studies was to identify indications of agreement in aesthetic preferences which were resistant to the influence of culture. McElroy (1952) and Lawlor's (1955) studies are considered as pioneers in this line. McElroy (1952) registered preference scores of 40 Australian aborigines and 20 Caucasian students and Sidney University for similar materials to those used by Eysenck (1940): drawings of flowers, butterflies, fish, landscapes, reproductions of works by Paul Klee, and so on. His results yielded high correlations among participants belonging to each group. However, correlation between the scores awarded by Caucasians and aborigines was lower than expected and in many instances below statistical significance levels. Correlation between the general factors extracted for each group varied depending on the specific test. Correlation values varied from non-significance (Birds, Flowers, Landscapes, Paul Klee, Polygons, Portraits of Caucasians) to significantly positive (Fishes, Colours) to significantly negative (Tartans, Portraits of Africans). In no case, however, were cross-cultural correlations as high as within each group of participants. The author concluded that his results "provide much evidence in favour of the view that the 'beauty' of a visual object is almost entirely determined by the cultural conditioning of perception" (McElroy, 1952, p. 94), and that the data he collected

> appear to offer little support to Eysenck's inter-racial "good taste" or "inherited predisposition" as accounting for the tendency to agreement between judges with material satisfying his three conditions of freedom from "irrelevant associations" (McElroy, 1952, p. 93).

Lawlor (1955) compared the preference scores awarded by 56 European and 56 West African participants to 8 East African decorative elements reproduced from motifs appearing on woodcuts, metal figures, earrings, necklaces, and fabrics. Although she found an elevated agreement among the opinions of people belonging to each of the participating groups, there was no indication of intercultural agreement. This, again, suggested that if there is in fact a universal aesthetic preference factor, it is largely superseded by cultural experience.

Child and Siroto (1965) attributed the results of these experiments to the fact that the people included in the samples, those whose preference was recorded, were not selected for their interest in art. They were representative of the general community. Child and Siroto (1965) believe that there is no reason whatsoever to expect that aesthetic values are shared even by the members of the same community. From their perspective, preferences of laypeople are not necessarily coincident with traditional aesthetic values, which have to do with the assessment of stimuli in relation to their adequacy to satisfy a certain kind of interest that people may have developed or not. In this sense, "It is possible that esthetic evaluations may be made by or known to only some people in each society, and yet that agreement will be found between such people in various societies (Child & Siroto, 1965, p. 350). Hence, according to these authors, the question about the existence of aesthetic universals refers to whether the preference of people interested in art in one culture will coincide with the preference of people interested in art in a different culture.

In order to test these assertions, Child and Siroto (1965) gathered a series of 39 photographs of BaKwele masks used in different rituals. They asked 13 North American experts to judge the aesthetic value of each stimulus. These experts were advanced art students and other people considered by the researchers to be capable of performing such judgments. They also recruited 16 BaKwele participants, male elders that had made masks, or that had participated in rituals involving masks, as well as young men interested in masks, who were asked to state which masks they preferred. Child and Siroto's (1965) results revealed a reasonable agreement between both groups of judges: the images that had been judged as having a greater aesthetic value by American experts were also those which were most preferred by BaKwele judges. The authors interpreted these results as a preliminary indication that the masks "do really vary one from another in general suitability for arousing and sustaining interest in anyone who enjoys visual art, and both sets of judges are sensitive to this variation" (Child & Siroto, 1965, p. 357).

Ford, Prothro and Child's (1966) results also support Child's notion of an agreement among aesthetic judgments which is unaffected by cultural factors, though only in certain people who exhibit a specific aesthetic sensibility. In this study, though, they registered the opinions of North American judges about abstract artworks, artistic still lifes, and so on. These participants were required to judge the artistic merit of the stimuli. The other participant groups were constituted by artisans living on a remote Fiji island, and on a remote Greek island.

In our opinion there is a serious conceptual problem with these two studies: the task carried out by American participants is different to the one the researchers asked the other participants to perform. American experts judged the aesthetic value of the stimuli, whereas the other participants had to choose the most beautiful one, or the one they preferred. If aesthetic judgment is defined, as Child and Siroto (1965) do, as the judgment of the quality of a stimulus as a work of art, it is clear that participants who were asked to rate the beauty of each stimulus were not carrying out the same task as the American participants.

In a subsequent study, Iwao and Child (1966) gathered a larger set of stimuli and recruited a larger number of participants. The objective was to find out the extent to which aesthetic judgments of traditional Japanese potters would coincide with those American experts. They used pairs of black and white photographs of artworks of the same type, style, and content, and pairs of full-colour artistic abstract paintings. Each pair represented artworks that had been judged as unequal regarding artistic quality by at least 12 out of 14 American experts. In this study, Japanese potters were asked to perform the same task as American experts had. Results revealed that there was a statistically significant agreement between American experts and Japanese potters in their choices: 61 and 57.5% for black and white reproductions and abstract works, respectively. Although the researchers expected the values of agreement to be much greater that the 50% chance value, and that there was a great variation in the extent to which Japanese participants agreed with American ones, Iwao and Child (1966) concluded that the data reflect a tendency of people interested in art to agree on their aesthetic judgment, irrespective of their particular traditions.

In a follow-up study, Iwao, Child and García (1969) showed the same materials to 31 additional Japanese participants related with the practice or teaching of at least one Japanese artistic tradition, including flower arranging, the tea ceremony, textile dying, manufacture of dolls, woodcutting, painting, and calligraphy. However, agreement with American experts was even lower than in the previous study Iwao and Child (1966): 58.5 and 51.5% for black and white and abstract materials, respectively. In spite of these low agreement values, the second of which does not even reach statistical significance, the authors concluded that these results add to the evidence that aesthetic valuing by people involved in artistic activities in two different traditions tend to coincide (Iwao, Child, & García, 1969). These results and conclusions are very similar to those obtained by Anwar and Child's (1972) attempt to extend this line of research to other cultures.

Eysenck’s perspective on cross-cultural research into aesthetic universals differs from Child’s in two important aspects. First, western art is discarded as materials for experiments, and stimuli which are less culturally biased are used: polygons and simple designs, which are not familiar to any of the participant groups. Second, the opinion of experts is abandoned as a reference point for cross-cultural comparisons. Eysenck’s work is based on the premise that if there actually is a universal aesthetic value, it will be revealed by the coincidence in the aesthetic preference of the majority of the participants, including laypeople.

With these considerations in mind, Eysenck began articulating his cross-cultural comparison of aesthetic preference. Soueif and Eysenck (1971) recruited a broad set of British and Egyptian art students and laypeople, who were asked to rate the pleasingness of each of Birkhoff's (1932) original 90 polygons. Their results revealed that whereas British art students preferred simple figures, British participants without art education preferred the complex figures. There were no significant differences between both groups of Egyptian participants, though the tendency was the opposite of British groups. Although the cross-cultural differences were somewhat greater than those found in Child's studies, Soueif and Eysenck (1971) did not believe that their data support considerably large differences in aesthetic preference between both cultures.

In a subsequent experiment Soueif and Eysenck (1972) studied whether the factorial structure of the scores awarded by Egyptian participants to Birkhoff's (1932) 90 polygons was comparable to the one revealed by a previous study involving only British participants (Eysenck & Castle, 1970a). Soueif and Eysenck's (1972) results showed that the factors underlying the aesthetic preference of Egyptian participants were very similar to those underlying the preference of British participants: rectangular figures, with radial symmetry, cross-like, elliptic, triangular, circular, and so on. Hence, the authors believed that, in addition to a predisposition to prefer certain polygonal figures to others, the causes of this preference seem to be the same in both cultures. This suggests "the possibility of a more deeply based, biologically determined cause for aesthetic judgments" (Soueif & Eysenck, 1972, p. 153).

Eysenck and Iwawaki (1971) performed a study to ascertain whether this coincidence in aesthetic preferences of British and Egyptian participants could be extended to other cultural groups, specifically Japanese people. In order to do this, they used a very similar procedure as in Soueif and Eysenck's (1971) study. The only difference is that they compared how much British and Japanese participants liked Birkhoff's polygons and a set of 131 simple geometric designs. Results showed no significant differences between the scores of both groups of participants. The correlation between the scores awarded to polygons by both groups was .8 and to designs was .6. However, there was a tendency for British participants to score the designs somewhat higher that the Japanese, and the opposite tendency for polygons.

Just as in the comparison between British and Egyptian participants, Eysenck and Iwawaki (1975) wanted to know whether the features of the stimuli that determined aesthetic preference were the same for Japanese and British participants. Their results revealed a great similarity in the factors underlying the preference of people from different cultures, and support the notion of the universality of the processes that determine the aesthetic preference of human beings.

Eysenck's line of research was further explored by Farley and Ahn (1973), who carried out a study aimed at comparing the aesthetic preference for polygons varying in complexity by participants from 5 different cultures. In order to do so they recruited participants from the United States, Korea, China, India, and Turkey who were at the time studying at the same university in the US. Participants belonging to the last four groups were residing in the US temporally. None of the participants had formal training in art, and they all had similar social and economic backgrounds. Twelve polygons varying in the number of sides, from 4 to 160, were used as materials. Participants were asked to indicate the four polygons they preferred most and the four they preferred least. Their analysis revealed that there were no significant differences among the groups of participants regarding the most or least preferred levels of complexity. Hence, these results are in agreement with the existence of aesthetic universals, in which complexity has a similar influence in different cultures. However, the results and conclusion of this last study are limited by the fact that the data were collected in the United States. This means that all participants had been exposed to a greater or lesser degree to North American culture, evidenced by the fact that they all had mastered English enough as to study in the US.

1.3.2.3. Summary

The main objective of this section was to examine whether aesthetic preference could be adequately measured in a simple and direct way in a laboratory setting, given that it is a broad phenomenon with many aspects to it, and which requires the participation of a varied set of cognitive and affective processes. Early studies suggested that there was a single factor underlying aesthetic preference. However, Eysenck's factor analyses uncovered two main factors he named *T* and *K*. The former was conceived as a general and universal factor of aesthetic preference very closely related with our perception of beauty. The latter was related with our liking for modern or traditional representation. Subsequent studies using different methods and different kinds of stimuli have corroborated the primacy of beauty ratings as an adequate representation of aesthetic preference. However, cross-cultural studies have provided weak evidence, at best, for the notion that this general factor of aesthetic preference is universal. This could be due to methodological inadequacies of those studies or to the fact that cultural particulars override the effects of this general factor, making it virtually impossible to detect it using cross-cultural designs.

In spite of the support for a single general factor underlying aesthetic preference, whether it be universal or not, a number of studies have shown that there is a considerable degree of variation among people's aesthetic preference. Researchers have attempted to explain this variation as a function of a number of personality traits, general cultural background, specific art education, and sex, among other variables. We will review some of these explanations in the following sections.

1.3.3. The influence of personality traits and cognitive styles

A great deal of work has been carried out in relation to the notion that individual differences influence aesthetic appreciation of visual, as well as auditory, stimuli. The first modern approach to this issue was based on the findings made by Alfred Binet (1903). He distinguished four different kinds of people depending on the way they apprehended visual objects. The first kind of people, who he termed *descriptive* type, tend to arrive at a pure description of the object's details, and do not seek to grasp its meaning or significance in relation to other objects. The second type of people, the *observers*, assess the expressive and significant features of an object, they realize that not all features are equally important and that they hold specific relations with other aspects and with the whole. The third type, which he called *erudite*, do not focus their attention on the impression caused by the object, but on the associated or remembered facts called up by it. The last type, known as *emotional* or *imaginative*, do not focus on the visible details of the object, but on its emotional meaning.

Although this typology was derived from the study of children's description of visual stimuli, which had no aesthetic purpose, Edward Bullough (1921) was the first to realize that such individual differences might lead to measurable differences in aesthetic preference. Based on his studies of the appreciation of colours, he distinguished among four kinds of appreciation: *objective*, *intra-subjective*, *associative*, and *character*. The first of these is characterized by an impersonal attitude towards the colours and the grounding of appreciation on saturation, luminosity and its consistency with preconceived standards. The colour appreciation of the second type is influenced by mood and bodily sensations, viewing colours as depressing, warm, stimulating, or relaxing. The third type expresses preference for colour as a function of the power of the colour to call up associations or images of past events. For the fourth type, colours have moods and personalities: they can be happy, active, serious, funny, and so on. It is this character attributed to the colour that determines the appreciation of it. There is no straightforward equivalence between Binet's and Bullough's classifications. However, the latter author suggested that his *objective* type incorporates features of Binet's *descriptive* and *erudite*, the *intra-subjective* shares peculiarities with the *observer* and the *emotional*, Bullough's *associative* type is a combination of the *observer*, *emotional* and *erudite*, and finally, the *character* type shares features with the French author's *emotional* and *observer* kinds.

Subsequent research, summarized by Burt (1933), highlighted two main issues. First, that the types of colour preferences could also be found for music, which suggested that they might not be completely bound by perceptual processes. Second, although Bullough (1921) had suggested that the types he described were more than transitory attitudes of the subject, that they were fundamental and permanent ways of appreciating colour, it later became apparent that each of the four tendencies may be discerned in most people, and the difference is the result of predominance or degree, and not a strict definition of clear-cut groups of people.

This work paved the path for subsequent approaches which made use of psychometric tools and factor analyses, represented by Burt (1933) and Eysenck's (1941c) studies. Whereas the first author's starting point were personality types which were subsequently tested for differences in aesthetic preference, the latter's starting point was the identification of type factors in aesthetic preference which were later compared with personality factors. Burt's (1933) studies report the analysis of aesthetic preferences of people with extreme scores on two personality dimensions: extraversion and stability. He found that unstable extraverts prefer dramatic and romantic art, depictions of human figures rather than landscapes or still lifes. They prefer vivid colours with strong contrasts and vital flowing curves.

Instead of the emotional aspects, the second type, stable extraverts, emphasize the rational, realistic and practical features of pictures, and is more attracted to solidity and mass than to decoration and flowing curves. The third kind of people, unstable introverts, prefer impressionist art, subjects related with the mystical and supernatural, and prefer landscapes –especially if they are surrounded by an air of mysticism- to portraits. People in the last category, stable introverts, show a marked intellectual attitude and prefer clear renderings, good drawing, and chiaroscuro to colours, the theatrical and sentimental.

We already mentioned Eysenck's (1941c) work on aesthetic preference type-factors in the section concerning the dimensional nature of aesthetic preference. We noted that this bipolar *K* factor separated people who preferred simple and ordered polygons from those who preferred complex and less organized polygons and shapes. Subsequent studies involving several groups of participants revealed significant correlations between the *K* factor and extraversion-introversion –as Dewar (1938) had previously suggested- and radicalism-conservatism, with extroverts and radicals liking bright and modern stimuli the most and introverts and conservatives, the older masters.

In 1947, Welsh constructed a test to aid in the detection of psychiatric disorders consisting of 200 drawings and administered it to large groups of psychiatric patients and non-patients. This test, known as the *Welsh Figure Preference Test*, required participants to indicate whether they liked each of the drawings. The factor analysis revealed two factors: a general acceptance factor, related with the general tendency of the participant to either like or dislike the drawings, and a bipolar factor, orthogonal to the previous one, related to the preference for simple-symmetrical figures or for complex-asymmetrical figures. It was noted at the time that healthy participants tended to form two distinct groups with markedly different personality traits. Those who preferred simple and symmetrical figures were conservative and conventional, while those who preferred the other kind of stimuli were eccentric, cynical, and radical (Barron, 1952).

The Welsh test was thereafter enlarged to 400 stimuli and a specific scale which could discriminate between the preference of artists and non-artists was extracted and used independently. This is known as the *Barron-Welsh Art Scale* (Barron & Welsh, 1952), and was used by Barron (1952) to verify whether promising people with a great deal of potential success would better discriminate the good from the poor drawings than those who showed little promise and potential. It was expected, thus, that their preferences would more closely parallel those of artists than those of non-artists. Accordingly, 40 psychology students were asked to go through the scale, 20 of which had been highly rated by the faculties on qualities like originality and personal soundness, promise and potential, whereas the other 20 students had been rated as low in originality, personal soundness and potential success.

Contrary to the original hypothesis, the distribution of both groups of participants was approximately even between both simple-symmetrical and complex-asymmetrical pictures. However, two groups of participants did appear towards the poles of the simplicity-complexity continuum. In a subsequent phase of the study, participants had to express their preference for reproductions of a variety of artworks. It was found that the group who had preferred simple-symmetrical drawings also preferred paintings portraying good breeding, religious motifs, and scenes reflecting a certain degree of authority, and rejected paintings with esoteric, unnatural and openly sensual contents. Conversely, the group of people who had expressed a greater appreciation for the more complex drawings also gave higher ratings to modern, experimental paintings, those with primitive or sensual content, and disliked those related with religion, aristocracy, tradition, and emotional control.

Barron (1952) suggested that the differences observed in the preferences for drawings varying in complexity and paintings with diverse content might be explained by the different views both groups of participants have of themselves and the world. The analysis of their responses on a checklist of adjectives they could use to describe themselves revealed that they had different attitudes towards the perception of stability, predictability, balance, symmetry, and the use of simple general principles, as well as towards tradition, religion, authority and sensuality. The group that preferred simple-symmetric figures described themselves as contented, gentle, conservative, unaffected, patient, and peaceable, while the group who had preferred complex-asymmetric figures described themselves as unstable, dissatisfied, pessimistic, emotional, pleasure-seeking, and irritable. These results add to the increasing consistency of the suggestion that the extroversion-introversion and conservatism-radicalism dimensions contribute to the preference for visual stimuli varying in complexity.

On the grounds laid down by these pioneering studies, research on the influence of personality on aesthetic phenomena took two very related, but distinct, forms. On the one hand, further work was done to identify personality traits that explained differences in *aesthetic preference*. On the other hand, a new line was opened by Irvin Child: the study of personality influence on *aesthetic judgment*. Given that our main interest for the present research is in aesthetic preference, our review of studies concerning aesthetic judgment will be much more concise. In fact, we will report only two studies, one by Child, who pioneered this research field, and a very recent one by Adrian Furnham. This will afford a brief historical perspective, while allowing us to quickly turn to aesthetic preference.

In a similar way to McWhinnie's (1968) definition of aesthetic judgment we have adopted in the present work, Irvin Child conceived it as “the extent to which, when a person judges the esthetic value of works of art, his judgments agree with an appropriate external standard of their esthetic value. The external standard used here is provided by the judgment of experts.” (Child, 1965, p. 476). Child (1965) asked 138 male students with no special formal education in art to look at 120 pairs of artworks and decide “which of the two works of art is better esthetically – that is, the better work of art.” (Child, 1965, p. 477). The pairs had previously been prepared mostly by art and art history graduate students. Each pair represented the same subject matter and most of them were done in the same artistic style. Pairs were then shown to 14 art experts who were asked to choose the better work of art in each pair. Only pairs for which expert agreement was high were finally selected for the experiment. The participants in the experiment were also administered a large amount of questionnaires, behavioural measures, and standardized tests. These measured, among other variables, background in art (including art education, experience in galleries and museums, art-related hobbies, and family attitudes towards art), skill in the perception of visual forms, tolerance for complexity, tolerance for ambiguity, scanning, sharpening, field dependence, independence of judgment, Jungian measures of cognitive orientation (introversion-extroversion, intuition-sensation, perception-judgment), masculinity-femininity, originality, and colour preferences.

Results revealed that, while some of the measured variables showed significant relations with aesthetic judgment, others did not. It is surprising to find some variables among the latter, such as skill in the perception of visual form, skill in the perception of human meaning in ambiguous stimuli, and originality. On the other hand, it is not as striking to learn that others, like masculinity-femininity, and some behavioural measures of cognitive style, were unrelated to aesthetic judgment, mainly because of conceptual weakness or the way in which they were measured. Measures of artistic background showed very strong relations with aesthetic judgment, especially formal education in at and experience in visiting art galleries and museums. Turning now to personality dimensions, the variables that showed strong relations to aesthetic judgment were tolerance for complexity, scanning (awareness of events outside the main focus of attention), independence of judgment (preference for the development of one's own views on matters as opposed to conformity with others'), regression in the service of the ego (psychodynamic concept referring to the positive use of relatively immature functions in the development of mature ones), intuition rather than sensation (going beyond what is strictly perceived rather than limiting oneself to what is actually presented), perception rather than judgment. From these results Child

(1965) advanced a description of people who showed good aesthetic judgment, i.e., that tended to agree with art experts about which of the two paintings in each pair represents a better work of art:

> a person of actively inquiring mind, seeking out experience that may be challenging because of complexity or novelty, ever alert to the potential experience offered by stimuli not already in the focus of attention, interested in understanding each experience thoroughly and for its own sake rather than contemplating it superficially and promptly filing it away in a category, and able to do this with respect to the world inside himself as well as the world outside." (Child, 1965, p. 508).

This description suggests that people who approach new experiences with an open attitude should "be capable a better aesthetic judgment". Based on Child's (1965) results, as well as on many other studies, Furnham and Chamorro-Premuzic (2004) carried out an experiment to examine the relation between aesthetic judgment and the personality traits measured by the NEO Five-Factor Inventory (FFI) (Costa & McCrae, 1992), as well as intelligence. They predicted that two of these traits would be related with aesthetic preference, as measured by the *Maitland Graves Judgment Test*: Openness to Experience and Conscientiousness. The first of these relations was predicted to be positive, while the second was expected to be negative. They asked 28 male and 46 female participants to carry out the *Maitland Graves Judgment Test*, which consists of 90 slides presented in pairs or trios, of which one represents the best design. Stimuli are black, white and green regular and abstract figures. Participants were also administered the NEO FFI, a test of general intelligence, and a questionnaire on art interests, activities, and knowledge.

Correlational analysis revealed significant positive correlations among the three aspects of experience with art (interests, activities, and knowledge). In addition, these three measures were positively correlated with Openness to experience. Knowledge of art was negatively correlated with Conscientiousness. Finally, scores on the aesthetic judgment test were positively correlated with Extraversion and the measure of general intelligence (Furnham & Chamorro-Premuzic, 2004). Regression analyses were performed to clarify the predictors for art interests, activities, and knowledge, on one hand, and aesthetic judgment on the other. Results showed that the Big Five personality inventory accounted for 15.5%, 25.7%, and 21.1%, of art interests, activities, and knowledge, respectively. In all three cases, the only significant predictor in the model was Openness to Experience. The second regression analysis showed that the combination of the Big Five (mainly Extraversion and Conscientiousness –negatively) and intelligence scores were the best predictors of aesthetic judgment, though in this case the model did not reach strict significance levels. The authors concluded that their study supported the notion that personality, especially Openness to Experience, and experience with art are strongly related. However, and contrary to Child's, (1965) predictions, Openness to Experience seems to be quite unrelated with aesthetic judgment (Furnham & Chamorro-Premuzic, 2004). We feel that Furnham and Chamorro-Premuzic's (2004) meticulous study suggests that Child's (1965) results concerning the relation between openness and aesthetic judgment might be confounded by participants' prior artistic interests, activities, and/or knowledge. In this sense, people who are open to novel experiences, and feel challenged by them, tend to show greater interest in art, participate in more artistic activities, and develop greater knowledge of art, than those who score low on Openness to Experience, but do not necessarily show a better aesthetic judgment.

After examining the work by Child and other authors that have followed in his research into the relation between personality and aesthetic judgment, let us turn now to the studies that continued Barron's (1952) work on the relation between personality traits and aesthetic preference. The early study conducted by Knapp and Wulff (1963) was aimed at assessing the relation between certain individual differences and preference for abstract and representational works of art. Their first objective was to determine whether preferences for abstract and representational artworks was related to values, scores on the sensation-intuition continuum, and several measures of academic achievement. They asked 88 male students to rate 36 still lifes varying in their degree of abstraction for "their degree of pleasingness as aesthetic objects" (Knapp & Wulff, 1963, p. 257). Based on the agreement among three judges, stimuli were included in three groups: abstract (with works by Picasso, Braque, Gris, and Rivera), intermediate (with works by Renoir, Cezanne, Matisse, and Gaugin, among others), and representational (with paintings by Chardin, Zurbaran, and Harnett, among others). The analysis of the data collected by the authors revealed significant differences between participants who held strong religious values, who tended to prefer representational artworks, and those who held strong aesthetic values, who showed greater preference for abstract paintings. Additionally, participants high on intuitiveness showed a greater appreciation for the abstract stimuli than those high on sensation. Furthermore, preference for abstract art was also greater for participants with "superior verbal and mathematical abilities, a family background of greater intellectual cultivation, and, finally, superior performance at the precollegiate level." (Knapp & Wulff, 1963, p. 261). However, generalization of their results must be cautious, given that the experiment only included still lifes and male participants.

Kloss and Dreger (1971) designed an experiment to determine whether aesthetic preferences are related to temperament. They asked 64 male and 66 female participants with no specific art education to express their liking for 25 slides of modern abstract works of art on a 7-point scale. Materials included paintings by Miró, Mondrian, Kandinsky, Pollock, Guston, and Hartung, among others. Additionally, participants were administered the Guilford-Zimmerman Temperament Survey, which measures General Activity, Restraint, Ascendance, Sociability, Emotional Stability, Objectivity, Friendliness, Thoughtfulness, Personal Relations, and Masculinity. Factor analysis of the participants' responses revealed three underlying factors. The first one included paintings which primed the geometrical and cool blue and green colours. Paintings with high loadings on the second factor were created with subtle strokes placed across the whole canvas, lacking a focal point and a specific form. The third factor included the abstract expressionists, which were characterized by broad blows across the canvas with mostly warm colours. There was a strong negative correlation between factor 1 and both 2 and 3, which showed a strong positive correlation between them. This suggested a non-geometric second order factor in opposition to the geometrical first order factor for abstract artworks. With regards to the relation between the preference judgments clustered in the three factors and the temperament factors, only two correlations reached significance at the .10 level. Specifically, preference for geometric art (factor 1) was correlated with poor personal relations, and preference for abstract expressionism (factor 3) was associated with lower scores in the restraint scale. The authors attributed the lack of significant relations between temperament and aesthetic preference to two possibilities. Either the traits measured by the psychometric tool they used are not relevant to aesthetic preference, or the relation between temperament and aesthetic preference is not very strong: "Most studies have shown that art preferences are influenced considerably by talent and by training, neither of which is central to temperament" (Kloss & Dreger, 1971, p. 377).

Wilson, Ausman and Mathews' (1973) experiment was designed to assess the relation between conservatism and aesthetic preference. Here, conservatism, understood as having conventional, conformist, dogmatic, superstitious, and antiscientific attitudes, among others, is viewed as the consequence of "a generalized susceptibility to feeling threat or anxiety in the face of uncertainty" (Wilson, Ausman, & Mathews, 1973, p. 286). The authors assumed that if stimulus uncertainty was just as aversive to conservatives, then this might reflect on aesthetic preference as a rejection for abstract and complex art. In order to test this assumption 16 female and 14 male participants were asked to rate their personal preference on a 7-point liking scale, as well as complete Wilson and Patterson's Conservatism Scale. Materials consisted of twenty artworks divided into four categories: simple representational, simple abstract, complex representational, and complex abstract. The choice of the five paintings in each category was made by an art expert. Complexity was defined as the amount and density of elements (objects, shapes, lines, colours, and so on), and abstraction was defined as a function of the degree with which the elements were identifiable and the extent to which the painting corresponded to visual reality. The analysis of the collected data showed that conservatives' preference for simple representational was greater than liberals', and that the preference of liberals for complex representational and complex abstract was greater than that of conservatives. In fact, conservatives did not show a mere smaller preference for paintings in both categories of complex art, but the average score they awarded was within the dislike pole of the rating scale. The authors concluded that these results provide support for the notion that conservatism represents a reaction against environmental complexity and uncertainty (Wilson *et al.*, 1973).

Savarese and Miller (1979) designed a study to clarify the relation between cognitive style and aesthetic preference. Specifically, they set out to determine whether there would be any relation between participants' preference for paintings varying on the linear-painterly dimension and their performance on an embedded figures and an incomplete pictures tests. These tests require participants to find a single figure confounded within a complex pattern, and to find out the identity of an object drawn with some of its parts are missing, respectively. High scores on these tests require different perceptual styles. Persons who are capable of ignoring the whole and attend to the parts do well on embedded figures, while those who are able to synthesize parts into wholes do well on incomplete figures. In order to establish the relation between these cognitive styles and aesthetic perception, the authors created an Art Preference Test by pairing 36 paintings and sketches of similar subject, but created in two different styles. Paintings and sketches done in the linear style had clear forms, with easily identifiable elements, and a strong emphasis on the outlines. Paintings created in the painterly style stressed mass over contour, elements were not clearly distinguished, and there were no strong boundaries whatsoever. In order to mask the dimension under consideration, an additional 23 pairs were added. In this case, both paintings were done in the same style.

One hundred and thirty seven female and 141 male participants carried out an embedded figures and incomplete pictures task. Thereafter they were asked to choose their preferred painting in each of the total 59 pairs that constituted the

Art Preference Test. Results of this experiment showed that participants with high scores on the embedded figures test tended to show a greater preference for the painterly stimuli than those who had obtained a low score on that test. This association was significant for the male participants, but not for the female ones. There were no significant results in relation with the incomplete figure test. The authors interpreted these results as showing that men who have difficulties in identifying objects in a complex visual field prefer artistic stimuli that places strong emphasis on contours, and thus, makes the elements more salient: "The clear outlines and boundary definitions of linear art in a sense do the perceptual work for these individuals (…) On the other hand, males who do well at disengaging a smaller part from its whole (…) may find the structure of linear art redundant or may simply not have as great a need for it" (Savarese & Miller, 1979, p. 49).

Tobacyk, Myers and Bailey (1981) carried out a study designed to clarify the relation between aesthetic preference and individual differences in cognitive style and personality: field-dependence and sensation-seeking. The first of these constructs distinguishes people who have a more analytic approach to perception and cognition, and who are able to impose structure on unstructured stimuli, from those who are less analytic in their perception and cognition, and who are less able to structure stimuli lacking an inherent structure. The second construct distinguishes people in regards to their optimal arousal level. Higher sensation-seeking is found in people who prefer novel and varied experiences. Eighty-eight female and 122 male participants with no specific art education were asked to rate 40 paintings, presented as slides, on a 5-point scale ranging from a strong liking to a strong disliking. They were also administered standardized field dependence and sensation-seeking measures. Materials were chosen "based upon theoretical considerations, so as to, hopefully, form clear dimensions of painting preference that would be related to field-dependence and sensation-seeking." (Tobacyk *et al.*, 1981, p. 270). Thus materials belonged to several categories: representational paintings of aggressive scenes, representational landscape scenes, representational still-life paintings, and several forms of abstract art, such as minimalist, futurist cubist, and impressionist.

The first step in data analysis consisted in a factor analysis of the responses given by participants on the liking scale, expecting factors to correspond with the chosen stimuli categories. The procedure resulted in 7 interpretable factors: aggression, abstract minimalism, landscape, abstract futurist, portrait, hunting scenes, and abstract impressionism. Thereafter, the authors related the scores on field dependence and sensation-seeking with each of these dimensions. It was hypothesized that participants scoring high on field dependence would show greater preference for the representational categories (landscape, portrait, and hunting) –those with greater structure- and less preference for the abstract categories than participants scoring low on field dependence. It was also hypothesized that participants with high scores on sensation-seeking would prefer abstract categories and the representational paintings rendering aggressive themes than participants low in sensation-seeking. Results showed support for some of these expectations. Specifically, highly field-dependent participants showed greater preference for representational landscape, portrait, and hunting paintings, but did not show less preference for paintings in the abstract categories. Additionally, participants with high scores on sensation-seeking awarded higher ratings to aggressive, abstract futurist, and abstract impressionist pictures, than participants low in sensation-seeking, but there were no significant differences for the other painting categories. Although these results support the influence of cognitive styles and personality traits on aesthetic preference, we feel there are two aspects of the present study that suggest caution. First, given that stimuli were deliberately chosen by the experimenter to create meaningful differences between participants scoring high and low in both measures of individual differences, there is a chance that their results might not generalize to a broader range of artistic stimuli. Second, the largest amount of variance accounted for by either measure on any category was only 9% (Tobacyk, Myers, & Bailey, 1981).

Heinrichs and Cupchik (1985) carried out a study to clarify the relation between personality and aesthetic preference. Three aspects distinguish this effort from the ones we have just described. First, the authors wished to contrast responses to realist vs. abstract art, to representations of specific content (sexuality, aggression) created in different styles: idealized (emphasis on form and conveying proportion and perfection) vs. expressionist (emphasis on the subjective and conveying emotions), and linear (emphasis on outline) vs. painterly (emphasis on mass). Second, participants' responses were recorded on two preference dimensions: interest and pleasure. Third, they did not rely on standard personality inventories, but used a combination of questionnaires, as well as a series of measures of background in art. Materials were constituted by 48 paintings, 32 of which had been rated by judges as to emphasis on sexuality or aggression, and idealization vs. expressionism. There were 8 stimulus in each category resulting from crossing these two dimensions. An additional 16 stimuli were included. These were 4 linear, 4 painterly, 4 representational, and 4 abstract artworks. The 24 male and female participants were asked to view the whole set of materials, presented in pairs, and rate the pleasingness and interest of each stimulus on an 8-point scale: "The subjective set consisted of instructions to view the pairs of paintings in a 'very emotional manner'. Subjects were asked to use their emotional reactions as a guide in indicating on bipolar 8-point scales which painting in a pair was more pleasing and which painting they would like to see again. Under the objective set subjects were encouraged to 'analyse the paintings in terms of composition, style, etc.' in an objective manner." (Heinrichs & Cupchik, 1985, p. 508).

The results of this study revealed significant relations within the sexual and aggression subject dimensions, as well as within the linear-painterly and abstract-representational dimensions. Given the conceptual weakness of some of the independent variables, and the amount of interactions that are difficult to interpret, we will concentrate on the most significant and straightforward results. Participants' ratings of paintings with sexual and aggressive content in the subjective set were predicted by two variables: memories of emotionally inexpressive mothers and emotional lability (intense experiences elicited by affectively charged imagery). Objective ratings were predicted by sex, memories of unaffective fathers, and trait-anxiety. Turning to results concerning the linear-painterly dimension, it was found that participants who showed a great subjective preference for the painterly style, also scored higher on trait-anxiety, felt closer to their mothers than fathers, and reported feeling comfortable in social situations. There were no significant relations for the objective preference ratings. Finally, preference for abstract art was governed by emotional lability, in that people who awarded higher subjective preference ratings to abstract art also tended to report stronger reactions to affectively charged imagery. No significant relations were found for objective preference on the abstract-representational dimension (Heinrichs & Cupchik, 1985).

Furnham and Walker's (2001) study attempted to clarify the relation between aesthetic preference and measures of sensation seeking, conservatism, and the Big Five personality traits. Specifically, the authors set out to show that aesthetic preference for artworks is influenced by conservatism, sensation seeking, neuroticism, openness, agreeableness, conscientiousness, and exposure to art. In order to do so, the authors asked 71 female and 30 male psychology students to express their preferences for 40 paintings, which included traditional representational artworks, abstract paintings, pop art pictures, and 18th and 19th century Japanese paintings. There were five rating scales: how much would they like the painting in an art gallery, how much would they like it in their living room, talent of the artist, how much would they pay for the painting, and their familiarity with it. Additionally, participants were administered a test of art knowledge, a sensation seeking scale, the five factor inventory, and an attitude inventory.

Correlational analyses revealed that scores on Extraversion and Agreeableness were unrelated to preference ratings for the four stimuli categories. On the other hand, participants with high scores on Disinhibition considered pop art and Japanese artists as more talented than low scorers on this scale. Participants who scored high on Thrill and Adventure Seeking considered abstract artists to be more talented, and showed a greater preference for abstract art, than did participants that scored low. Openness to experience was also positively related with preference for pop art and abstract paintings. Conscientiousness was negatively correlated with preference for pop art, but, contrary to original hypotheses, high scorers on this scale rated the talent of representational artists lower than participants with low scores. Finally, Conservatism was negatively related to preference for abstract, Japanese, and pop art. In fact, the negative relation between Conservatism and preference for art which is not traditional or representational, turned out to be the most consistent finding of the study. However, several combinations of Conservatism, sex, familiarity and measures of experience with art explain only between 16 and 32% of the overall variation in preference scores (Furnham & Walker, 2001).

Feist and Brady's (2004) experiment was carried out to study how personality and non-conformist attitudes are related with aesthetic preference for abstract and representational artworks. Based on different theoretical approaches, as well as on prior empirical results, Feist and Brady (2004) expected that, in general, their participants would prefer representational art over abstract art. They predicted, however, that abstract art would be especially preferred by participants with high scores on measures of openness, liberal attitudes, and tolerance for drug use. The selection of participants with high and low scores on openness produced a sample including 55 highly open participants, 36 of which were women and 19 were men, and 49 participants scoring low in openness, 32 women and 16 men. In this case, openness was computed by combining scores on an experience-seeking scale (part of a sensation-seeking test) and an openness scale. Attitudinal information was retrieved by means of an especially designed questionnaire. Participants were asked to rate how much they liked each of the 45 artworks that constituted this experiment's material on a 9-point Likert scale. Stimuli had previously been classified into three categories: abstract, representational, and ambiguous.

Results of this experiment showed that, overall, representational artworks were preferred more than abstract and ambiguous ones. In regards to the magnitude of this effect, the authors report that the degree of abstraction explained 29% of the variance in art preference. Concerning the individual differences studied in this experiment, results also showed that participants with high scores on openness preferred all kinds of art more than participants with low openness scores. This difference was especially marked for the abstract artworks. However, the magnitude of the interaction effect between openness and abstraction explained less than 5% of the variance of preference scores. Finally, liberal attitudes were also associated with a greater preference for abstract art. Demographic variables such as age or sex did not show any significant effects on preference ratings for abstract art (Feist & Brady, 2004). The authors took their results as supporting the notion that people who approach novel events with an open attitude are more appreciative of art in general, and of abstract art in particular.

1.3.3.1. Summary

Some of the studies we have just gone over suggest there might be a relation between certain personality traits or cognitive styles and aesthetic preference. However, these personality traits vary from study to study, especially in the early ones. For instance, whereas Knapp and Wulff's (1963) study suggested the relevant traits were intuitiveness vs. sensation and holding strong religious vs. aesthetic values, Wilson, Ausman and Mathews' (1973) results show conservatism to have a significant impact on aesthetic preference. Subsequent studies have supported the notion that conservatism determines, at least to a certain extent, the responses participants give in aesthetic preference tasks (Feist & Brady, 2004; Furnham & Walker, 2001), though they have also added other significant traits, such as openness (Feist & Brady, 2004), and sensation-seeking (Furnham & Walker, 2001; Tobacyk, Myers, & Bailey, 1981). Some cognitive styles have also been shown to influence aesthetic preference, such as analytic vs. synthetic (Savarese & Miller, 1979), or field dependence (Tobacyk, Myers, & Bailey, 1981).

However, not all the studies have found significant effects of personality on aesthetic preference. Kloss and Dreger (1971) found no relation between personality and aesthetic preference, and Furnham and Chamorro-Premuzic's (2004) model predicting aesthetic preference by a combination of the Big 5 personality traits and intelligence did not reach significance levels. Even in those cases that have found a significant relation between both variables, it seems to be a rather weak one. Furnham and Walker's (2001) study accounted for between 16 and 32% of the variance in aesthetic preference scores, whereas Tobacyk and colleagues' (1981) study did so just for 9%, and Feist and Brady (2004) only for 5%. This has also been noted in previous reviews of studies on the relation between personality measures and aesthetic preference (Hekkert & Wieringen, 1996a). Heinrichs and Cupchik (1985) wrote that "One notable limitation of these and similar studies is the finding that personality measures rarely account for more than a small amount of variability in preferences for different kinds of paintings." (Heinrichs & Cupchik, 1985, p. 503). Hardiman & Zernich (1977) reviewed several early studies attempting to draw relations between aesthetic preference and personality. They noted that their results range from no evidence of such relation to a significant correlation between preference scores and certain personality traits. However, the majority of the studies have produced only small correlations between these two measures. Hardiman & Zernich (1977) concluded that "These studies bring little clarity to the hypothesized relationships between preference and personality. Although several studies used personality assessment instruments that are reliable and valid, there was no generalizability of the stimulus dimensions used to elicit these preference judgments." (Hardiman & Zernich, 1977, p. 469).

Heinrichs and Cupchik (1985) noted that cultural background and general educational level have shown to influence aesthetic appreciation, and that these factors might better explain aesthetic preferences. For instance, Knapp, Brimner and White (1959) found that social class predicted aesthetic preference for Scottish tartan designs. Whereas middle class adolescents showed strong preferences for complex designs without saturated colours or striking contrasts, lower class adolescents preferred simple designs with saturated colours and strong contrasts. Francès (1976) recorded the aesthetic preferences of participants with high and low general educational background for stimuli varying on six kinds of complexity. Results showed that, overall, participants with a high educational background preferred complex stimuli over simple ones, whereas participants with little general education showed the opposite preference trend. Whereas number and variety of elements produced no significant differences between the preferences of both groups, regularity and incongruity produced very significant differences (Francès, 1976).

However, effects of class and educational level on aesthetic preference are not as strong as the influence of art-specific education. It has been suggested that the observed effects of general background are actually due to differences in the amount of specific art education (Hekkert & Wieringen, 1996a). It is interesting to recall that some of the studies we have reviewed above suggest that personality might have a greater impact on artistic interests and activities than on aesthetic judgment and preference per se (Furnham & Chamorro-Premuzic, 2004). Thus, certain personality traits, such as Openness to experience and Conservatism, might attract people towards and away from artistic interests and experience. It is this experience with art, be it formal or informal, which seems to have a greater impact on aesthetic preferences, especially for those styles which are more unfamiliar, such as abstract painting. Let us review some of the studies that have examined this influence of art education on aesthetic preference.

1.3.4. The influence of art training

In this section we will review studies that have searched for differences in aesthetic preference for visual stimuli between groups of people with and without artistic education. Given the objectives of the present work, we will emphasize studies that have taken into account the complexity of stimuli in the determination of aesthetic preference.

The main objective of Eysenck and Castle's (1970b) study was to assess whether participants with and without artistic training would agree in their preference for Birkhoff's (1932) 90 polygons. They asked a very large number of participants to rate the aesthetic pleasingness of each figure on a 7-point scale. Their groups were composed by 369 male and 408 female artists, and 176 male and 180 female controls. The group of artists included people who were attending or had attended courses in graphic, typographic, textile, industrial, interior, stained glass or fashion design, fine arts (painting and sculpture), architectural studies, photography, cinematography, and so on, as well as some professional artists. The group of controls included students enrolled in law, accounting, electrical engineering, catering, hairdressing, surveying, retailing, among other careers. The main finding of this study was that participants with artistic training prefer forms which are characterized by simplicity and order, while the control group seemed to give higher preference ratings to figures which were more complex. Similar results were obtained later Eysenck and Castle (1971) with similar groups of participants but using a different set of stimuli, namely the *Maitland Graves Design Judgment Test*. There are two possible explanations for these results, but these studies were not designed to decide between them. First, training in arts might lead people to develop an appreciation for simplicity and order. Second, people who appreciate simplicity and order are especially proficient in artistic activities. Although only a longitudinal study could actually settle this question, the fact that the scores of artistically trained participants on three different measures of aesthetic sensitivity showed low correlations, led Eysenck (1971b) to tentatively favour the first option.

Bezrucsko and Schroeder (1994) were able to carry out a similar study with even a larger sample of art-trained and untrained participants. They recruited 1,578 people, approximately the same number of men and women, with little or no art training or experience, 107 participants, also almost even numbers of men and women, with some art training and experience, and 62 professional artists whose main activity was the design and production of visual artworks at the time of the study. The latter groups included slightly more women than men, but the main occupation of all of them was painting, sculpting, architecture, or stage and film production. They were all asked to complete a series of artistic judgment scales as well as a battery of cognitive aptitude tests. The former set included the *Design Judgment Test*, the *Visual Designs Test*, and the *Proportion Appraisal* task. The first one, which we have already mentioned, is composed of ninety items, each of which presents the examinees with three visual designs, two of which violate such basic aesthetic principles as balance, symmetry, proportion, unity, and so on. The viewer is asked to indicate which one of the three designs he or she prefers or likes the most. The final score reflects the number of choices that match the one considered by the test's authors to be artistically superior. The second test also requires participants to indicate which stimuli they like most. In this case, they have to choose among stimuli varying in complexity, defined as the number of elements, and order, defined as the degree of repetition of the pattern. The last tests measures preferences for 50 sets of 3 visual designs that differ in their proportions, such as the ratio of width to length of parabolic curves. The set of aptitude tests participants were asked to complete included the assessment of colour perception, several modes of reasoning, numerical abilities, visualization of three-dimensional forms, rotation of two-dimensional shapes, several forms of memory and motor ability, among others. The results of this study showed significant differences between the preferences of professional artists and non-artists on the following dimensions: symmetry, complexity, order, and shape. The most relevant results for our study include: (i) the finding that whereas artists tended to prefer the asymmetrical designs, non-artists preferred the more symmetrical ones; (ii) artists preferred less complex designs than non-artists; (iii) artists preference for unordered designs was higher than that of non-artists; and finally, (iv) the scores of artists on inductive reasoning, spatial ability, visual memory and dexterity were higher than those of non-artists.

However, Eysenck's (1971b; Eysenck & Castle, 1970b) and Bezrucsko and Schroeder's (1994) results are in sharp contrast with studies that have suggested that artistically trained participants tend to prefer more complex stimuli than untrained participants. This trend appeared in the study performed by Barron and Welsh (1952), which had a twofold objective: to discover systematic differences between artists and non-artists in preferences for figures and to construct a scale of artistic discrimination. They asked a group of 37 artists and art students and a group of 150 people without artistic training, who varied in educational and occupational background, to sort 400 figures according to their preference for them. Thereafter, the authors selected 40 items which were consistently disliked by artists more often than non-artists and 25 which were preferred by artists but not by laypeople, making sure that the differences were statistically significant. The study of these figures revealed that all 40 figures disliked by the artist group were simple and symmetrical, while all the figures they preferred, but non-artists rejected, were complex and asymmetrical. The set of 65 figures were used to construct a scale, such that agreement with preferences expressed by the art group awarded examinees a high score. This scale effectively separated the original participating groups, with scores of 16.9 and 40.25 for non-artists and artists respectively. Its application to two different groups also separated artists from non-artists, with scores of 18.37 and 39.07, a highly significant difference. Thus, it is suggested that people with art training or professional artists have a higher preference for complexity than those who do not have art education or carry out artistic activities.

Munsinger and Kessen (1964) designed a series of experiments to study preference for random polygons varying in complexity, determined by the number of turns, which ranged from 3 to 40. They compared the preferences of art students, who had extensive experience with painting and graphic design, with those of inexperienced participants. Results showed that whereas the latter group's preferences increased with the complexity of the polygons to a certain point – around ten turns-, and then decreased for more complex polygons, art students gave very low preference ratings for simple polygons and very high ratings for the most complex polygons. The authors concluded that

> The almost linear relation between preference and number of turns suggests that the art students' past experience with patterns and shapes has changed their preference for variability from that of the unsophisticated observer. This difference can be taken as evidence that experience increases one's ability to group independent characteristics of stimuli and thereby reduce cognitive uncertainty (Munsinger & Kessen, 1964, p. 16).

The study carried out by Taylor and Eisenman (1964) lead to similar conclusions. In this case, however, only art students were included in the experiment, but they varied in creativity (as rated by a member of an art faculty) and experience with arts. Participants were asked to indicate which three polygons he or she preferred most and least out of a set of twelve varying from 4 to 24 vertices. Overall, participants tended to prefer the more complex polygons. However, significant differences were observed between participants rated as highly creative and with greater experience and those rated as less creative and lacking experience in arts. Creative participants showed a tendency to choose more complex figures than the less creative participants. Eisenman and Cofee (1964) attempted to verify whether there were differences between the preference for polygons of art students and mathematics students, who were also familiar with geometrical forms, although from quite a different perspective. They asked 10 art students and 10 mathematics students to express their aesthetic preference for 5 symmetrical and 5 asymmetrical polygons, each of which had six points. Their results showed that the first choice of all art students was an asymmetrical polygon, whereas the first choice of each mathematics student was a symmetrical polygon. The authors concluded that, given that asymmetrical polygons are more complex than their symmetrical counterparts, artists prefer more complex forms than non-artists.

Hare (1974) framed his study of the influence of expertise in the arts on the relation between complexity and aesthetic preference within Berlyne's conceptual structure. As an explanation for the fact that stimuli preferred by artistically experienced participants tend to be more complex than those preferred by laypeople, as revealed by the studies we have just commented (Barron & Welsh, 1952; Eisenman & Cofee, 1964; Taylor & Eisenman, 1964), he suggested that experience with a variety of artistic stimuli might improve the ability to process more complex stimuli, which may increase the amount of complexity required to produce an optimal hedonic tone. Hare's (1974) aim was to verify whether the preference for complexity was limited to the most familiar stimuli class, or whether it would extend to other classes. First he studied the differences between the ratings of complexity, pleasingness and interest for 12 sound sequences varying in uncertainty made by a group of 24 fine art students (enrolled in painting and sculpture courses) and 24 psychology students with not art background. His results showed that the complexity and interest ratings of both groups of participants grew linearly with the uncertainty of the sound sequences. Importantly for our purposes, there were no significant differences between complexity ratings made by participants with and without artistic education. However, preference scores awarded by art students to stimuli with high uncertainty were significantly higher than those awarded by psychology students. A second experiment paralleled this one, but assessed the ratings of random polygons varying in number of sides from 3 to 146 by music and psychology students. Again, participants were asked to rate the stimuli on pleasingness, complexity and interest. Although in this case scores in the three scales increased with the number of sides, there were no significant differences between music and psychology students. Although this study suggests a certain cross-modal transfer of complexity preference, the choice of materials might be masking interesting relations, and the reader is left wondering why the first experiment did not include a group of music students and the second one a group of fine art students, which would have provided an interesting reference point.

More recently, Hekkert, Peper and Van Wieringen (1994) designed an experiment to clarify the influence of the instructions given by the experimenter on differences between artistically trained and untrained participants' ratings of rectangles varying in proportions. They created two counterbalanced conditions. In one of them, twelve participants with art education and twelve with no art-related experience, were asked to express their (subjective) aesthetic preference for a series of rectangles presented in a paired comparison procedure. Specifically, they had to choose the one they found more pleasing or attractive. In the other condition, participants were asked to make an (objective) aesthetic judgment by choosing the one they believed was better proportioned or more balanced. The analysis of the participants' responses indicated that in the subjective condition both groups showed a preference peak for proportions close to the golden section, with trained participants exhibiting an additional peak for proportions close to the square. Under the objective condition both groups of participants showed a maximum preference for rectangle proportions close to the square. Thus, it seems that differences between groups of participants varying in experience with art are especially large when they are asked to rate their preferences. These differences tend to disappear when they are asked to conform to some external objective criterion (Hekkert, Peper, & Van Wieringen, 1994).

Neperud (1986) asked seventeen art students, 4 of which were male, and 31 non-art students, including 7 males, to rate representational and abstract pictures, collages, and patterns on a series of bipolar adjective scales designed to measure pleasingness, hedonic tone, arousal, and uncertainty. Evaluative ratings (which were taken to represent hedonic tone) of art students were higher than non-art students. The ratings on pleasingness given by art students to abstract stimuli were also significantly higher than those given by non-art students. There were no significant differences between these two groups of participants on the arousal and uncertainty scores, nor on the pleasingness scores given to representational pictures. These results were interpreted by the author as evidence that artistic education provides information about art styles, the structure and organization of compositions, that results in differences in the way art is viewed and valued (Neperud, 1986).

Winston and Cupchik's (1992) work represents one of the best-designed studies of the effects of art education on aesthetic preference, and stimulated further research in this area with more ecologically valid stimuli. They recruited 17 male and 14 female Psychology students, who had never undergone any art-related courses, and 10 male and 15 female art students, who had taken at least five art history or studio art courses. All participants were asked to rate 50 stimuli on four 7-point scales: pleasant-unpleasant, simple-complex, warm-cold, and like-dislike. Half of the stimuli used in this study belonged to the popular art category, and the other were exemplars of high art. The former included sentimental, anecdotal paintings and wildlife prints, country scenes and children, while the latter included works exhibited in great museums and collections of the world, and are valued by art critics and curators. Whereas popular pictures emphasize the pleasing effects of the represented subject, providing soothing emotions for the viewer, high art pictures achieve a balance between subject matter and style, and explore a greater variety of emotional effects (Winston & Cupchik, 1992).

Results showed significant differences between art-trained and untrained participants on some of the measurements. Whereas untrained participants expressed a greater liking for popular art than for high art, experienced participants expressed the opposite preference. Furthermore, untrained participants found popular art to be warm and pleasant and high art to be more unpleasant and colder, while there were no significant differences between ratings of art-trained participants on warmth and pleasantness for high art and popular art. The last significant difference on the scales refers to the ratings of complexity. Untrained participants did not rate high art and popular art differently, but experienced participants rated the complexity of high art stimuli higher than that of popular art (Winston & Cupchik, 1992).

Hekkert and Wieringen (1996b) compared the ratings of a group of non-experts (university students lacking experience or interest in art), a group of relative experts (senior industrial design students), and a group of experts (senior art school students with at least two years of education and experience related with visual arts) on a series of scales. These included three referring to colour, as well as like-dislike, abstract-figurative, balanced-unbalanced, and complex-simple. The materials used in this study consisted of 12 postimpressionist paintings, 12 black and white versions of the same paintings, 12 distorted versions of the same paintings which appeared abstract, and 12 black and white versions of the distorted pictures. The analysis of these ratings led to several interesting results. First, the liking scores given by non-experts and relative experts to representational stimuli were significantly greater than those given to abstract stimuli. However, this difference was not significant for the group of art experts, which suggests that as expertise increases, the preference of the representational over the abstract versions decreases. Second, whereas art experts expressed similar liking for the colour and black and white versions, non-experts and relative experts preferred the colour versions.

Hekkert and Wieringen's (1996a) study is characterized by a series of interesting issues. First, whereas other similar studies have recorded participants' preferences or liking scores, here participants were asked to rate the stimuli along dimensions which represent criteria commonly used to discuss the merit of artworks. Second, the material used in this study is composed of a set of works created by young artists beginning their careers. This choice aimed at offering participants with unfamiliar stimuli that would also reach standard artistic qualities. Stimuli ranged from representational to abstract and from traditional to avant-garde works. The third feature has to do with the degree of expertise of the participants rating the stimuli. In this case, the group of experts included 16 well-established artists and 18 gallery directors, curators and art critics, whereas the group of non-experts included 26 people with professions unrelated to art, but who showed a certain interest in art, that is to say, they regularly visited museums and art galleries, read art reviews in magazines, or carried out amateur artistic activities. Participants were asked to rate the material on several scales, including complexity, craftsmanship, expressive power, interest, quality, originality, concept richness, and so on, as well as an average quality score. The analysis of the scores awarded on these scales by both groups of participants revealed that artists relied most heavily on concept richness, craftsmanship and originality when awarding the mean score. Conversely, non-artists relied mainly on craftsmanship and development of individual style. Furthermore, experts and non-experts showed significant differences in their ratings of concept richness, expressive power, interest and quality, although they agreed on complexity, dynamics, coherence and originality.

Furnham and Walker (2001) asked 71 female and 30 male psychology students varying in experience and interest in art to rate 40 paintings, including traditional, abstract, pop art, and 18th and 19th century Japanese relatively unknown artworks, on five different scales. These were: (i) how much they would like the painting in a gallery; (ii) how much they would like the painting in their living room; (iii) how talented did they consider the artist; (iv) how much would they pay for the painting; (v) how familiar they were with the painting. They also asked their participants to complete a demographic questionnaire, a test of their knowledge of art, as well as some personality scales. The results of this study showed that those participants who had studied art more and those who regularly went to museums tended to award higher talent scores to pop art and abstract stimuli. The authors concluded that people who have studied some art, attend exhibitions, or visit galleries, are more likely to have a better grasp of the meaning of works of art, and have developed skills related with the interpretation of art, such as an understanding of the intention of artists or the historical relevance of certain art movements.

The objective of the study carried out by Locher, Smith and Smith (2001) was to assess the impact of different format presentations when asking trained and untrained participants to rate certain features of artworks. The same nine works of art were presented to three sets of artistically trained and untrained participants in a gallery (20 trained and 20 untrained participants), on slides (20 trained and 30 untrained), and by means of a computer (20 trained and 25 untrained). Participants were asked to rate the stimuli's complexity, symmetry, familiarity, interest, and pleasingness, among other features, on 9-point scales. We will not discuss the results related with format presentation; instead, we will focus on the significant effects found between the expert and non-expert groups. The authors found main effects for training and a single instance of interaction between presentation format and viewer training (for the similar-contrasting rating scale), and considered this as a spurious result. Regarding the differences between the two groups, and irrespectively of format, trained participants found the stimuli to be more complex, varied, asymmetrical, contrasting, interesting and pleasant than the untrained participants.

Despite the studies reviewed until now, not all experiments have produced significant differences between art-trained and untrained participants. A good example of this is the work carried out by Neperud and Marschalek (1988) and Lindauer (1990). Neperud and Marschalek (1988) asked 26 participants with no art education and 14 participants who had received a considerable amount of artistic education to rate 20 black and white stimuli on the following 7-point scales: beautiful-ugly (taken as a measure of hedonic tone), powerful-powerless (taken as a measure of arousal), active-passive (considered as a measure of uncertainty), and pleasant-unpleasant (a measure of aesthetic preference). Stimuli consisted of four original paintings (a male portrait, a female portrait, a landscape, and a cityscape), and four altered versions of each. These versions were obtained by increasing and reducing the number of black pixels by 10 and 20%. Thus, stimuli were graded according to information density, with the original representing the intermediate level of information. As we just mentioned, the results of this study revealed no differences between both groups of participants. In both cases the measure of arousal showed an asymptotic tendency to grow with information density, and in both cases hedonic tone and preference ratings were not influenced by level of information (Neperud & Marschalek, 1988). Very similar results were obtained with an additional group of 21 participants with art education and another of 21 without. We believe that the lack of differences due to artistic education lie in the kind of stimuli manipulation performed to produce the information levels. The authors equated information density with complexity, and thus, expected to find an inverted U distribution of preference. However, inspection of the example of materials provided in the paper suggests that the increase and reduction of black pixel percentage might have two opposite effects on perceived complexity. On one hand, increasing pixels does indeed result in increased information, but most of it is redundant. On the other hand, the reduction of pixels does reduce information density, but it also increases the uncertainty as to what is represented. Hence, the authors might have used a kind of transformation that leads to effects that cancel themselves out, producing no real effect on perceived complexity.

Lindauer (1990) studied the aesthetic appreciation of mass-produced art by art-trained and untrained people. This is an affordable form of art found in offices, hotels, homes, and public places. It sometimes resembles high art, but it is not found in museums. It is based on borrowed ideas with little originality, and it is produced mainly to be sold in large amounts. Despite all of this, it undoubtedly has a broad audience. Materials included 24 reproductions of this kind of art, twelve of which had been rated in a previous study as highly liked by a group of untrained participants, and twelve had been negatively rated. In the current study participants included a group of 12 art students (2 men), 15 dance students (1 man), and 15 students with no art or dance education (10 men). They were asked to rate how much they liked each of the stimuli on a 7-point scale ranging from least liked to most liked. Contrary to the author's original hypothesis, which suggested art students –and maybe dance students- would give lower ratings than non-art students, the three groups of participants gave higher ratings to the paintings previously catalogued as most liked than to those pre-classified as least liked. The only difference to be found was that positive ratings by art students were lower than those by the other two groups. The author concluded that this kind of decorative art is "highly regarded by people of all backgrounds" (Lindauer, 1990, p. 106).

Most of the studies we have reviewed in this section provide evidence that ratings of preference and artistic merit differ between participants with and without art education. What is the reason for these differences? In the remainder of the present section we will consider several possible explanations: (i) differences in the attributes on which participants base their judgments; (ii) differences in the visual exploration of the stimuli; (iii) differences in visual cognition proficiency; (iv) differences in the cognitive representation of the stimuli; (v) differences in the appraisal of the stimuli. All of these differences are believed to contribute to a greater tolerance of art-trained participants for complexity, and are reviewed below.

O'Hare (1976) used multidimensional scaling techniques to assess whether trained and untrained art viewers attend to different attributes or artworks when judging their similarity and when expressing their preference for them. Participants included an initial 16 undergraduate students in their first year of psychology and 19 first-year art students who had been studying art full-time for at least three years. After familiarizing all the participants with the twelve projected reproductions of landscape paintings created in a variety of styles which served as material, he asked both groups to make judgments of the degree of similarity for every pair of pictures. Thereafter they were asked to rank the pictures they had seen in order of preference. The examination of the reliability of the similarity judgments revealed that sixteen participants did not reach the established criterion and their judgments and ratings were not considered further, which left a sample of 9 participants with art education and 10 without. The analysis of the similarity judgments revealed two main underlying dimensions. The first one distinguished highly realist landscapes from the less representational ones, and the second set the stimuli apart according to their clarity of detail. It was shown that whereas art-trained participants tended to prefer the less realist but clearer paintings, the untrained participants tended to prefer the highly realist but indefinite stimuli. Furthermore, it was also noted that art-trained participants relied more heavily than the others on the clarity dimension to carry out the similarity task, while the untrained participants based their similarity judgments mostly on the degree of realism.

Hekkert and Wieringen (1996b) results also suggested that differences between the aesthetic rating of visual stimuli by participants with and without artistic training owe to the two groups emphasizing different aspects of the works presented. It seems that untrained people rely more on semantic features, such as the content or the themes of the pictures, and colour properties, and their way of perceiving is regarded as an extension of common perception. Non-expert participants have generally shown realistic works of art over abstract ones. These participants only rely on formal aspects when rating abstract images. Conversely, the reliance of art-trained participants on content is minimal, whereas they emphasize formal, stylistic and relational properties. Their responses take into account elements which are specific to the fields of the arts, and their aesthetic perception seems to be different from common perception (Hekkert & Wieringen, 1996b).

These conclusions were supported and expanded by Winston and Cupchik's (1992) aforementioned study. High art and popular art stimuli were presented in subject-matched pairs, and participants were asked to choose their preferred item and to indicate the reasons for their choices among 13 possibilities that included such factors as 'expressiveness', 'realism', 'familiarity', 'induces happiness', 'reminiscent of things in their lives', and so on. Afterwards, participants responded to a questionnaire about art philosophy, whose scores load on two factors: interpretative challenge and the viewer's experience of pleasure. The different preference of the two groups for the different kinds of stimuli we noted above was confirmed by the choice trial results, which indicated that the most frequent choice of untrained participants had been popular art, and that trained participants had most often chosen the high art alternative. The reasons given by experienced participants tended to be originality, abstraction, expressiveness, complexity and dynamism. Untrained participants tended to base their response on warmth, realism, reminiscent of daily things or events and peacefulness. Hence, it seems that naïve participants responded to qualities of artworks which provide pleasant feelings, while experienced participants responded to abstract and expressive qualities of the stimuli. The questionnaire also revealed that "Pleasure is more important for naïve viewers, and forms the basis for their valuing of popular art and rejection of high art. Challenge is more salient for experienced viewers, and governs their rejection of popular art and preference for high art" (Winston & Cupchik, 1992, p. 11). So, participants with art education seem to have developed a different conception of the purpose of art, constituted around the belief that art should challenge the viewer's view of the world, express deep feelings of the artist, and require effort from the viewers. Untrained participants, conversely, believe paintings should evoke peaceful and tender feelings, and happy memories, give immediate pleasure and appeal to a large number of people. This difference in art philosophy may be the cause of the observed differences between the responses to artistic and decorative stimuli by both groups of participants. While untrained viewers generalize from everyday perception and search for the familiar and moderately stimulating, art-trained people go beyond the immediate represented meaning and objects, and search for the indications of harmony, composition, contrast, texture, and emotional expressiveness.

Hence, the studies by O'Hare (1976), Hekkert and Wieringen (1996b), and Winston and Cupchik (1992) suggest that differences in aesthetic preference between participants with and without art training or experience are related at least with the fact that both groups of participants base their preference ratings on different attributes of the presented stimuli. However, as we mentioned above, there are additional factors explaining the effects of art training on aesthetic preference. Nodine, Locher and Krupinski (1993) designed a study to determine whether there is a relation between the differences in preference ratings between participants with and without art education and differences in the strategies of visual exploration of artistic materials. The analysis of eye-fixation patterns while participants scan visual stimuli is able to distinguish two distinct kinds of exploration. Dispersed and sparse clusters of eye-fixations are usually associated with extracting information from global pictorial features, such as symmetry or the relation between the compositional elements (diversive exploration). Patterns revealing clearer high-density clusters are associated with a different information-gathering strategy. They are believed to reflect an interest on the semantic aspect of certain specific elements of the artwork (specific exploration). The general trend of scanning visual stimuli shows that the first pattern is most common during the initial stages of visual processing, while the second one progressively becomes more relevant during later stages.

Nodine, Locher and Krupinski (1993) created a set of stimuli by altering the formal balance of six paintings by renowned artists, namely Seurat, Mondrian, Bellow, Cézanne and Gauguin, such that the elements in one version exhibited a more formal geometric arrangement than in the other. They then asked seven untrained participants and seven other participants who had received formal art training, were professional artists, or were working in art-related fields, to view each of the twelve stimuli for 12 seconds while their eye movements were recorded. After viewing each of the six pairs, the participants were asked to say which version they preferred "in terms of aesthetic and pleasing expressions of harmony and beauty" (Nodine *et al.*, 1993, p. 222). The results of this study showed there are differences between trained and untrained participants in two main aspects: the kind of exploration and the design area preferentially attended to. First, art trained participants exhibited a greater degree of diversive exploration for the unbalanced versions than for the balanced versions, whereas the untrained participants carried out more diversive exploration for the balanced versions. These results are interpreted by the authors as implying that "training leading to the recognition of design structure can lead to faster attainment of equilibrium. Certainly, untrained viewers were less prepared to separate issues of form and balance from issues of content in judging aesthetic value than were art-trained viewers" (Nodine *et al.*, 1993, p. 224). Second, results also showed that art-trained participants spent more time looking at background features, whereas untrained participants spent more time focusing on central and foreground figures. Given that assessing the relations among shapes, colours, and space requires information about background features, the authors believe that art-trained participants attended primarily to the relationships among objects, and the untrained group attended mostly to the objects as individual elements. "Thus, formal art training results in a shift of purpose of perceptual scanning away from local feature analysis and information gathering to global recognition of pictorial structures and their relationship to narrative themes (i.e. from picture-driven to schema-driven purposes)" (Nodine *et al.*, 1993, p. 227).

The third factor behind art-trained and naïve participants diverging aesthetic preferences, namely that visual artists differ from non-artists in visual cognition, was tested by Kozbelt (2001). He asked 46 participants varying in training and practice with drawing to complete four perception tasks, in addition to seven drawing tasks which we will not consider here. Participants recruited for this study included 17 first-year art students, 13 fourth-year art students, and 16 first-and fourth-year students who majored in other subjects and had no experience with drawing. The four perception tasks required participants to identify the subject of an out-of-focus picture (out-of-focus picture task), identify the subject of a drawing with missing visual information (Gestalt completion task), find a simple shape hidden within a complex pattern (embedded figure task), and to compare two block figures to determine whether they can be matched through rotation (mental rotation task). Results showed that experienced participants, even first-year art students, significantly outperformed inexperienced ones in every single perception test. Kozbelt (2001) suggested that these results owe to the great experience of artists with the demands of drawing and other artistic activities, which would have led them to develop a greater declarative knowledge about the visual world, as well as flexible procedures for understanding key structural characteristics of visual representations.

Cela-Conde, Marty, Munar, Nadal and Burges (2002) assessed the validity of the fourth explanation for differences between the preferences of participants with and without art training. Their study was designed to verify whether there were differences in the way in which art-trained and untrained participants encoded visual artistic and non-artistic representations, both abstract and representational. They recruited 50 participants with art education, fourth- and fifth-year art history students, and 50 participants with no artistic background, fourth- and fifth-year psychology students. The materials they used were composed of 48 relatively unknown High Art and 48 Popular Art black and white reproductions. Half of the stimuli of each kind were abstract and the other half were representational. This made a total of 96 images equally divided in four categories (abstract High Art, representational High Art, abstract Popular Art, representational High Art). Images were selected such that they could be assembled into 48 pairs of target and distracter, according to their role in the recognition task. Distracters were selected according to the following criteria: they were created by the same author in the same period and exhibited the same theme as the targets. In an initial session, participants were asked to look carefully at each of the target stimuli. Twenty-four hours later, participants were randomly presented with the whole set of targets and distracters, and were asked to mark each of them as seen or unseen the previous day. Results show that whereas all participants were better at detecting High Art representational targets than High Art abstract targets, there was no difference in the detection of abstract and representational Popular Art targets. The difference between art-trained and untrained participants appeared only for High Art stimuli. Here, the detection of abstract targets by untrained participants was significantly worse than their detection of representational ones. Conversely, there were no significant differences between trained participants' detection of abstract and representational targets. This was interpreted by the authors as revealing that art-trained participants were more capable of finding semantic content in the abstract High Art stimuli than untrained participants.

The last possible reason for differences in aesthetic preference related with art education was tested by Silvia (2005), whose approach represents an ongoing effort to explain the affective components of aesthetic experience by means of appraisal theories of emotion, which suggests that emotions arise from the subjective evaluations people make of objects and situations. Silvia (2006) explained why aesthetic preferences of artistically trained and untrained participants differ. Although his research focus has been on interest, rather than beauty, he presents an interesting case in favour of the notion that the aforementioned differences stem from differences in the appraisals made by trained and untrained participants. Prior research had shown that interest has a relatively simple appraisal structure, consisting of two basic appraisals: novelty-complexity and coping potential. Silvia (2006) designed to experiments to verify whether experience and art affects appraisals relevant to interest. It could be that trained participants of finding complex art more interesting because they view it as more complex, easier to understand, or both.

He asked 50 participants, only eight of which were men, to rate a set of 12 pictures. Half of the participants were students of art, art history, graphic design, or interior architecture. The other half had taken no college classes in art, and expressed a low interest in art. The materials used included stimuli that had been previously rated as very simple and six stimuli that had been previously rated as a very complex. Participants were asked to rate their impressions on 6 semantic scales, two of which measured interest (interesting-uninteresting and boring-exciting), one measured appraised complexity (simple-complex), and 3 measured coping potential (comprehensible-incomprehensible, coherent-incoherent, easy to understand-hard to understand). Results showed an interaction for training in art and complexity, in that training did not affect interest in simple pictures but it did increase interest in complex pictures, just as the literature we have reviewed above would suggest. The analysis of the data pertaining to appraisals showed that training had an insignificant effect on appraised complexity, but a significant effect on the appraised ability to understand (average of the three coping potential scales). Both groups of participants expressed a lower ability to understand complex pictures than simple pictures, although in both cases trained participants expressed the highest appraised ability to understand. Hence, Silvia (2006) concluded that they increase interest shown by art-trained participants owes to the fact that they feel more capable of understanding the visual stimuli.

1.3.4.1. Summary

In this section we have reviewed a number of studies showing that formal art education influences aesthetic preference for diverse visual stimuli varying in complexity. Although some of these suggest that participants with art education prefer simpler materials than uneducated participants (Bezrucsko & Schroeder, 1994; Eysenck & Castle, 1970b), most of them have presented results favouring the opposite pattern, that is to say, that scores awarded by educated participants to complex stimuli are higher than those awarded by uneducated participants. Conversely, laypeople tend to express greater preference for simple stimuli than experts (Barron & Welsh, 1952; Hekkert *et al*, 1994; Munsinger & Kessen, 1964; Neperud, 1986; Taylor & Eisenman, 1964; Winston & Cupchik, 1992). These differences could owe to the influence of cognitive processes in any of the stages identified by Leder and colleagues (2004), such as differences in visual exploration strategies, visual cognition, attributes attended to, cognitive representation, and appraisals (Cela-Conde *et al.*, 2002; Kozbelt, 2001; Nodine, Locher, & Krupinski, 1993; O'Hare, 1976; Silvia, 2005; Winston & Cupchik, 1992).

1.3.5. The influence of sex

The final factor influencing aesthetic judgment that we will review in the present work is sex. Here we use the term "sex" and not "gender" following Ashmore's (1990) distinction between these concepts. Thus, here we will take the former to refer to the set of biological and evolutionary factors that contribute to the ways in which men and women appear, behave, think, and feel. Gender, on the other hand, will be understood as the set of differences between the cultural constructs "male" and "female". Given that our primary interest lies in the performance of cognitive and affective processes in aesthetic judgment and preference tasks, and not in the cultural aspect of male and female roles, we feel the use of the term "sex" to refer to differences between women and men is more appropriate.

Several studies have suggested that there are significant differences between the aesthetic behaviour of women and men. These differences refer, on the one hand, to women's greater aesthetic sensitivity, as reflected, for instance, in their higher scores on the *Maitland Graves Design Judgment Test* (Eysenck & Castle, 1971) and on the *Visual Aesthetic Sensitivity Test* (Chan, Eysenck, & Götz, 1980; Frois & Eysenck, 1995), although the significance of these differences varies across the studies, some even showing non-significant differences (Bernard, 1972; Götz, Borisy, Lynn, & Eysenck, 1979). On the other hand, differences have also been observed in regard to aesthetic preference. Although these differences do not seem to emerge with very simple stimuli, such as colours (Eysenck, 1941a), some studies have revealed differences between men and women's preference for more complex stimuli. We will review some of these studies in greater depth, given that the present work is concerned with aesthetic preference and involves the use of more complex stimuli.

However, before we delve into this review, we must acknowledge the fact that the general study of sex differences has been the object of criticisms on various fronts. Although this is not the place to spell out these objections, we must at least take them into account when reviewing the specific literature on sex differences in aesthetic appreciation. Ashmore (1990) pointed out the lack of agreement among studies of sex differences concerning the existence and extent of such differences as one of the field's most obvious weaknesses. This disagreement arises from many procedural variations in the literature. For instance, the characteristics of the participants in the studies –most notably age-, the instruments used to measure differences, the different weights awarded to culture and biology, as well as the studied variables themselves, are often a source of incoherence among the results of different experiments. The methodological and conceptual problems related with the results of studies on sex differences has led some researchers to call for the restriction or elimination of reports on this topic. However, instead of ignoring the work that has been carried out in relation to the objective of our present study, we believe that a careful analysis is called for. Thus, in agreement with Ashmore (1990), if only to point out possible ways to improve the design of future work, it is profitable to review some of the most significant literature on sex differences in aesthetic preference, but we must not be oblivious to the problematic issues we mentioned above.

One of the first experimental studies of sex differences in preference for aesthetic stimuli or artworks was carried out by Frumkin (1963). He asked 228 male and 302 female undergraduate students to numerically express their appreciation for 30 colour reproductions of paintings by renowned artists representing a broad spectrum of styles, ranging from traditional to avant-garde. The results of this study showed that the general appreciative scores awarded by women were significantly higher than those awarded by men. This general tendency was particularly marked for modern paintings. Although this study merits recognition for the recruitment of a large amount of participants, there seems to have been no causal hypothesis to test, and the author suggests no explanation for the identified differences. Furthermore, there is no way to tell whether the differences are related to the fact that stimuli were artistic, or they are common to other forms of visual stimuli. In addition, the study reports no demographical information concerning the participants other than they were college students. The lack of information about art background and interest, as well as the absence of a theoretical framework, makes it difficult to go beyond the conclusion that, overall, the men and women who participated in the study differed in the kinds of artworks they preferred.

Johnson and Knapp's (1963) study represents a more sophisticated attempt, in that they analyzed aesthetic preferences of men and women for three different art forms: verbal imagery used in poetry, visual artistic stimuli and tartan designs, and music. Although our main focus will be on the results they obtained using visual stimuli, it might be useful to frame them within the results they obtained using other materials. Their study of preference for poetic metaphor revealed that men and women's preference for metaphors is greatly influenced by the subject. Whereas men tended to prefer powerful and aggressive images, women preferred metaphors of containment and self-improvement. Although these differences were statistically significant, the authors noted that they are not as influential as other variables, such as social background and interest in art. Differences in preference for music were, for the most part, non-significant. As the authors suggested, this could be due to the low number of participants –thirty-two men and twenty-eight women- and to the limited range of stylistic variation of the compositions they used as materials –sixteen musical selections from 19th century composers.

Turning now to their work with visual stimuli, Johnson and Knapp (1963) performed two studies, one using abstract paintings and the other with tartan designs. In both cases, the choice of materials aimed to minimize the possible influence of subject matter. For the first study they recruited 100 participants, equally distributed between male and female students enrolled in art-related and unrelated courses, and asked them to express their preference for 25 abstract artworks produced by renowned artists. The results of this experiment showed that there were no significant differences between art-trained men and women. Conversely, the comparison of the preference scores of untrained men and women revealed significant differences. This difference owes mostly to the fact that untrained male participants tended to prefer clean, geometrical styles, with round and curvilinear features more than untrained women did. Interestingly, differences between untrained women and the trained participants (both men and women) were much smaller than the differences between untrained men and the trained participants.

As we mentioned above, these authors carried out a second experiment using visual stimuli: tartan designs. In this case, four groups of participants, distributed as in the previous experiment, were asked to rate their preference for each of 30 tartan plaids reproduced in colour prints. These had been classified by the authors in four kinds: warm colour (red, orange, yellow) with an open broad design, warm colour with a closed fine design, cold colour (blue, green) with an open broad design, cold colour with a closed fine design. The results of this study revealed that men preferred warmer colours than women did. However, whereas this difference is significant for participants without art training, it is not for the art-trained groups. Furthermore, the preference ratings awarded by men to closed fine designs were higher than women's. Again, this difference was non-significant for the art students and highly significant for the non-art students.

The study carried out by Bernard (1972) is interesting both in its methodology, which emphasized ecological validity, and in that it is one of the first to be explicitly designed to assess sex differences in aesthetic preference. The author did not require participants to score or rate several stimuli on given scales, but studied the purchases of 78 single men and 80 single women, chosen from the clients of an art reproduction gallery in Paris. The results show noteworthy differences between men and women regarding the painting style and the represented subject matter. There were few differences between male and female choice of classic paintings, but the preference of women for impressionist artworks was greater that that of men, who seemed to prefer modern works, expressionist and cubist. The greatest difference concerned abstract works of art, which represented 10% of their total purchases, whereas women did not purchase a single abstract painting. Regarding the represented content, there was a striking difference in men and women's preference for sceneries, the former preferring harbours and aquatic landscapes, and the latter showing a greater appreciation for city scenes.

More conventional laboratory procedures were used in subsequent studies. Let us comment here Savarese and Miller's (1979) results concerning sex differences. In their experiment, 137 female and 141 male participants carried out an "embedded figures" task and an "incomplete pictures" task. Thereafter they were asked to choose a painting from each of the 59 pairs that constituted the *Art Preference Test*. These stimuli varied on a painterly-linear dimension. As we mentioned before, the results of this experiment revealed that male participants with high scores on the embedded figures test tended to show a greater preference for the painterly stimuli than those who had obtained a low score on that test. This association was not significant for the female participants. Thus, performance on an embedded figures test could predict men's preference for painterly or linear art, but not women's. The authors concluded that "female preferences for linear or painterly art are based on strategies that are at least in part different from the strategies used by males." (Savarese & Miller, 1979, p. 49).

Polzella (2000) asked 38 men and 55 women enrolled in an introductory course to Psychology to rate reproductions of 40 representational artworks on 12 seven-point scales, which included complexity, interestingness, pleasingness, beauty, among others. Materials included samples of five artistic periods (Renaissance, Rococo, Impressionist, Post-Impressionist and Modern Art) and of four subjects (portraits, landscapes, still lifes and depictions of behaviours). The analysis of the data revealed no main effect for sex in any of the rating scales, but there was a significant interaction between sex and artistic period in some of the scales. Namely, women found the Rococo and Impressionist paintings more pleasing than did men, and they rated Impressionist stimuli as more pleasurable and relaxing than did men. Ratings of beauty also showed a significant interaction between sex and period, with women rating the beauty of Impressionist and Rococo higher than men, and Modern Art lower than men. However, these differences did not survive the significance level correction for multiple comparisons. Finally, there were no significant differences between the scores awarded by men and women to the stimuli in regards to complexity.

The study carried out by Furnham and Walker (2001) we mentioned in section 1.3.4 also revealed some interesting results in relation to sex. Let us recall that they asked 71 female and 30 male participants to rate 40 paintings, including traditional, abstract, pop art, and Japanese ones, on five different scales: how much they would like it in a gallery, how much they would like it in their living-room, talent of the artist, how much would they pay, and their familiarity with each painting. Significant differences between the sexes appeared in several scales. Specifically, women would like traditional, pop art, and Japanese paintings in their living room less than men would. They also rated pop artists as less talented than men did, and rated pop art as less valuable than men.

It must be noted that not all studies that have addressed sex differences in aesthetic appreciation have found differences between male and female preferences. For instance, sex differences were studied in Lindauer's (1990) research on aesthetic appreciation for mass-produced art. Let us recall that materials included 24 reproductions of this kind of art, twelve of which had been rated in a previous study as highly liked by a group of untrained participants, and twelve had been negatively rated. Participants included a group of 12 art students (2 men), 15 dance students (1 man), and 15 students with no art or dance education (10 men). They were asked to rate how much they liked each of the stimuli on a 7-point scale ranging from least liked to most liked. The results of this study revealed that "Sex differences played no role in these judgments. Men and women equally liked the paintings, either the set as a whole, or the works divided into those relatively liked or disliked" (Lindauer, 1990, p. 99).

Farrell and Rogers (1982) designed an experiment to determine the influence of age, sex, and IQ on aesthetic appreciation. They recruited three groups of twenty participants from fourth, seventh, and eleventh grades and asked them to choose some words from a pre-selected list of 10 items to describe each of 11 stimuli and their reactions to them. The stimuli were postcard-sized reproductions of samples of western art considered masterpieces, but were quite unfamiliar to the participants. The words that participants could select from were: funny, warm, heavy, calm, serious, sad, weird, soft, old, and loud. The results of this experiment revealed no differences owing to sex, age or IQ, and the words chosen by the participants seemed to be mainly determined by the paintings themselves. We think that the contrast between this study's results and the others mentioned above might be related to two facts. First, this is the only study we have reviewed in this section in which aesthetic responses were elicited from children. Second, the sample of materials is constituted by a small number of stimuli, and the words the participants had to choose from did not include any related to beauty or preference, such as nice, pleasant, beautiful and so on.

1.3.5.1. Summary

We have reviewed a number of studies which give more or less complete descriptions of how the aesthetic preferences of men and women differ. But when attempting to put forward an explanation for these differences there is not much to draw on. In fact, if we take Leder and colleagues' (2004) five stage model as a guideline of cognitive processes involved in aesthetic appreciation, we must conclude that, at present, there is no way to determine whether sex differences in aesthetic preference owe to perceptual, mnemonic, semantic or affective processes, or any combination of them. However, there is data from other fields of inquiry suggesting that men and women might differ in all of these processes, and in the integration of cognitive and affective information.

There is evidence to support that men and women differ in their performance on tasks involving the cognitive processes included in Leder and colleagues' (2004) first stage, perceptual analysis. Moving beyond discussions about whether these differences owe to biological or social factors, McGuinness (1976) and Richardson's (1997) reviews of the literature, as well as Voyer, Voyer and Bryden's (1995) metaanalysis, suggested that men perform better than women on certain measures of spatial ability. There is also strong evidence showing that these perceptual differences are related with differences in brain activity. For instance, Georgopoulos and colleagues (2001) found that when performing an object construction task men engage the right hemisphere predominantly, while women tended to show a left hemisphere lateralization. Bell, Willson, Wilman, Dave and Silverstone (2006) found significant differences between male and female's neural correlates of the performance of a word generation task, a spatial attention task, and a working memory task. These differences were apparent even in instances when performance in these tasks did not vary. In addition, they also suggested that sometimes differences in performance might not be reflected in the neural correlates.

The role of memory in aesthetic preference was also pointed out by Leder and colleagues (2004) and Chatterjee (2003). Gender differences in memory and its neural correlates have been identified in several studies, mainly in those involving the recognition of affective stimuli (Mackiewicz, Sarinopoulos, Cleven, &

Nitschke, 2006). Nevertheless, there is also evidence for sex-related differences in autobiographical memory (P. J. Davis, 1999; Fujita, Diener, & Sanvik, 1991). In fact, Piefke, Weiss, Markowitsch and Fink's (2005) results suggest that even when behavioural differences are not apparent in the access to autobiographical information, differences in neural activity are still observed.

The role of affective processes in aesthetic preference was underscored by both Leder and colleagues (2004) and Chatterjee (2003). There is a great amount of evidence showing sex-related differences in emotion and affective disorders (APA, 1994; Bradley, Codispoti, Sabatinelli, & Lang, 2001; Brody, 1993). Moreover, it seems that these differences in the processing and expression of emotions are accompanied by differences at a neurobiological level. For instance, Tranel, Damasio, Denburg and Bechara (2005) found evidence suggesting that women tend to use verbally-mediated strategies during the processing of emotional information more than men. The results of Kemp, Silberstein, Armstrong and Nathan's (2004) study showed that despite there were no significant differences in subjective mood or ratings of pleasantness of a set of images taken from the IAPS (International Affective Picture System), electrophysiological differences were registered. These differences appeared preferentially before negatively-valued visual stimuli, and women's activity was interpreted by Kemp and colleagues (2004) as consistent with the widespread observation that women are more susceptible to negative life experiences and more prone to mood disorders.

There also seem to be sex-related differences in cognitive and neural processes related with attention, decision-making, planning, and other executive functions which were considered by Leder and colleagues (2004) and Chatterjee (2003) as essential processes in the later stages of aesthetic preference. Chatterjee (2003) in particular noted the importance of attentional processes in aesthetic preference, which was later illustrated by Vartanian and Goel's (2004) neuroimaging results. McGuinness (1976) reviewed a number of studies showing sex-related differences in attentional tasks. In addition, Tranel, Damasio, Denburg, and Bechara's (2005) results suggest that whereas men tend to use holistic or gestalt-type strategies in decision-making, women seem to rely on analytic and verbally guided strategies to solve the same problems, tendencies that are also apparent when presented with humorous stimuli (Azim, Mobbs, Jo, Menon, & Reiss, 2005). With regards to planning, Boghi *et al.* (2006) found that when carrying out the Tower of London task, men rely primarily on visuospatial abilities and women on executive processes. Similar conclusions were presented by Haier, Jung, Yeo, Head and Alkire (2005), whose results suggest that men and women obtain similar scores on IQ tests with the involvement of different brain regions.

In sum, the studies that we have reviewed in this section suggest that men and women differ in their preference for various artistic styles. Women seem to prefer impressionist and rococo styles more than men (Bernard, 1972; Polzella, 2000). Men, in turn, seem to prefer expressionism, cubism, pop art, and abstraction more than women (Bernard, 1972; Furnham & Walker, 2001; Polzella, 2000). In spite of the fact that other studies have found no significant differences between men and women's aesthetic preference (Farrell & Rogers, 1982; Lindauer, 1990), there is evidence supporting the notion that men and women differ in their performance of many of the cognitive and affective processes involved in aesthetic preference, including perceptual analysis, attention, recognition, classification, affective evaluation, and decision-making. The study carried out by Savarese and Miller (1979) suggests that men and women might be using different strategies, or relying on different cognitive processes to carry out aesthetic preference tasks, though their performance on these may not differ that much. It remains for future studies to determine the extent to which and how these strategies or reliance on certain cognitive and affective influence aesthetic preference, as well as the way in which they interact with each other.

1.4

Summary, objectives, and hypotheses

Although the birth of empirical aesthetics is usually associated with Gustav Fechner's methodological and theoretical contributions, current research in the field derives directly from Daniel Berlyne's reformulation. This new perspective was grounded on the notion of arousal and its influence on organisms' behaviour. Organisms choose to expose themselves to environmental stimuli depending on their capacity to increase or decrease their level of arousal. This general framework was seen as an adequate explanation of aesthetic behaviour. In this case, complexity was considered one of the most important features of visual stimuli in the determination of aesthetic preference. Berlyne (1971) reasoned that people would tend to prefer intermediately complex stimuli to very simple or highly complex ones. Subsequent attempts to verify this theoretical proposal have produced confusing results. Whereas some of them have corroborated Berlyne's (1971) formulation, other have found that aesthetic preference increases linearly with complexity, and yet other have found that people seem to prefer simple visual stimuli over complex ones.

The main objective of the present work is to ascertain the reasons for this divergence in the results of prior studies that have attempted to verify Berlyne's (1971) predicted inverted U function of aesthetic preference as the complexity of visual stimuli increases. Here we suggest three possible factors behind the aforementioned divergence:

1. The use of different kinds of materials in the studies designed to verify Berlyne's (1971) hypothesis. Some of the studies reviewed in the introduction used reproductions of works that are exhibited in museums, whereas other used figures which were created with no artistic intentions whatsoever. Additionally, these studies vary in the proportion of abstract versus representational stimuli. The results of a number of results suggest that the use of different proportions of artistic and non-artistic, as well as abstract and representational, stimuli may be a plausible explanation for the contradictory results of studies attempting to verify Berlyne's (1971) predicted relation between complexity and aesthetic preference. Hardiman & Zernich (1977) reviewed a large amount of studies and concluded that, especially for adults, the degree of realism is an important determinant of aesthetic preference. This was later corroborated by Heinrichs and Cupchik (1985), Kettlewell and colleagues (1990), Furnham and Walker (2001), and Feist and Brady (2004), who found that preferences were higher for representational than for abstract or ambiguous works of art. Hekkert and Wieringen (1996a) provided an explanation for these differences. They found that naïve viewers base their preference ratings on formal qualities only in the absence of explicit content (abstract works of art). When the content is easily identified, semantic features guide their decisions. It has even been suggested that there might be neuropsychological differences between people who preferred abstract paintings and those who preferred representational ones (Kettlewell & Lipscomb, 1992). Additionally, Neperud (1986) and Cela-Conde and colleagues' (2002) results suggest that the relations between preference, sex, and degree of abstraction may differ for artistic and non-artistic stimuli.

2. The recruitment of different proportions of male and female participants. As we saw in section 1.3.5 of the present work, there is some evidence of differences in the aesthetic preference of men and women. Even though it can be argued that the performance of men and women on aesthetic preference tasks is not too different, there is reason to believe that there are differences in the way they carry out cognitive and affective strategies underlying aesthetic preference, and in their neural correlates. Hence, it could be the case that, when deciding about the beauty or ugliness of visual stimuli, men and women rely to a different extent on certain cognitive and affective processes.

3. The use of different conceptions and measures of visual complexity. As we mentioned in section 1.2.3 of the present work, studies that have explored the relation between complexity and aesthetic preference have defined complexity in a variety of different ways to mean, for instance, numerousness, heterogeneity, disorder, asymmetry, and so on. We suggest that these are not merely different ways of viewing the same concept of complexity, but that they are in fact different kinds of visual complexity. Additionally, we suggest that these different kinds of complexity might have different effects on aesthetic preference. For instance, we believe that it is possible that people prefer visual stimuli with many elements to those with very few elements and all the intermediate possibilities, and that they might prefer highly ordered stimuli over intermediately or completely disordered images. In short, we are suggesting three points in relation to complexity: (i) that people base their subjective impression of visual complexity on a variety of different features depending on their sex and the degree of abstraction and artistry of the stimuli; (ii) that these features are not equal or reducible to a single measure of complexity; and (iii) that these complexity dimensions are related with aesthetic preference in different ways.

In order to carry out these objectives we suggested the following null hypotheses:

I.I. Aesthetic preference for diverse visual stimuli of low, intermediate, and high complexity will be equal.

I.II. Aesthetic preference for abstract and representational stimuli will be the same.

I.III. Aesthetic preference for artistic and decorative stimuli will be the same.

II. Men and women's aesthetic preference for diverse visual will be equal.

III.I. The sex of the participant and the kind of stimuli do not influence the features people use to judge the complexity of visual stimuli.

III.II. All features of complexity are reducible to a single measure.

III.III. All features of complexity are related with aesthetic preference in the same way.

Although the experiment designed to test these hypotheses is described in detail in the following section, we feel it necessary to advance here our decisions regarding two factors whose influence on aesthetic preference we have reviewed in this section, but are not reflected in our hypotheses. In regards to art training, we have chosen to control the effects of this variable by only including participants with no formal art education. Conversely, given that the reviewed literature suggests that personality and cognitive style have very small effects on aesthetic preference, we have not controlled the effects of these variables.

2

Method

2.1

Participants

Abstract

Two samples of participants were included in the present study. A sample of 240 men and women, in approximately the same number, volunteered to take part in the first phase of the study, aimed at creating an adequate set of stimuli to test our hypotheses. The second sample was constituted by 38 men and 56 women. They took part in the actual testing of the hypotheses concerning the influence of the kind of stimuli, sex, and complexity dimensions on aesthetic preference. In this section we describe both samples in detail.

All the participants in this part of the study were students at the *Universitat de les Illes Balears*, in their last two terms of psychology, philosophy, or history. Those who reported having received formal training in any form of art or art history were excluded. This was an important requirement, given the results of previous studies reviewed in the introduction (see section 1.3.4). Two groups of participants took part in the present work. The first group was involved in the creation of an adequate sample of materials to be used in the second phase of the study. The second group of participants, who took part in the second phase, were involved in the actual testing of the hypotheses outlined in the section 1.4.

2.1.1. Description of the sample of participants involved in the preparation of the materials

Two hundred and forty participants took part in the selection of an adequate sample of materials to be used in the actual experiment carried out to test our hypotheses. This sample included 112 men and 128 women. Participants in this initial phase were divided into eight groups as described in the procedure section, below. Table 2.1 shows the composition of the 8 groups that participated in the material preparation phase. The whole sample included slightly more women than men (53.3% to 46.7%, respectively). Within groups, however, it was not always possible to achieve a balanced number of male and female participants. The most unbalanced of the groups, number 3, included 36.7% of men and 63.3% of women. The opposite trend appears in group 7, in which men and women represented 60% and 40%, respectively.

		Sex				Group Total	
		Men		Women			
		Count	Row %	Count	Row %	Count	Row %
Group	1	15	50,0%	15	50,0%	30	100,0%
	2	13	43,3%	17	56,7%	30	100,0%
	3	11	36,7%	19	63,3%	30	100,0%
	4	13	43,3%	17	56,7%	30	100,0%
	5	15	50,0%	15	50,0%	30	100,0%
	6	16	53,3%	14	46,7%	30	100,0%
	7	18	60,0%	12	40,0%	30	100,0%
	8	11	36,7%	19	63,3%	30	100,0%
Group Total		112	46,7%	128	53,3%	240	100,0%

Table 2.1. Composition of the 8 groups in relation to sex

Table 2.2 shows the descriptive statistics for the age of the whole sample of 240 participants. Their ages ranged from 18 to 44, with a mean of 22.03 and a standard deviation of 3.75 years. Table 2.3 shows that the ages of male and female participants included in this part of the study were very similar, though the mean average age of males was slightly higher than that of females. This is probably due to the inclusion of some older men and the smaller standard deviation of women's scores. Figure 2.1, showing histograms for the ages of male and female participants, reveals that the age distributions for men and women are also very similar.

	Mean	Std Deviation	Minimum	Maximum	Range	Percentile 25	Median	Percentile 75
Age	22,03	3,75	18	44	26	20	21	23

Table 2.2. Descriptive statistics for age of the whole sample of participants

		Age							
		Mean	Std Deviation	Minimum	Maximum	Range	Percentile 25	Median	Percentile 75
Sex	Men	22,37	4,27	18	44	26	20	21	24
	Women	21,73	3,22	18	40	22	20	21	23

Table 2.3. Descriptive statistics for age of male and female participants

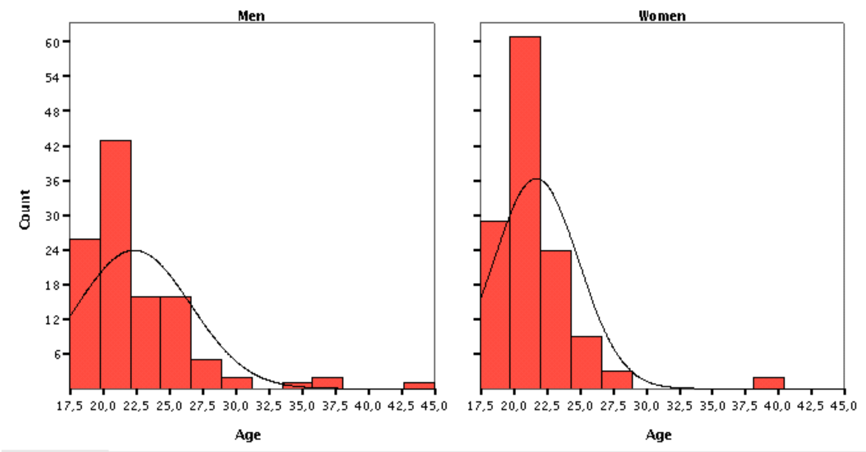


Figure 2.1. Age distributions of the 112 male and 128 female participants

Despite the similarity in age distributions of men and women, they depart from normality in two aspects, shown in table 2.4. Men and women's age distributions are both positively skewed, with women's being slightly more asymmetric. With regards to kurtosis, coefficients show that both distributions are leptokurtic. This is much more evident in the case of women. Normality tests performed on these distributions reveal they significantly depart from this trend (see table 2.5).

	Skewness	**Std. Error**	**Kurtosis**	**Std. Error**
Men	2.283	.228	7.581	.453
Women	2.768	.214	13.164	.425

Table 2.4. Asymmetry and Kurtosis coefficients for men and women age distributions

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Sex	Statistic	df	Sig.	Statistic	df	Sig.
Age	Men	,164	112	,000	,790	112	,000
	Women	,170	128	,000	,774	128	,000

a. Lilliefors Significance Correction

Table 2.5. Normality tests for men and women's age distributions

Studying the age of male and female participants in each of the 8 group reveals certain differences. This is reflected in the descriptive statistics included in table 2.6. The youngest group were women in group 2 (mean age 19.59 years), while the oldest group were men in group 5 (mean age 23.67). The average ages of the rest of the groups of participants are between these two values. Table 2.6. also reveals a great variation in the age ranges of the groups. These differences are mostly determined by the maximum value, which varies from 23 to 44, rather than the minimum, which varies from 19 to 21 years of age.

		Age					
		Mean	Std Deviation	Median	Minimum	Maximum	Range
1	Men	23,20	3,43	23,00	18	28	10
	Women	21,13	1,19	21,00	20	24	4
2	Men	23,08	3,48	23,00	18	28	10
	Women	19,59	1,50	19,00	18	23	5
3	Men	21,55	2,42	21,00	18	26	8
	Women	21,74	2,28	22,00	18	26	8
4	Men	21,69	6,76	20,00	19	44	25
	Women	23,29	4,77	23,00	19	40	21
5	Men	23,67	5,04	22,00	18	38	20
	Women	22,87	1,68	22,00	21	28	7
6	Men	22,50	5,07	21,00	18	38	20
	Women	22,00	5,62	20,50	18	39	21
7	Men	22,56	3,63	22,00	18	34	16
	Women	20,83	2,25	20,50	18	26	8
8	Men	19,73	,90	20,00	19	22	3
	Women	22,21	2,74	22,00	18	27	9

Table 2.6. Descriptive statistics for the age of men and women in each of the 8 groups

2.1.2. Description of the sample of participants involved in the actual testing of our hypotheses

Ninety-four participants voluntarily took part in the second phase of the present study. Thirty-eight of them were men and 56 were women, representing close to 40% and 60%, respectively (table 2.7). Eighty-four of the participants were psychology students, 9 philosophy students, and one history student. Men and women were not represented uniformly in each degree. About 64% of psychology students were female, while only close to 22% of philosophy students were female (see table 2.8). The sole history student was male.

Sex

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Men	38	40,4	40,4	40,4
	Women	56	59,6	59,6	100,0
	Total	94	100,0	100,0	

Table 2.7 Composition of the sample in relation to sex

		Degree								
		Psychology			Philosophy			History		
		Count	Row %	Col %	Count	Row %	Col %	Count	Row %	Col %
Sex	Men	30	78,9%	35,7%	7	18,4%	77,8%	1	2,6%	100,0%
	Women	54	96,4%	64,3%	2	3,6%	22,2%			
Group Total		84	89,4%	100,0%	9	9,6%	100,0%	1	1,1%	100,0%

Table 2.8. Degree of male and female participants

The mean age of the whole sample of participants was 22.41, with a standard deviation of 4.1 years. The youngest participant was 18 and the oldest was 46 years old. The age distribution is skewed to the right and highly leptokurtic (see figure 2.2 and table 2.9).

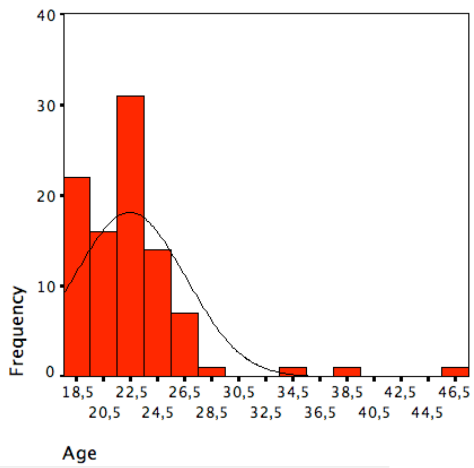


Figure 2.2. Age histogram for all participants

		Age
N	Valid	94
	Missing	0
Mean		22,41
Median		22,00
Mode		23
Std. Deviation		4,128
Skewness		2,751
Std. Error of Skewness		,249
Kurtosis		12,546
Std. Error of Kurtosis		,493
Range		28
Minimum		18
Maximum		46
Percentiles	25	20,00
	50	22,00
	75	24,00

Table 2.9. Descriptive statistics for all participants

With regards to the age distributions of male and female participants taken separately, table 2.10 shows that on average men were older than women, and that there was a greater homogeneity among the ages of the former than the latter. The sample of female participants included two women with noticeably greater ages than the majority. There is also a similar case in the sample of male participants, though the departure from the central tendency is less marked, as can be seen in figure 2.3. Tables 2.11 and 2.12 show that both age distributions are skewed to the right and highly leptokurtic. This is especially true in the case of females.

			Count	Mean	Std Deviation	Minimum	Maximum	Range	Percentile 25	Median	Percentile 75
Sex	Men	Age	38	23,24	3,53	18	38	20	21	23	25
	Women		56	21,86	4,43	18	46	28	19	22	23
Group Total			94	22,41	4,13	18	46	28	20	22	24

Table 2.10. Descriptive statistics for male and female age distributions

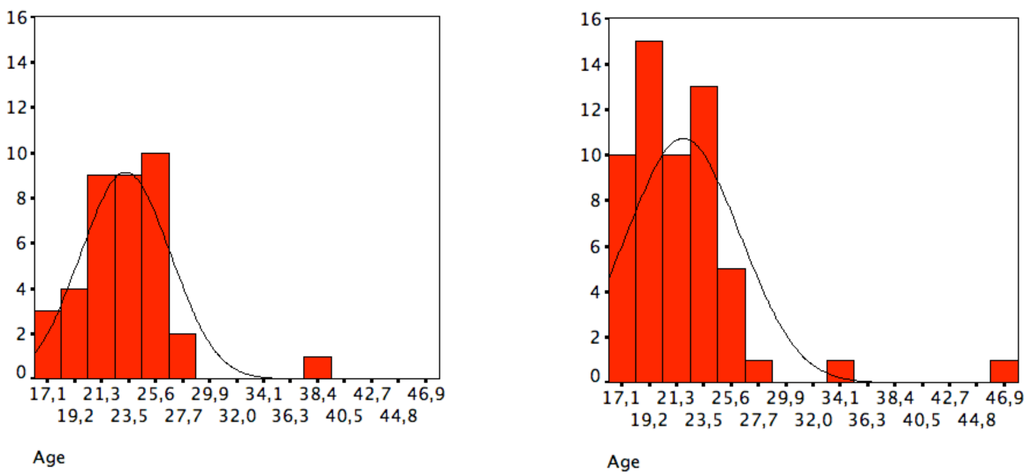


Figure 2.3. Age histograms for male (left) and female (right) participants.

	N	Skewness		Kurtosis	
	Statistic	Statistic	Std. Error	Statistic	Std. Error
Age	38	1,829	,383	7,289	,750
Valid N (listwise)	38				

Table 2.11. Skewness and Kurtosis coefficients for the age distribution of male participants

	N	Skewness		Kurtosis	
	Statistic	Statistic	Std. Error	Statistic	Std. Error
Age	56	3,345	,319	16,044	,628
Valid N (listwise)	56				

Table 2.12. Skewness and Kurtosis coefficients for the age distribution of female participants

2.2

Materials

Abstract

The materials used in the present study include the stimuli and computer hardware and software. Stimuli were selected from a pool of over 1500 digitalized images. In this section we describe the criteria used to select the stimuli and the procedures we implemented to control the effects of strange variables. We also describe the computer program that was used to present the stimuli to the participants and to register their responses, as well as the hardware on which this program ran.

2.2.1. Stimuli

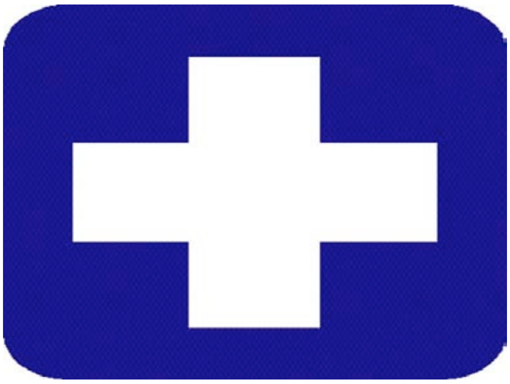
The initial pool of stimuli was a set of over 1500 digitalized images, including abstract and representational, as well as artistic and decorative stimuli. Studies reviewed in the introduction suggested the need of including stimuli of each of these types. Our distinction between artistic and decorative stimuli is equivalent to Winston and Cupchik's (1992) classification of High art versus Popular art. They noted that Popular art emphasizes the pleasing aspects of the subject matter, whereas High art explores a broader range of emotions and strives towards a balance between content and style. Specifically, in our case, artistic stimuli refer to reproductions of catalogued pieces created by renowned artists and exhibited in museums. Following Heinrichs and Cupchik's (1985) recommendations we also included images belonging to a broad array of styles, such as realism, cubism, impressionism, as well as others that have been articulated by art historians. We used included selected from the collection *Movements in Modern Art* of the Tate Gallery, London, adding European XVII and XVIII Centuries and American Art pictures. Decorative stimuli included photographs of landscapes, artefacts, urban scenes, and so forth, taken from the book series *Boring Postcards*, Phaidon Press, London, and photographs taken by us, together with a sample of images from the Master Clips Premium Image Collection (IMSI, San Rafael, CA), which are used in industrial design, illustrating books, and so on. On the other hand, the distinction between abstract and decorative images followed the usual criterion of the presence or absence of explicit content.

2.2.2. Stimuli selection and modification

The original set of materials was subjected to a series of modifications in order to eliminate the influence of strange variables. Aiming to avoid the influence of other collative variables, such as novelty, or the celebrity of the artworks, only relatively unknown pieces were selected. In order to avoid the influence of ecological variables we eliminated those stimuli that contained clear views of human figures and human faces, as well as those stimuli portraying scenes that could elicit emotional responses. To avoid the undesired influence of psychophysical variables, all stimuli were adjusted to the same resolution of 150 ppi and set to the same size of 9 by 12 cm. Additionally, the colour spectrum was adjusted in all images. Values of extreme illumination and shadow in each picture were adjusted to reach a global tone range allowing the best detail. Stimuli were classified according to their dominant tone (dark, medium, or light), and those with a mean distribution of pixels concentrated in both the left (dark) and right (light) extremes of the histogram were discarded. Thereafter the luminance of the remaining stimuli was adjusted to between 370 and 390 lx. Stimuli that could not be reasonably modified in this sense were discarded. Finally, the signature was removed from all signed pictures. This process of stimuli selection and modification was carried out such that we were left with 800 images, of which 200 were abstract artistic, 200 were abstract decorative, 200 were representational artistic, and 200 were representational decorative.

2.2.3. Hardware and software

Stimuli modifications were carried out by means of Photoshop 7.0 running on a PowerBook G4 computer. The luminance of the stimuli was measured in a dark room, by means of a Minolta Auto Meter IV F digital photometer placed 40 cm from the screen with an accessory for 40° reflected light. All stimuli were presented by means of a specifically designed software running on Compaq EVO300 Pentium IV / 1,7 GHz computers with Windows 2000 SP4. When participants opened this program they were presented with a screen which required them to fill in demographic and other kinds of information: name and surnames, age, sex, degree, and the date. After this section was completed they went on to a screen with the instructions of the task they had to carry out. For the first phase this task was rating the complexity of the stimuli, for the second phase it was rating the beauty of the stimuli, and finally, in the third phase it was rating one of seven complexity dimensions, as explained below in the procedure section. These instructions were clearly written. Only in the first phase were participants presented with examples to illustrate what was meant by complexity.



Examples given to participants of low and high complexity

After participants had read and understood the instructions they pressed the *begin* button. This led to a 2-second masking screen. Thereafter the first stimulus was presented. All stimuli were presented within a grey frame. In the upper segment of the frame there was a brief reminder of the task they were asked to perform. In the lower segment of the frame there was a reminder of the scale they were required to use.

Based on previous studies that showed no effect of viewing time on aesthetic preference (McWhinnie, 1993; Smith, Bousquet, Chang, & Smith, 2006), it had been decided not to impose a time limit on participants' responses. Hence, each stimulus was presented until participants responded. They did so by pressing a key between 1 and 9 in the first and third phases, and a key between 1 and 5 in the second phase. If participants pressed any other key there was no response from the program. If the response was correct it was fed-back on to the screen for 1.5 seconds, after which the 2-second masking screen appeared again. This same pattern was repeated for the 100, 120, and 60 stimuli in the first, second, and third phases, respectively (see below in the procedure section). The computer program registered all the demographic information given by the participants and each of their responses to the stimuli in each phase.

2.3

Procedure

Abstract

The present work was structured in three phases. The first phase was aimed at obtaining a set of stimuli to test our hypotheses. This set had to include artistic, decorative, abstract and representational stimuli belonging to three complexity levels: low, intermediate, and high. The objective of the second phase was to test our hypotheses concerning the effects of the kind of stimuli and the sex of the participants on their aesthetic preferences. Hence, participants were asked to rate the beauty of the stimuli selected in the previous phase. Finally, the third phase was designed to explore the conceptual nature of visual complexity. We selected half of the stimuli used in the previous phase and asked the same participants to rate them on seven complexity dimensions. These ratings were then used to determine which of the dimensions were the best predictors of the judgment of general complexity, to clarify the relations among the different complexity dimensions, and to probe the relations between each of the complexity dimensions and the beauty ratings.

In order to test the hypotheses listed at the end of the introduction we structured the present work into three stages. The first stage was designed to create a set of stimuli suitable to carry out the aforementioned tests. The second stage consisted in the actual testing of the hypotheses concerning the relation between complexity and aesthetic preference, namely hypotheses I.I, I.II, I.III, and II, by means of an aesthetic preference task using the set of stimuli created in the first phase. Finally, the objective of the third stage was to test the hypotheses relating to the conceptual structure of visual complexity: hypotheses III.I, III.II, and III.III.

2.3.1. Creation of a suitable set of stimuli

The test of hypotheses I.I, I.II, and I.III required a sample of stimuli varying in complexity, and which includes both abstract and representational, as well as artistic and decorative stimuli. Our aim in this first phase of the study was to obtain a set of 120 stimuli equally divided into three complexity levels: low, intermediate, and high. Each of these complexity levels would include 10 abstract artistic (AA), 10 abstract decorative (AD), 10 representational artistic (RA), and 10 representational decorative (RD) stimuli.

As previously described, the 240 participants recruited for this stage were divided into 8 different groups of 30 individuals, attempting to balance each of them in relation to sex. The set of 800 stimuli was randomly divided into 8 groups of 100, using a stratified randomized method, such that there were 25 stimuli of each kind (AA, AD, RA, RD). Each set of stimuli was randomized and presented to all participants in the same order. The participants in each group were asked to rate the complexity of a different set of 100 images (25 AA, 25 AD, 25 RA, 25 RD) on a 1 to 9 Likert scale. In order to avoid biasing the participants' responses towards any given feature of complexity, this concept was not explicitly defined by the experimenter. He only clarified that it related to the image and its contents, not to how difficult participants though each stimulus must have been to achieve, and emphasized that we were looking for their first subjective impression of the stimuli.

The 8 groups took part in the procedure on different days at the same time during the morning and in a mildly illuminated and noise-isolated room. The 30 participants in each group were sat at different computers and collectively given the instructions before they began. The experimenter answered any doubts before beginning the testing. Presentation of the stimuli was individual, as were their responses. Although participants did not have a time limit for their responses, and thus, the rhythm of stimuli presentation was controlled by each of them, the experimenter encouraged participants to answer based on their initial subjective impression of each stimulus.

After all eight groups of participants had carried out this task, their responses were collected. Two statistics were calculated for each stimulus: the average rating awarded by the 30 participants, and the standard deviation. The first measure was considered as the complexity score for each stimulus, and the second one was considered as the measure of agreement of participants regarding that score.

The selection of stimuli for each complexity level was based on their complexity score and measure of agreement. The selection was carried out separately for each of the stimuli types (AA, AD, RA, RD) according to the following procedure. Each of the four sets of 200 images was ordered according to their complexity score. To select stimuli for the low complexity level the experimenter began at the bottom of the list of stimuli (those with the lowest complexity score). If the standard deviation for the stimulus was below .80 it was selected. If it was .81 or above, the stimulus was discarded and the operation was repeated with the stimulus immediately above in complexity score. This process was carried out for each of the four stimuli types until 10 stimuli of each particular type had been selected. In order to select stimuli for the high complexity level the same procedure was followed, except that it began at the top of the list and moved down the complexity scores. Again, this finished when 10 stimuli had been selected for each stimuli type. In order to select stimuli for the intermediate level of complexity, the median of the complexity scores was calculated for each stimuli kind. The experimenter started the selection at that point, using the same agreement criterion as mentioned above, only that he alternatively moved up and down the list to select or discard the stimuli. When the 10 images of each kind were selected, the process was ended.

This procedure was followed with the objective of maximizing the difference between complexity levels and to minimize the difference in complexity within levels. Choosing images whose complexity score showed a small standard deviation was aimed at including stimuli for which people tend to agree on their degree of complexity. Hence, our sample of 120 stimuli to be used to test our hypotheses would be composed of stimuli that belonged to complexity levels that were actually different, within which stimuli were virtually indistinguishable as to their complexity. Moreover, there was a great level of agreement among participants regarding this distribution.

2.3.2. Aesthetic preference

The objective of this stage was to test hypotheses I.I, I.II, I.III, and II, as outlined at the end of the introduction (See section 1.4). These hypotheses refer to the relation between complexity and aesthetic preference, abstraction and aesthetic preference, artistry and aesthetic preference, and the influence of sex on aesthetic preference. As argued in the introduction, beauty ratings are the best measure of aesthetic preference. Thus, the group of 94 participants described above was asked to rate the beauty of the 120 stimuli selected in the previous phase on a 1 to 5 Likert scale. Stimuli were randomized and presented in the same order to all participants. They took part in this procedure at the same time in a mildly illuminated and sound-isolated room. They were sat at different computers and collectively given the instructions before they began. The following instructions were given in written and spoken format:

> A series of images will now be presented. Your task is to score**, according to your own criterion**, the beauty of each of the images. Please use the following rating scale:
>
> 1: very ugly 2: ugly 3: indifferent 4: beautiful 5: very beautiful
>
> Please try to use value 3 as little as possible. If you have understood the instructions, you can begin the test.

The experimenter then answered any doubts before beginning the procedure. Presentation of the stimuli was individual, as were their responses. Participants did not have a time limit for their responses, and thus, controlled the rhythm of stimuli presentation. The experimenter encouraged participants to answer based on their subjective and personal impression of each stimulus.

After all participants had finished the task, their ratings were collected. The average rating awarded by male participants and the average rating awarded by female participants were calculated for each stimulus. These were the two dependent variables that were used in our analysis of the influence of the three independent variables that were taken into account: (i) Complexity, an ordinal variable with three levels (low, intermediate, high); (ii) Abstraction, a nominal variable with two levels (abstract and representational); (iii) Artistry, a nominal variable with two levels (artistic and decorative). Thus, there were 120 cases (the rated stimuli), three independent variables (Complexity, Abstraction, Artistry), and two dependent variables (male beauty ratings and female beauty ratings). To avoid an excessively complex design, it was decided not to include sex as an independent variable, and to consider the influence of independent on dependent variables for men and women separately. This meant that the test of this variable's influence was, in essence, only indirect and exploratory. This design solely allows assessing whether the influence of the independent variables on men and women's responses is comparable. The results of this analysis are presented in the results section, below.

		Complexity					
Abstraction	**Artistry**	Low		Intermediate		High	
Abstract	Artistic	mbr	wbr	mbr	wbr	mbr	wbr
	Decorative	mbr	wbr	mbr	wbr	mbr	wbr
Representational	Artistic	mbr	wbr	mbr	wbr	mbr	wbr
	Decorative	mbr	wbr	mbr	wbr	mbr	wbr

mbs: men's beauty rating *wbs: women's beauty rating*

2.3.3. Dimensions of visual complexity

The objective of this stage was to test hypotheses III.I, III.II, III.III, as outlined at the end of the introduction. These hypotheses refer to the influence of different features of visual stimuli on judgments of complexity, the relations between these features, and their relation with aesthetic preference. In order to test these hypotheses we selected 60 of the 120 stimuli used in the previous section. This subset was constituted by including five stimuli from each of the four kinds in each level of complexity from those that had been selected for the 120 stimuli set during the first stage of the study. The median value of complexity was calculated for each of the twelve subgroups. We included the stimuli corresponding to the median value and the two adjacent stimuli on both sides.

Based on our review of the literature on visual complexity and its influence on aesthetic preference, we selected seven complexity dimensions we believed could relate to different aspects of visual complexity. These dimensions were:

Dimension 1: Unintelligibility of the elements. How difficult it is to identify the elements in the image.

Dimension 2: Disorganization. How difficult it is to organize the elements into a coherent scene.

Dimension 3: Amount of elements. Numerousness of the elements in the image.

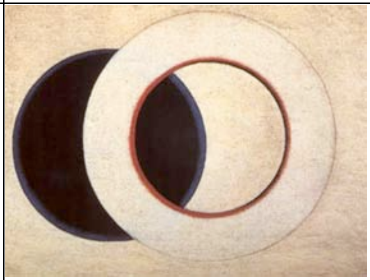
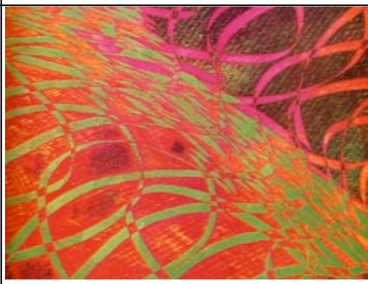
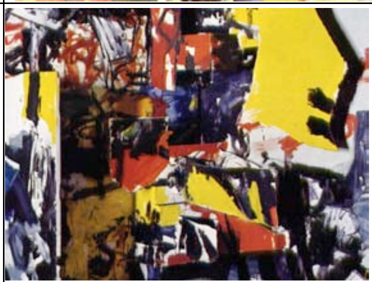
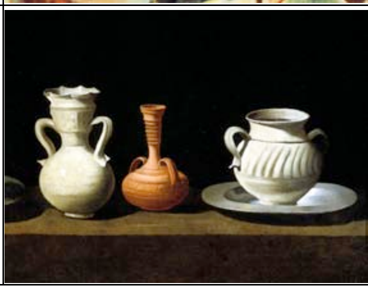
Dimension 4: Variety of elements. Heterogeneity of the elements in the image.

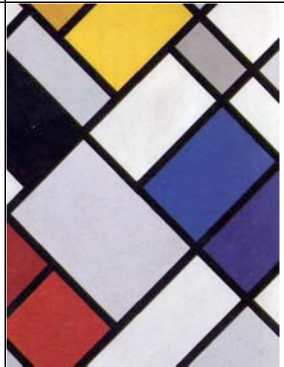
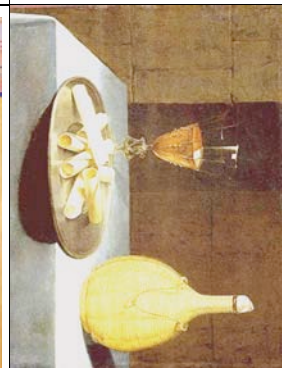
Dimension 5: Asymmetry. How unbalanced is the image.

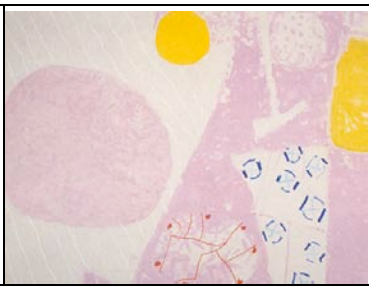
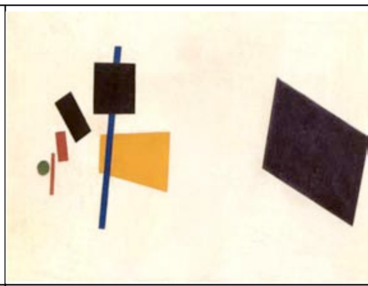
Dimension 6: Variety of colours. Heterogeneity of the colours present in the image.

Dimension 7: Three-dimensional appearance. How three-dimensional does the image look.

In order to illustrate what was meant by each of the dimensions, the following table contains examples for each dimension examples of stimuli expected to receive low and high scores on each dimension. Examples include abstract and representational images, though only artistic. It must be noted that these examples were not presented to participants.

Dim	Kind	Expected low scores	Expected high scores
Unintelligibility of the elements	Abstract		
	Representational		
Disorganization	Abstract		
	Representational		
Amount of elements	Abstract		
	Representational		

Variety of colours		Asymmetry		Variety of elements	
Representational	Abstract	Representational	Abstract	Representational	Abstract
					
					

Three-dimensional appearance	Abstract		
	Representational		

The same group of 94 participants as in the previous stage took part in this third and last stage. In this case they were asked to rate each stimulus on a 1 to 9 Likert scale for each of the seven scales detailed above. All the stimuli in the subset were rated on each scale separately. Stimuli were presented in a different random order for each rating scale. Before rating them on each particular dimension, participants received written and verbal instructions and the same brief definition we included above. These were the instructions given before participants rated the first dimension (italics indicates the part of the instructions that varied from one rating scale to the other):

A series of images will now be presented. Your task is to score**, according to your own criterion**, *how difficult it is to identify the elements in each of the images.* Please use the following rating scale:

1	2	3	4	5	6	7	8	9

← Low difficulty   High difficulty →

Please try to use value 5 as little as possible. If you have understood the instructions, you can begin the test.

All participants took part in this procedure at the same time in a mildly illuminated and sound-isolated room. They were sat at different computers and collectively given the instructions before they began. The experimenter answered any doubts before beginning the procedure. Presentation of the stimuli was individual, as were their responses. Participants did not have a time limit for their responses, and thus, controlled the rhythm of stimuli presentation. The experimenter encouraged participants to answer based on their subjective and personal impression of each stimulus. Images were presented within a grey frame. In the upper part of the frame there was a written reminder of the task they were required to perform, and in the lower part of the frame there was a reminder of the rating scale they were asked to use.

After all participants had finished the task, their ratings were collected. The average rating awarded by male participants and the average rating awarded by female participants on each dimension were calculated for each stimulus. Hence, there were 14 dependent variables: men's ratings on dimension 1, women's ratings on dimension 1, men's ratings on dimension 2, women's ratings on dimension 2, and so on for the seven dimensions. These variables were used in three different ways in order to test hypotheses III.I (regarding the impact of each dimension on general complexity ratings), III.II (regarding the relations among the dimensions), and III.III (regarding the relation between the dimensions and beauty ratings).

In order to test hypothesis III.I a series of discriminant analyses were carried out. This technique is used to ascertain which among a series of quantitative variables predict the values of an ordinal variable with the greatest accuracy. In this case, this variable was the complexity level (low, intermediate, high). We first tested which of the seven complexity dimensions as rated by men predicted the complexity scores of the overall sample of 60 stimuli. We then repeated the procedure with scores awarded by women on each of the dimensions. Thereafter we carried out both analyses for each kind of stimulus (AA, AD, RA, RD) separately. In each case, the complexity level of each stimulus served as the grouping value, and men or women's ratings on each complexity dimension were entered as independent variables.

In order to test hypothesis III.II we performed two factor analyses. This procedure allows simplifying relations among variables, our complexity dimensions, by identifying underlying factors that explain the greatest possible amount of original information. Factor analysis has the advantage over other data reduction procedures of yielding a small number of easily interpretable factors. We carried out separate analyses for men and women's scores on the seven complexity dimensions.

Finally, a preliminary and exploratory assessment of hypothesis III.III was carried out by means of a series of curve estimation tests. We took each of the seven complexity dimensions separately as independent variables and the beauty scores awarded by men and women collected in the prior phase as the dependent variable. The fit of linear, quadratic, and cubic functions was assessed separately for men and women's scores.

3

Results

3.1

Creation of three complexity levels

Abstract

This section is divided into three parts. First we will present the results concerning the creation of the three complexity levels in each stimulus category. Here we will describe the resulting set of 120 stimuli used to examine the influence of complexity on aesthetic preference and the nature of complexity judgments themselves. The second section is devoted to reporting the effects of complexity, abstraction and artistry on aesthetic preference of men and women. The third and final section is devoted to the exploration of the concept of visual complexity. Here we report the results of the discriminant analysis that allows to determine which of the 7 complexity dimensions is the best predictor of complexity judgments for each kind of stimulus. The relations among the complexity dimensions were explored by means of factor analysis. These results are also reported here. Finally, we will also report the results of the exploratory analysis of the different relations between the seven complexity dimensions and men and women's beauty ratings.

The objective of this first part of the study was to create a set of stimuli with three levels of complexity which could be used to study the effects of complexity on aesthetic preference, and to clarify what the main aspects influencing complexity ratings are. The results related with these two issues are presented in sections 3.2 and 3.3, respectively.

Here we provide a brief description of the scores awarded by participants to stimuli belonging to each stimulus category. Table 3.1a, which includes descriptive statistics of the complexity scores awarded to the four kinds of stimuli, shows that participants felt that, overall, abstract artistic stimuli were the most complex. Conversely, they scored abstract decorative as the least complex of the four stimuli kinds. The ranges of the scores are similar, and range from 2.9 for abstract artistic stimuli to 3.46 for representational artistic images.

	Count	Mean	Std Deviation	Minimum	Maximum	Range
Complexity of abstract artistic	240	3,78	,54	2,06	4,96	2,90
Complexity of abstract decorative	240	1,79	,51	1,00	4,08	3,08
Complexity of representational artistic	240	3,46	,61	1,32	4,78	3,46
Complexity of representational decorative	240	2,76	,68	1,00	4,20	3,20

Table 3.1a. Descriptive statistics of the complexity scores awarded to the four kinds of stimuli

Table 3.1b shows the percentile distributions for the complexity scores participants awarded to stimuli within each category. Here the differences in the scores received by abstract artistic and decorative images becomes very clear. Only abstract decorative stimuli with the 5% highest complexity scores come close to the abstract artistic stimuli with the lowest 5% complexity scores. The overlap between complexity scores awarded to the two kinds of representational stimuli is larger. For instance, whereas complexity scores above 3.5 were awarded to about

50% of the representational artistic images, they were awarded to only about 20% of representational decorative stimuli.

		Percentiles						
		5	10	25	50	75	90	95
Weighted Average(Definition 1)	Complexity of abstract artistic	2,7260	3,0060	3,4800	3,8100	4,1775	4,3990	4,5585
	Complexity of abstract decorative	1,1100	1,1800	1,4100	1,7400	2,0600	2,5000	2,7085
	Complexity of representational artistic	2,3535	2,6500	3,0900	3,5300	3,8800	4,2000	4,4675
	Complexity of representational decorative	1,4522	1,8200	2,3175	2,8275	3,2550	3,6220	3,7935
Tukey's Hinges	Complexity of abstract artistic			3,4800	3,8100	4,1750		
	Complexity of abstract decorative			1,4100	1,7400	2,0600		
	Complexity of representational artistic			3,0900	3,5300	3,8800		
	Complexity of representational decorative			2,3200	2,8275	3,2550		

Table 3.1b. Percentile distributions for complexity scores awarded to each stimulus kind

Frequencies of complexity scores awarded to stimuli belonging to each category by participants are reflected in figure 3.1. There are striking differences between the distributions of the complexity ratings of abstract artistic and decorative stimuli, with the former receiving scores in the high end of the complexity scale, and the latter receiving low scores in general. Conversely, distributions of representational artistic and decorative stimuli are more similar, and participants seem to have tended to award intermediate complexity scores. In regards to symmetry, the distribution of complexity scores awarded to abstract decorative stimuli is skewed to the right, whereas the other three distributions are slightly skewed to the left (see table 3.2). The distributions of complexity scores awarded to artistic stimuli, both representational and abstract, are very slightly leptokurtic. The distribution of complexity scores awarded to abstract decorative stimuli is quite leptokurtic, whereas the distribution of representational decorative stimuli is slightly platykurtic. Tests of normality carried out on the four distributions reveal that none of them conform to a normal distribution (see table 3.3).

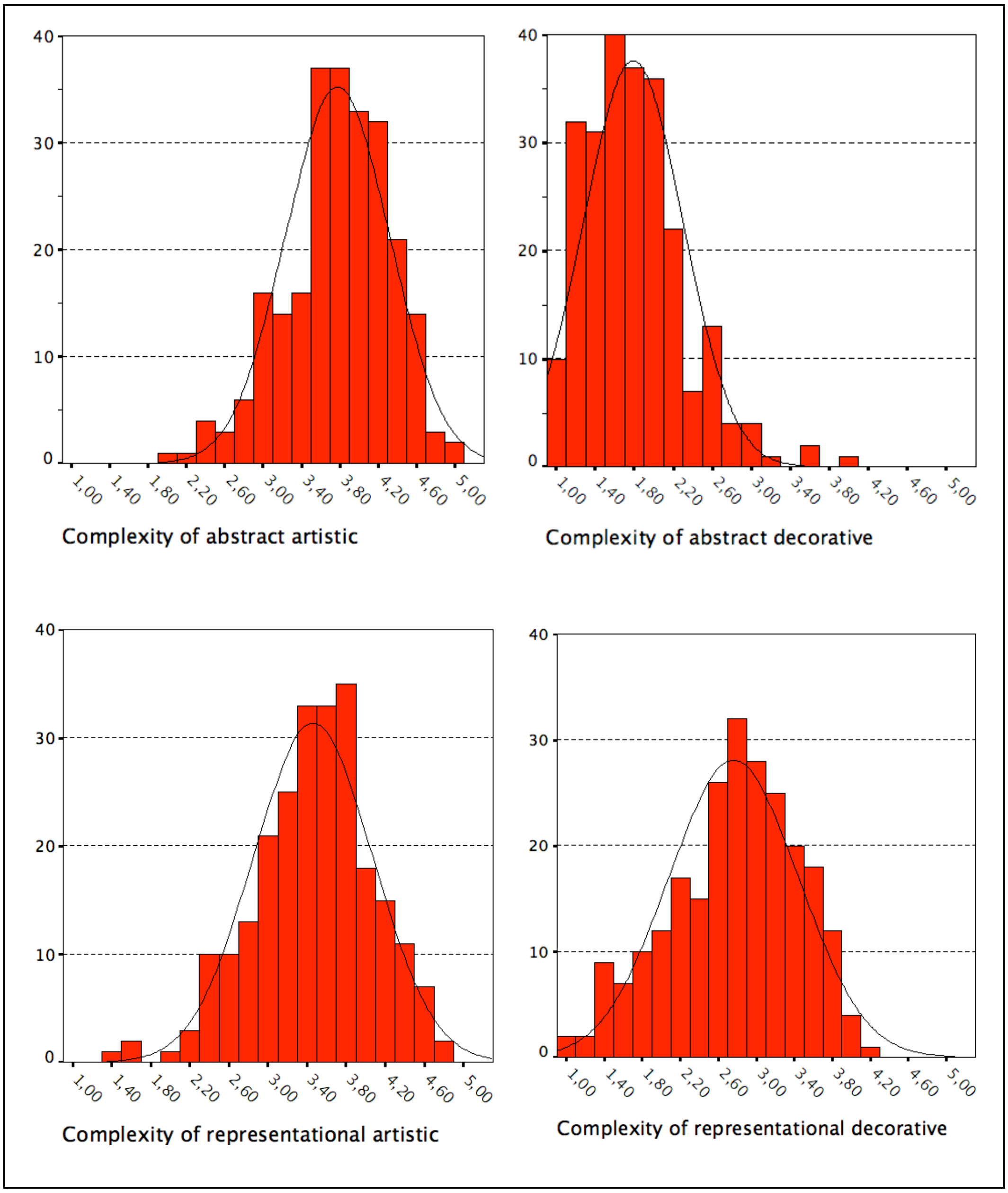


Figure 3.1. Histograms of the complexity scores awarded to stimuli in each kind

	N	Skewness		Kurtosis	
	Statistic	Statistic	Std. Error	Statistic	Std. Error
Complexity of abstract artistic	240	-,560	,157	,270	,313
Complexity of abstract decorative	240	1,068	,157	1,969	,313
Complexity of representational artistic	240	-,430	,157	,405	,313
Complexity of representational decorative	240	-,371	,157	-,386	,313
Valid N (listwise)	240				

Table 3.2. Skewness and Kurtosis coefficients for complexity ratings for each stimulus category

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Complexity of abstract artistic	,061	240	,029	,979	240	,001
Complexity of abstract decorative	,076	240	,002	,939	240	,000
Complexity of representational artistic	,057	240	,060	,987	240	,027
Complexity of representational decorative	,058	240	,052	,983	240	,005

a. Lilliefors Significance Correction

Table 3.3. Normality tests for complexity ratings for each stimulus category

One hundred and twenty images were selected out of the initial set of 800 following the criteria mentioned in the procedure section. Table 3.4 shows the descriptive statistics of this set of stimuli for each complexity level by stimuli kind and style.

Complexity Level	Artistic				Decorative			
	Style	n	m	s	Style	n	m	s
High	A	10	4.66	.15	A	10	2.98	.44
	R	10	4.37	.16	R	10	3.75	.19
Intermediate	A	10	3.47	.06	A	10	2.09	.04
	R	10	3.49	.03	R	10	2.52	.15
Low	A	10	2.48	.20	A	10	1.19	.03
	R	10	2.68	.12	R	10	1.40	.08

Table 3.4. Descriptive statistics of the composition of the three complexity levels for each stimulus kind (A stands for abstract and R for representational).

Levene's test of equality of variances was performed to test the null hypothesis that the variance of Complexity is equal across all groups. Results of this test are presented in table 3.5.

Between-Subjects Factors

		Value Label	N
Complexity group	1	low	40
	2	intermediate	40
	3	high	40
Abstraction	1	abstract	60
	2	rerpesentational	60
Artistry	1	artistic	60
	2	decorative	60

Dependent Variable: Complexity

F	df1	df2	Sig.
7,453	11	108	,000

Table 3.5. Levene's test of equality of variances

Both subsequent phases, those designed to study the influence of complexity on aesthetic appreciation and to clarify the concept of complexity, required three sets of stimuli differing in complexity. Given the fact that normality could not be assumed, and neither could variance equality, a series of Kruskal-Wallis tests were carried out to make sure that the three sets of images were well suited to use in these additional sessions. As table 3.6 shows, there were significant differences between complexity scores of stimuli included in the high, intermediate, and low complexity levels.

Stimuli	**Complexity levels mean ranks**			χ^2	**d.f.**	p
	Low	**Interm**	**High**			
AA	5.50	15.50	25.50	25.94	2	< .001
AD	5.50	15.50	25.50	25.97	2	< .001
RA	5.50	15.50	25.50	26.02	2	< .001
RD	5.50	15.50	25.50	25.88	2	< .001
All	29.56	57.13	94.81	71.02	2	< .001
Abstract	16.17	29.50	45.83	28.97	2	< .001
Representational	14.80	26.83	49.88	41.76	2	< .001

Artistic	10.50	30.50	50.50	52.78	2	< .001
Decorative	10.50	30.83	50.17	51.67	2	< .001

Table 3.6. Results of the non-parametric mean comparisons for the different stimuli categories

Pairwise comparisons revealed that scores of stimuli included in the high complexity level were significantly greater than those in the other two levels. Likewise, stimuli included in the intermediate levels had been rated higher than those included in the low level. This is true for each of the stimuli categories and the whole set of stimuli taken together (see table 3.7). Hence, the objective of the first experimental session, the creation of a set of stimuli belonging to different categories and grouped in three distinct levels of complexity, had been accomplished. Reproductions of these 120 stimuli, as well as their complexity score and beauty ratings by men and women can be found in Annex A.

Stimuli	**Contrasts**			**Z**	***p***
		Mr1	**Mr2**		
AA	1-2	5.5	15.5	3.811	< .001
	1-3	5.5	15.5	3.782	< .001
	2-3	5.5	15.5	3.811	< .001
AD	1-2	5.5	15.5	3.820	< .001
	1-3	5.5	15.5	3.800	< .001
	2-3	5.5	15.5	3.803	< .001
RA	1-2	5.5	15.5	3.832	< .001
	1-3	5.5	15.5	3.788	< .001
	2-3	5.5	15.5	3.823	< .001

RD	1-2	5.5	15.5	3.795	< .001
	1-3	5.5	15.5	3.791	< .001
	2-3	5.5	15.5	3.790	< .001
All	1-2	28.63	52.38	4.578	< .001
	1-3	21.44	59.56	7.339	< .001
	2-3	25.25	55.75	5.879	< .001
Abstract	1-2	15.5	25.5	2.711	.006
	1-3	11.18	29.83	5.049	< .001
	2-3	14.5	26.5	3.252	< .001
Representational	1-2	14.8	26.2	3.093	.002
	1-3	10.5	30.5	5.414	< .001
	2-3	11.13	29.88	5.084	< .001
Artistic	1-2	10.5	30.5	5.465	< .001
	1-3	10.5	30.5	5.413	< .001
	2-3	10.5	30.5	5.464	< .001
Decorative	1-2	10.5	30.5	5.421	< .001
	1-3	10.5	30.5	5.416	< .001
	2-3	10.82	30.17	5.240	< .001

Table 3.7. Results for the pairwise comparisons between complexity levels in each stimulus category.

3.2

The influence of independent variables on aesthetic preference

Abstract

This section includes the results of the analyses carried out to test the hypotheses listed at the end of the introduction concerning the influence of the kind of stimuli and the sex of the participant on the relation between visual complexity and aesthetic preference. After presenting the descriptive statistics, we show the results of the non-parametric techniques that were applied to clarify these relations.

3.2.1. Descriptive statistics

In this subsection we describe the beauty ratings given by male and female participants to the four classes of stimuli: abstract artistic, abstract decorative, representational artistic, and representational decorative. First, we graphically present frequency distributions of men and women's beauty ratings to stimuli in each category. Thereafter, we analyze outliers and extreme values. After explaining how these cases were dealt with, central tendency and dispersion statistics are presented.

Figure 4.1 shows the histograms of men's beauty ratings to stimuli in each category. It can be seen that the four are quite different. Whereas men's ratings of the beauty of abstract artistic stimuli tend to be concentrated around the intermediate values, they were generally high for representational artistic stimuli. Conversely, beauty ratings of abstract decorative stimuli fall for the most part on the lower part of the scale. Finally, men awarded representational decorative stimuli low, intermediate, and high scores in about equal measure. These trends are also present in women's beauty scores, though the rejection of abstract decorative stimuli does not seem as extreme (see figure 4.2).

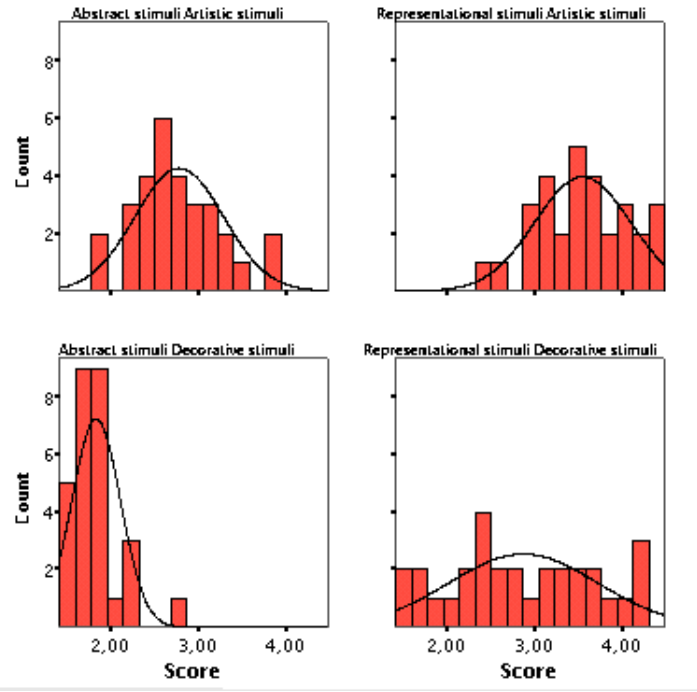


Figure 4.1. Men's beauty ratings for the four classes of stimuli

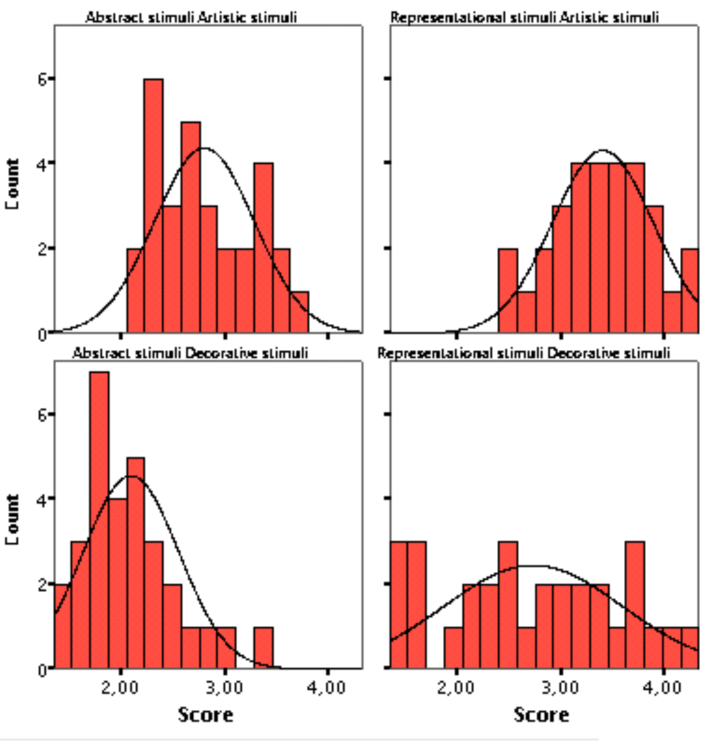


Figure 4.2. Women's beauty ratings for the four classes of stimuli

Let us turn now to the study of outliers and extreme values. Figure 4.3. presents the boxplots for men and women's beauty scores to each kind of stimulus belonging to each of the three complexity levels.

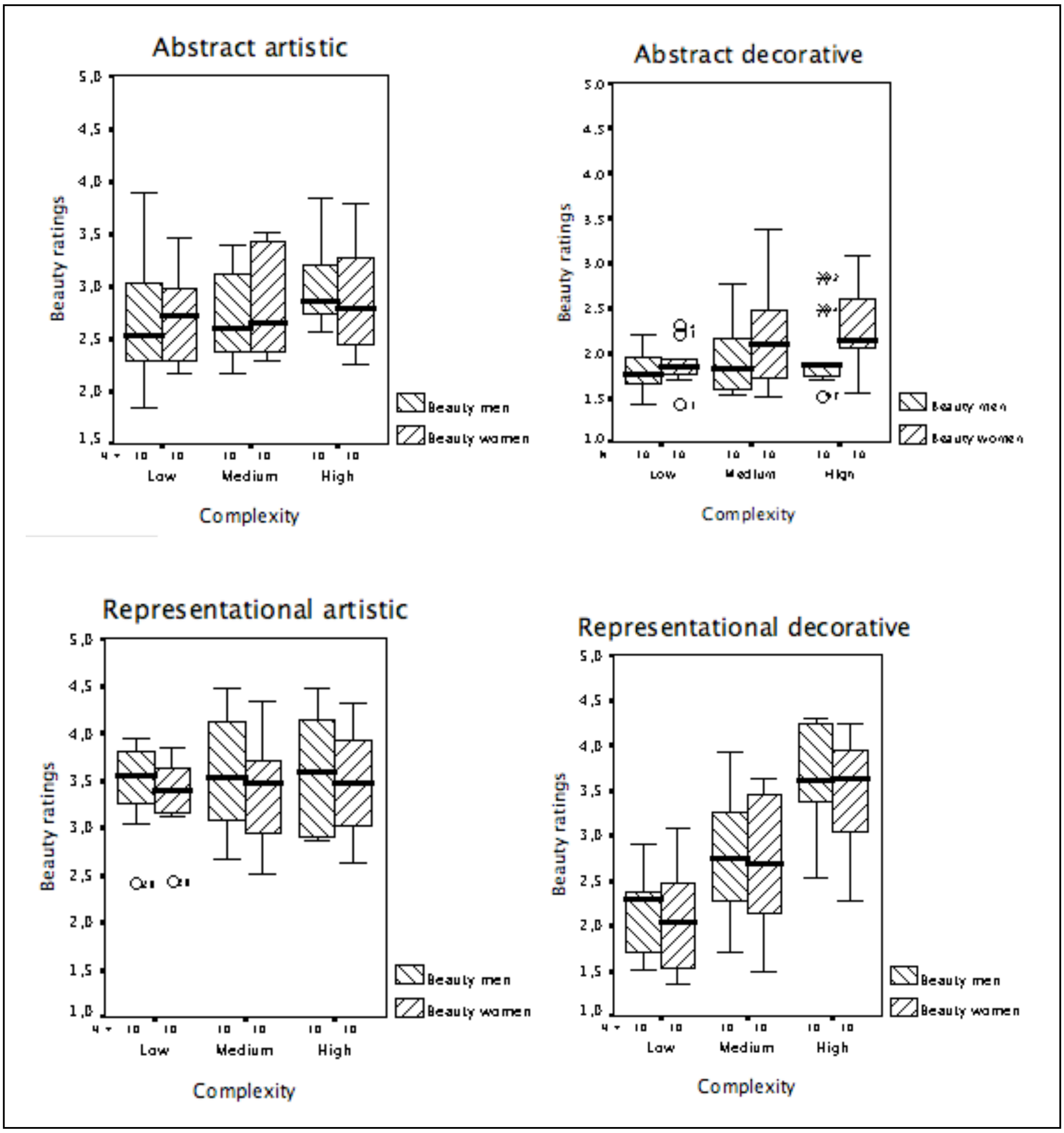


Figure 4.3. Boxplots of men and women's beauty ratings to each kind of stimulus in the three complexity levels

As figure 2.5 reveals, outliers and extreme values are only present for distributions with very small interquartile ranges. For this reason, it was decided to keep outlying values, but to eliminate extreme values. Two extreme values were found in male ratings for abstract decorative stimuli. They corresponded to images

3121 and 3123 (see Annex A), rated with scores of 2.83 and 2.47 respectively, which were above the exterior frontier, i.e., more than three times the interquartile range above the first quartile. These values were removed and were considered missing in the ensuing data analysis.

Now we turn to central tendency and dispersion statistics. Men and women's first, second, and third quartiles of their beauty ratings of each kind of stimulus in each of the three complexity levels, are reported in tables 4.1 and 4.2, respectively.

Complexity	**Realism**	**Type**	**Q1**	**Q2**	**Q3**
Low	**Abs**	**A**	2.19	2.55	3.08
		D	1.66	1.76	1.97
	Rep	**A**	3.21	3.57	3.83
		D	1.67	2.30	2.41
Intermediate	**Abs**	**A**	2.36	2.61	3.18
		D	1.58	1.84	2.20
	Rep	**A**	3.09	3.54	4.12
		D	2.23	2.76	3.38
High	**Abs**	**A**	2.72	2.86	3.30
		D	1.71	1.84	1.88
	Rep	**A**	2.92	3.61	4.22
		D	3.33	3.63	4.26

Table 4.1. Quartile distribution of men's beauty ratings for the different categories of stimuli (Abs: Abstract; Rep: Representational; A: Artistic; D: Decorative).

Complexity	Realism	Type	Q1	Q2	Q3
Low	**Abs**	**A**	2.27	2.74	3.06
		D	1.75	1.85	2.00
	Rep	**A**	3.15	3.41	3.67
		D	1.53	2.05	2.54
Intermediate	**Abs**	**A**	2.37	2.67	3.44
		D	1.68	2.09	2.49
	Rep	**A**	2.95	3.49	3.74
		D	2.02	2.71	3.46
High	**Abs**	**A**	2.41	2.80	3.35
		D	2.00	2.15	2.68
	Rep	**A**	3.00	3.49	3.97
		D	3.01	3.65	3.97

Table 4.2. Quartile distribution of women's beauty ratings for the different categories of stimuli (Abs: Abstract; Rep: Representational; A: Artistic; D: Decorative).

Mean scores, and their standard deviation, awarded to each kind of stimulus belonging to the three complexity levels by men and women are shown in tables 4.3 and 4.4, respectively. Minimum and maximum scores, as well as the range are also shown.

Complexity	Realism	Type	n	m	s	Max	Min	Rng
Low	Abs	A	10	2.64	.61	3.89	1.86	2.03
		D	10	1.80	.22	2.21	1.42	0.79
	Rep	A	10	3.45	.46	3.95	2.41	1.54
		D	10	2.14	.46	2.92	1.51	1.41
Intermediate	Abs	A	10	2.71	.44	3.39	2.17	1.22
		D	10	1.19	.40	2.78	1.53	1.25
	Rep	A	10	3.58	.59	4.49	2.67	1.82
		D	10	2.82	.70	3.93	1.72	2.21
High	Abs	A	10	3.01	.41	3.84	2.58	1.26
		D	10	1.78	.13	1.89	1.51	0.38
	Rep	A	10	3.62	.61	4.49	2.87	1.62
		D	10	3.66	.57	4.30	2.53	1.77

Table 4.3. Descriptive statistics for men's beauty ratings for each category of stimuli (Abs: Abstract; Rep: Representational; A: Artistic; D: Decorative).

Complexity	Realism	Type	n	m	s	Max	Min	Rng
Low	**Abs**	**A**	10	2.72	.45	3.46	2.18	1.28
		D	10	1.87	.25	2.29	1.41	.88
	Rep	**A**	10	3.37	.42	3.86	2.43	1.43
		D	10	2.08	.59	3.09	1.36	1.73
Intermediate	**Abs**	**A**	10	2.81	.48	3.52	2.29	1.23
		D	10	2.16	.55	3.38	1.52	1.86
	Rep	**A**	10	3.41	.53	4.34	2.52	1.82
		D	10	2.68	.77	3.64	1.50	2.14
High	**Abs**	**A**	10	2.90	.54	3.79	2.27	1.52
		D	10	2.29	.47	3.09	1.55	1.54
	Rep	**A**	10	3.47	.55	4.32	2.64	1.68
		D	10	3.47	.60	4.25	2.29	1.96

Table 4.4. Descriptive statistics for women's beauty ratings for each category of stimuli (Abs: Abstract; Rep: Representational; A: Artistic; D: Decorative).

Tests of normality were performed on men and women's ratings of stimuli in each level of the three independent variables: complexity, abstraction, and artistry. Results for these tests are presented in tables 4.5 and 4.6 for male and female participants, respectively.

	Kolmogorov-Smirnov			Shapiro-Wilk		
Complexity	**Statistic**	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Low	.128	40	.099	.922	40	.009
Medium	.082	40	.200	.967	40	.297
High	.127	38	.129	.950	38	.089
	Kolmogorov-Smirnov			**Shapiro-Wilk**		
Abstraction	**Statistic**	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Abstract	.159	58	.001	.159	58	.004
Decorative	.089	60	.200	.089	60	.127
	Kolmogorov-Smirnov			**Shapiro-Wilk**		
Artistry	**Statistic**	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Artistic	.069	60	.200	.981	60	.480
Decorative	.179	58	.000	.865	58	.000

Table 4.5. Normality tests for men's beauty ratings to stimuli in each variable level

	Kolmogorov-Smirnov			Shapiro-Wilk		
Complexity	**Statistic**	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Low	.100	40	.200	.954	40	.101
Medium	.127	40	.106	.966	40	.274
High	.116	38	.200	.969	38	.364
	Kolmogorov-Smirnov			**Shapiro-Wilk**		
Abstraction	**Statistic**	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Abstract	.103	58	.200	.103	58	.069
Decorative	.113	60	.053	.113	60	.013
	Kolmogorov-Smirnov			**Shapiro-Wilk**		
Artistry	**Statistic**	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Artistic	.097	60	.200	.097	60	.102
Decorative	.142	58	.005	.142	58	.001

Table 4.6. Normality tests for women's beauty ratings to stimuli in each variable level

3.2.2. Analyses of main effects and interactions

Given that the normality could not be assumed (see section 3.2.1, above), and that Box's test of equality of variances is susceptible to departures from normality, we carried out Levene's tests for men and women's scores awarded to the different kinds of stimuli in the three complexity levels. Results show that equality of variances cannot be assumed, at least for men's scores (table 4.7).

		Value Label	N
Complexity	1	Low	40
	2	Medium	40
	3	High	38
Abstraction	1	Abstract stimuli	58
	2	Representational stimuli	60
Artistry	1	Artistic stimuli	60
	2	Decorative stimuli	58

		Value Label	N
Complexity	1	Low	40
	2	Medium	40
	3	High	40
Abstraction	1	Abstract stimuli	60
	2	Representational stimuli	60
Artistry	1	Artistic stimuli	60
	2	Decorative stimuli	60

Dependent Variable: Beauty men

F	df1	df2	Sig.
1,994	11	106	,036

Dependent Variable: Beauty women

F	df1	df2	Sig.
1,807	11	108	,061

Table 4.7. Results of Levene's test of equality of variances for men (left) and women's (right) scores.

Given that homogeneity of variances cannot be assumed for men's scores, and that some of the distributions of beauty ratings cannot be considered to approach normality, we have used non-parametric techniques to test our hypotheses regarding the influence of complexity on the ratings men and women award to the beauty of visual stimuli varying in abstraction and artistry (hypotheses I.I, I.II, I.III, and II; see section 1.4).

3.2.2.1. Main effects

We carried out a series of non-parametric tests in order to determine whether any of the independent variables –Complexity, Abstraction, Artistry- had main effects on the dependent variables –Men's beauty rating, and Women's beauty rating. Under this heading we will present these results, and the study of interactions will be presented further below.

Main effects of Complexity

We performed a Kuskal-Wallis test to study the influence of complexity on the beauty ratings awarded by men and women to all 120 stimuli. Both dependent variables –men's beauty scores and women's beauty scores- were entered as test variables in the SPSS *k independent samples* tool included under the *nonparametric tests* option. Complexity was included as the grouping variable, with range as complexity levels 1 to 3 (low, medium, and high).

Ranks

	Complexity	N	Mean Rank
Beauty men	Low	40	48,59
	Medium	40	58,78
	High	38	71,75
	Total	118	
Beauty women	Low	40	48,80
	Medium	40	60,65
	High	40	72,05
	Total	120	

Test Statistics[a,b]

	Beauty men	Beauty women
Chi-Square	8,963	8,939
df	2	2
Asymp. Sig.	,011	,011

a. Kruskal Wallis Test

b. Grouping Variable: Complexity

Table 4.8. Kruskal Wallis test of the influence of Complexity on men and women's beauty ratings

Results presented in table 4.8 reveal that complexity has a statistically significant effect both on men ($\chi2 = 8.963$, $p<.05$) and women's ($\chi2 = 8.939$, $p<.05$) beauty ratings of visual stimuli. In order to determine the levels between which there were differences we performed a series of contrasts by means of non-parametric Mann-Whitney tests. With the correction for multiple comparisons[1], the significance level is $\alpha = \frac{.05}{6} = .0083$

Table 4.9 shows the results for the contrast between men and women's beauty scores awarded to the stimuli belonging to low and intermediate complexity levels. Men's results revealed that there were no significant differences between beauty scores given to stimuli in low and intermediate complexity levels (Z = -1.448, ns). The same was true for women's beauty scores (Z = -1.574, ns).

Ranks

	Complexity	N	Mean Rank	Sum of Ranks
Beauty men	Low	40	36,74	1469,50
	Medium	40	44,26	1770,50
	Total	80		
Beauty women	Low	40	36,41	1456,50
	Medium	40	44,59	1783,50
	Total	80		

Test Statistics[a]

	Beauty men	Beauty women
Mann-Whitney U	649,500	636,500
Wilcoxon W	1469,500	1456,500
Z	-1,448	-1,574
Asymp. Sig. (2-tailed)	,147	,116

a. Grouping Variable: Complexity

Table 4.9. Mann-Whitney test of the differences between men and women's beauty ratings awarded to stimuli from low and medium complexity levels

[1] Following Clark-Carter (1997), throughout this work we have corrected for multiple comparisons using the following adjustment: $\alpha^* = \frac{\alpha}{k \cdot (k-1)}$

Table 4.10 shows the results for the contrast between men and women's beauty scores awarded to the stimuli belonging to intermediate and high complexity levels. Men's results revealed that there were no significant differences between beauty scores given to stimuli in intermediate and high complexity levels (Z = -1.795, ns). The same was true for women's beauty scores (Z = -1.516, ns).

Ranks

	Complexity	N	Mean Rank	Sum of Ranks
Beauty men	Medium	40	35,01	1400,50
	High	38	44,22	1680,50
	Total	78		
Beauty women	Medium	40	36,56	1462,50
	High	40	44,44	1777,50
	Total	80		

Test Statistics[a]

	Beauty men	Beauty women
Mann-Whitney U	580,500	642,500
Wilcoxon W	1400,500	1462,500
Z	-1,795	-1,516
Asymp. Sig. (2-tailed)	,073	,130

a. Grouping Variable: Complexity

Table 4.10. Mann-Whitney test of the differences between men and women's beauty ratings awarded to stimuli from medium and high complexity levels

Table 4.11 shows the results for the contrast between men and women's beauty scores awarded to the stimuli belonging to complexity levels low and high. Men's results revealed that in this case there were significant differences between beauty scores given to stimuli in complexity levels low and high (Z = -2.859 $p<.0083$). The same was true for women's beauty scores (Z = -2.930 $p<.0083$). For both men and women, beauty scores awarded to high complexity stimuli were significantly greater than those awarded to low complexity stimuli.

Ranks

	Complexity	N	Mean Rank	Sum of Ranks
Beauty men	Low	40	32,35	1294,00
	High	38	47,03	1787,00
	Total	78		
Beauty women	Low	40	32,89	1315,50
	High	40	48,11	1924,50
	Total	80		

Test Statistics[a]

	Beauty men	Beauty women
Mann-Whitney U	474,000	495,500
Wilcoxon W	1294,000	1315,500
Z	-2,859	-2,930
Asymp. Sig. (2-tailed)	,004	,003

a. Grouping Variable: Complexity

Table 4.11. Mann-Whitney test of the differences between men and women's beauty ratings awarded to stimuli from low and high complexity levels

Main effects of Abstraction

We performed a Mann-Whitney test to study the influence of Abstraction of visual stimuli on the beauty ratings awarded by men and women to all 120 pictures. Both dependent variables –men's beauty scores and women's beauty scores- were entered as test variables in the SPSS *2 independent samples* tool included under the *nonparametric tests* option. Abstraction was included as the grouping variable, with range as abstraction levels 1 and 2 (abstract and representational).

Table 4.12 shows the results of the test to determine the influence of the degree of abstraction on men and women's beauty ratings. Men's results revealed that there were significant differences between beauty scores given to abstract and representational stimuli (Z = -5.658, p<.001). The same was true for women's beauty scores (Z = -4.646, p<.001). For both men and women, beauty scores awarded to representational stimuli were significantly greater than those awarded to abstract stimuli.

Ranks

	Abstraction	N	Mean Rank	Sum of Ranks
Beauty men	Abstract stimuli	58	41,38	2400,00
	Representational stimuli	60	77,02	4621,00
	Total	118		
Beauty women	Abstract stimuli	60	45,75	2745,00
	Representational stimuli	60	75,25	4515,00
	Total	120		

Test Statistics[a]

	Beauty men	Beauty women
Mann-Whitney U	689,000	915,000
Wilcoxon W	2400,000	2745,000
Z	-5,658	-4,646
Asymp. Sig. (2-tailed)	,000	,000

a. Grouping Variable: Abstraction

Table 4.12. Mann-Whitney test of the influence of Abstraction on men and women's beauty ratings

Main effects of Artistry

We performed a Mann-Whitney test to study the influence of Artistry of visual stimuli on the beauty ratings awarded by men and women to all 120 pictures. Both dependent variables –men's beauty scores and women's beauty scores- were entered as test variables in the SPSS *2 independent samples* tool included under the *nonparametric tests* option. Artistry was included as the grouping variable, with range as artistry levels 1 and 2 (artistic and decorative).

Table 4.13 shows the results of the test to determine the influence of the degree of artistry on men and women's beauty ratings. Men's results revealed that there were significant differences between beauty scores given to artistic and decorative stimuli ($Z = -5.381$ $p<.001$). The same was true for women's beauty scores ($Z = -5.160$, $p<.001$). For both men and women, beauty scores awarded to artistic stimuli were significantly greater than those awarded to decorative stimuli.

Ranks

	Artistry	N	Mean Rank	Sum of Ranks
Beauty men	Artistic stimuli	60	76,16	4569,50
	Decorative stimuli	58	42,27	2451,50
	Total	118		
Beauty women	Artistic stimuli	60	76,88	4613,00
	Decorative stimuli	60	44,12	2647,00
	Total	120		

Test Statistics[a]

	Beauty men	Beauty women
Mann-Whitney U	740,500	817,000
Wilcoxon W	2451,500	2647,000
Z	-5,381	-5,160
Asymp. Sig. (2-tailed)	,000	,000

a. Grouping Variable: Artistry

Table 4.13. Mann-Whitney test of the influence of Artistry on men and women's beauty ratings

3.2.2.2. Interaction effects

Given that triple interaction effects appeared for both men and women's beauty scores, we will not report double interactions (see Annex C). In this section we will report results for differences between levels of complexity for each kind of stimulus category, resulting from the crossing of both levels of Abstraction and Artistry (for other triple interactions, see Annex D). Here the correction for multiple comparisons renders a significance level of $\alpha = \frac{.05}{12} = .0042$

Abstract artistic stimuli

We performed a Kuskal-Wallis test to study the influence of Complexity on the beauty ratings awarded by men and women to abstract artistic stimuli. Both dependent variables –men's beauty scores and women's beauty scores- were entered as test variables in the SPSS *k independent samples* tool included under the *nonparametric tests* option. Complexity was included as the grouping variable, with range as complexity levels 1 to 3 (low, intermediate, and high).

Table 4.14 shows the results for the contrast between men and women's beauty scores awarded to abstract artistic stimuli belonging to the three complexity levels. Men's results revealed that there were no statistically significant differences between beauty scores given to stimuli in the three complexity levels ($\chi 2$ = 4.257, ns). The same was true for women's beauty scores ($\chi 2$ = .795, ns).

Ranks

	Complexity	N	Mean Rank
Beauty men	Low	10	12,65
	Medium	10	13,70
	High	10	20,15
	Total	30	
Beauty women	Low	10	14,00
	Medium	10	15,95
	High	10	16,55
	Total	30	

Test Statistics[a,b]

	Beauty men	Beauty women
Chi-Square	4,257	,460
df	2	2
Asymp. Sig.	,119	,795

a. Kruskal Wallis Test

b. Grouping Variable: Complexity

Table 4.14. Kruskal Wallis test of the influence of Complexity on men and women's beauty ratings of abstract artistic stimuli

Abstract decorative stimuli

We performed a Kuskal-Wallis test to study the influence of Complexity on the beauty ratings awarded by men and women to abstract decorative stimuli. Both dependent variables –men's beauty scores and women's beauty scores- were entered as test variables in the SPSS *k independent* samples tool included under the *nonparametric tests* option. Complexity was included as the grouping variable, with range as complexity levels 1 to 3 (low, intermediate, and high).

Table 4.15 shows the results for the contrast between men and women's beauty scores awarded to abstract decorative stimuli belonging to the three complexity levels. Men's results revealed that there were no statistically significant differences between beauty scores given to abstract decorative stimuli in the three complexity levels ($\chi 2$ = .254, ns). The same was true for women's beauty scores ($\chi 2$ = 4.611, ns).

Ranks

	Complexity	N	Mean Rank
Beauty men	Low	10	13,95
	Medium	10	15,55
	High	8	13,88
	Total	28	
Beauty women	Low	10	10,95
	Medium	10	16,25
	High	10	19,30
	Total	30	

Test Statistics[a,b]

	Beauty men	Beauty women
Chi-Square	,254	4,611
df	2	2
Asymp. Sig.	,881	,100

a. Kruskal Wallis Test

b. Grouping Variable: Complexity

Table 4.15. Kruskal Wallis test of the influence of Complexity on men and women's beauty ratings of abstract decorative stimuli

Representational artistic stimuli

A Kuskal-Wallis test was performed to study the influence of Complexity on the beauty ratings awarded by men and women to representational artistic stimuli. Both dependent variables –men's beauty scores and women's beauty scores- were entered as test variables in the SPSS *k independent* samples tool included under the *nonparametric tests* option. Complexity was included as the grouping variable, with range as complexity levels 1 to 3 (low, intermediate, and high).

Table 4.16 shows the results for the contrast between men and women's beauty scores awarded to representational artistic stimuli belonging to the three complexity levels. Men's results revealed that there were no statistically significant differences between beauty scores given to representational artistic stimuli in the three complexity levels ($\chi 2$ = .214, ns). The same was true for women's beauty scores ($\chi 2$ = .051, ns).

Ranks

	Complexity	N	Mean Rank
Beauty men	Low	10	14,45
	Medium	10	16,00
	High	10	16,05
	Total	30	
Beauty women	Low	10	15,15
	Medium	10	15,35
	High	10	16,00
	Total	30	

Test Statistics[a,b]

	Beauty men	Beauty women
Chi-Square	,214	,051
df	2	2
Asymp. Sig.	,899	,975

a. Kruskal Wallis Test

b. Grouping Variable: Complexity

Table 4.16. Kruskal Wallis test of the influence of Complexity on men and women's beauty ratings of representational artistic stimuli

Representational decorative stimuli

A Kuskal-Wallis test was performed to study the influence of Complexity on the beauty ratings awarded by men and women to representational decorative stimuli. Both dependent variables –men's beauty scores and women's beauty scores- were entered as test variables in the SPSS *k independent* samples tool included under the *nonparametric tests* option. Complexity was included as the grouping variable, with range as complexity levels 1 to 3 (low, intermediate, and high).

Table 4.17 shows the results for the contrast between men and women's beauty scores awarded to representational decorative stimuli belonging to the three complexity levels. Men's results revealed that in this case there were statistically significant differences between beauty scores given to representational decorative stimuli in the three complexity levels ($\chi 2$ = 16.235 p<.0042). The same was true for women's beauty scores ($\chi 2$ = 13.194 p<.0042).

Ranks

	Complexity	N	Mean Rank
Beauty men	Low	10	7,75
	Medium	10	15,15
	High	10	23,60
	Total	30	
Beauty women	Low	10	8,70
	Medium	10	14,85
	High	10	22,95
	Total	30	

Test Statistics[a,b]

	Beauty men	Beauty women
Chi-Square	16,235	13,194
df	2	2
Asymp. Sig.	,000	,001

a. Kruskal Wallis Test

b. Grouping Variable: Complexity

Table 4.17. Kruskal Wallis test of the influence of Complexity on men and women's beauty ratings of representational artistic stimuli

In order to determine the complexity levels between which there are differences we performed a series of contrasts by means of non-parametric Mann-Whitney tests. With the correction for multiple comparisons, the significance level is $\alpha = \frac{.05}{6} = .0083$

Table 4.18 shows the results for the contrast between men and women's beauty scores awarded to the representational decorative stimuli belonging to low and medium complexity levels. Men's results revealed that there were no significant differences between beauty scores given to representational decorative stimuli in low and intermediate complexity levels (Z = -2.155, ns). The same was true for women's beauty scores (Z = -1.816, ns).

Ranks

	Complexity	N	Mean Rank	Sum of Ranks
Beauty women	Low	10	8,10	81,00
	Medium	10	12,90	129,00
	Total	20		
Beauty men	Low	10	7,65	76,50
	Medium	10	13,35	133,50
	Total	20		

Test Statistics[b]

	Beauty women	Beauty men
Mann-Whitney U	26,000	21,500
Wilcoxon W	81,000	76,500
Z	-1,816	-2,155
Asymp. Sig. (2-tailed)	,069	,031
Exact Sig. [2*(1-tailed Sig.)]	,075[a]	,029[a]

a. Not corrected for ties.

b. Grouping Variable: Complexity

Table 4.18. Mann-Whitney test of the differences between men and women's beauty ratings awarded to representational decorative stimuli from low and intermediate complexity levels

Table 4.19 shows the results for the contrast between men and women's beauty scores awarded to the representational decorative stimuli belonging to intermediate and high complexity levels. Men's results revealed that there were no significant differences between beauty scores given to representational decorative stimuli in intermediate and high complexity levels (Z = -2.419, ns). The same was true for women's beauty scores (Z = -2.307, ns).

Ranks

	Complexity	N	Mean Rank	Sum of Ranks
Beauty women	Medium	10	7,45	74,50
	High	10	13,55	135,50
	Total	20		
Beauty men	Medium	10	7,30	73,00
	High	10	13,70	137,00
	Total	20		

Test Statistics[b]

	Beauty women	Beauty men
Mann-Whitney U	19,500	18,000
Wilcoxon W	74,500	73,000
Z	-2,307	-2,419
Asymp. Sig. (2-tailed)	,021	,016
Exact Sig. [2*(1-tailed Sig.)]	,019[a]	,015[a]

a. Not corrected for ties.

b. Grouping Variable: Complexity

Table 4.19. Mann-Whitney test of the differences between men and women's beauty ratings awarded to representational decorative stimuli from intermediate and high complexity levels

Table 4.20 shows the results for the contrast between men and women's beauty scores awarded to the representational decorative stimuli belonging to low and high complexity levels. Men's results revealed that in this case there were significant differences between beauty scores given to representational decorative stimuli in low and high complexity levels (Men Z = -2.704, p<.0083). The same was true for women's beauty scores (Women Z = -3.326, p<.0083). Results reveal that for both men and women, beauty scores awarded to highly complex representational decorative stimuli were greater than those awarded to simple representational decorative stimuli.

Ranks

	Complexity	N	Mean Rank	Sum of Ranks
Beauty women	Low	10	6,10	61,00
	High	10	14,90	149,00
	Total	20		
Beauty men	Low	10	5,60	56,00
	High	10	15,40	154,00
	Total	20		

Test Statistics[b]

	Beauty women	Beauty men
Mann-Whitney U	6,000	1,000
Wilcoxon W	61,000	56,000
Z	-3,326	-3,704
Asymp. Sig. (2-tailed)	,001	,000
Exact Sig. [2*(1-tailed Sig.)]	,000[a]	,000[a]

a. Not corrected for ties.

b. Grouping Variable: Complexity

Table 4.20. Mann-Whitney test of the differences between men and women's beauty ratings awarded to representational decorative stimuli from low and high complexity levels

3.2.3.3. Summary of the results

Analysis of the main effects revealed that the three independent variables had a significant influence on beauty scores awarded by men and women. Specifically, high complexity stimuli were awarded higher beauty scores than low complexity stimuli (p<.01), representational stimuli were awarded higher beauty scores than abstract stimuli (p<.001), and artistic stimuli were awarded higher beauty scores that decorative stimuli (p<.001). However, the study of interactions suggested that these results were driven by scores given to a certain kind of stimuli. Specifically, high complexity representational decorative stimuli were rated as being more beautiful than low complexity representational decorative stimuli (p<.001). These results apply to both men and women.

3.3

The concept of visual complexity

Abstract

In this section we present the results of the tests of hypotheses III.I, III.II, and III.III, concerning the concept of visual complexity. In relation to hypothesis III.I, our results suggest that, overall, the amount of elements in a stimulus is the best predictor of general complexity ratings. However, except for abstract decorative stimuli, men and women seem to base their ratings of general complexity on different features of the stimuli, which vary for different kinds of stimuli. With regards to hypothesis III.II, our results show that the seven complexity dimensions we have studied in the present work can be reduced to three factors which refer to: (i) the amount and variety of elements in a visual stimulus, (ii) the organization of the stimulus, (iii) asymmetry. Finally, our exploratory approach to hypothesis III.III suggests that each of these three complexity factors may be related in a different way to aesthetic preference.

In this section we deal with the concept of visual complexity. Specifically, we have broken down the concept of complexity into a series of more operative dimensions to address the following questions: (i) which of these dimensions are the best predictors of general complexity scores of each kind of stimulus (subsection 3.3.1)? (ii) how do these dimensions relate to each other (subsection 3.3.2)? (iii) how are these complexity dimensions related with beauty scores (subsection 3.3.3)? We explore each of these issues for men and women separately. In order to do so, as stated in section 2.3.3 of the procedure, we used the set of 60 visual stimuli selected from the pool of 120 (described in sections 2.2 and 3.1). Reproductions of each of the 60 stimuli, as well as men and women's scores awarded to each of them on the seven complexity dimensions can be found in Annex B. Before we turn to the results of our hypotheses tests, a description of the scores awarded to each stimulus kind on each dimension by male and female participants is presented in tables 5.1 and 5.2, respectively.

			Low		Intermediate		High	
			Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Dimension 1 men	Abstract	Artistic	4,69	1,42	6,68	,25	7,61	,49
		Decorative	4,64	,49	4,86	,73	5,56	1,09
	Representational	Artistic	2,63	,48	3,40	,91	5,28	1,34
		Decorative	2,01	1,37	2,05	,37	2,50	,19
Dimension 2 men	Abstract	Artistic	5,47	1,40	7,31	,14	7,44	,25
		Decorative	5,23	,84	5,78	1,27	6,40	1,47
	Representational	Artistic	2,15	,68	3,21	1,34	5,68	1,80
		Decorative	2,46	1,44	1,95	,82	2,15	,28
Dimension 3 men	Abstract	Artistic	3,54	,39	5,38	,79	7,61	,48
		Decorative	1,38	,20	3,76	,35	4,15	1,06
	Representational	Artistic	4,69	1,00	6,39	,60	7,40	,69
		Decorative	1,94	,32	4,29	,89	6,63	,41
Dimension 4 men	Abstract	Artistic	3,04	,46	4,55	,38	6,66	,43
		Decorative	1,46	,16	2,79	,71	3,31	1,00
	Representational	Artistic	4,91	1,22	5,77	,80	6,97	,86
		Decorative	2,22	,17	4,12	1,28	6,15	,85
Dimension 5 men	Abstract	Artistic	5,19	1,64	4,75	1,39	4,51	,95
		Decorative	5,67	2,88	5,11	1,06	5,24	1,64
	Representational	Artistic	5,41	1,40	5,96	,66	4,59	1,19
		Decorative	5,59	,88	5,12	1,71	5,57	,81
Dimension 6 men	Abstract	Artistic	3,53	,66	4,48	,62	5,77	,87
		Decorative	1,40	,15	2,77	1,33	3,92	1,29
	Representational	Artistic	5,86	1,17	6,03	1,09	6,52	1,41
		Decorative	2,37	,21	4,61	,98	6,27	1,17
Dimension 7 men	Abstract	Artistic	2,91	1,88	3,40	1,60	4,26	1,26
		Decorative	1,20	,06	2,09	,42	3,47	2,06
	Representational	Artistic	6,43	,96	6,64	,77	5,81	1,15
		Decorative	2,34	1,51	5,52	2,66	7,33	,31

Table 5.1. Scores awarded to each stimulus kind on each complexity dimension by male participants

			Low		Intermediate		High	
			Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Dimension 1 women	Abstract	Artistic	4,51	1,28	6,85	,44	7,51	,42
		Decorative	3,86	,60	4,83	,82	5,53	1,11
	Representational	Artistic	1,96	,27	3,15	1,12	5,55	1,45
		Decorative	1,97	1,40	1,80	,37	2,19	,13
Dimension 2 women	Abstract	Artistic	5,35	1,03	6,81	,31	7,10	,53
		Decorative	4,48	,68	5,53	,91	5,96	1,08
	Representational	Artistic	2,31	,38	3,23	1,15	5,55	1,59
		Decorative	2,47	1,51	2,12	,59	2,41	,15
Dimension 3 women	Abstract	Artistic	3,35	,51	5,18	,54	7,32	,68
		Decorative	1,43	,17	3,98	,61	4,82	1,50
	Representational	Artistic	4,47	1,11	6,16	,70	7,50	,57
		Decorative	1,94	,55	4,28	,93	6,77	,64
Dimension 4 women	Abstract	Artistic	3,18	,58	4,87	,43	6,45	,83
		Decorative	1,44	,41	3,04	,69	3,68	1,04
	Representational	Artistic	4,76	1,57	5,91	1,04	6,96	,93
		Decorative	2,30	,62	4,64	1,43	6,21	,99
Dimension 5 women	Abstract	Artistic	5,05	1,56	4,99	1,06	4,42	1,32
		Decorative	5,73	2,61	5,07	,97	4,97	1,47
	Representational	Artistic	5,36	1,46	5,98	,73	4,74	,99
		Decorative	5,77	,73	4,99	1,23	5,45	1,18
Dimension 6 women	Abstract	Artistic	3,87	,96	4,57	,77	5,47	1,09
		Decorative	1,18	,08	3,32	2,01	4,14	1,24
	Representational	Artistic	5,47	1,39	6,14	1,22	6,59	1,41
		Decorative	2,37	,37	4,74	1,03	6,19	1,37
Dimension 7 women	Abstract	Artistic	3,42	1,74	3,70	1,55	4,41	1,23
		Decorative	1,33	,08	2,90	,81	4,13	1,97
	Representational	Artistic	5,98	,95	6,34	,96	5,94	1,16
		Decorative	2,50	1,16	5,33	2,18	7,09	,04

Table 5.2. Scores awarded to each stimulus kind on each complexity dimension by female participants

3.3.1. Discriminant analyses

The objective of these analyses was to determine whether ratings on any set of complexity dimensions could adequately predict the complexity level (low, intermediate, high) to which different kinds of stimuli belonged. In order to test this possibility we performed a series of discriminant analyses, a technique used to ascertain which among a series of quantitative variables predict the values of an ordinal variable with the greatest accuracy. We were interested in obtaining results for the whole set of 60 stimuli and for each stimulus kind in particular.

Discriminant analysis requires at least: (i) the existence of two or more groups, (ii) the existence of two or more cases in each group, (iii) that the number of discriminant variables does not exceed the number of cases minus two, (iv) that discriminant variables are not be linear combinations of each other, (v) that the group-defining variable is nominal and the discriminants must be scale variables, (vi) that covariance matrices of each group are approximately equal, (vii) that discriminant variables do not significantly depart from normality (Lévy Mangin & Varela Mallou, 2003). Although it has been pointed out that the robusticity of this technique allows for the infringement of the last two conditions (Lévy Mangin & Varela Mallou, 2003), we will explore normality and Covariance matrix homogeneity before we turn to the results of the discriminant analysis.

The results of the tests for normality carried out with the ratings of all 60 stimuli on the seven complexity dimensions awarded by men and women are shown in tables 5.3 and 5.4 respectively. As these results reveal, the scores on most of the dimensions significantly depart from normality. Tables 5.5. and 5.6 present the results for the test of homogeneity of covariance matrices for scores awarded by male and female participants, respectively. These results indicate that there is not reason enough to assume they are not homogeneous. However, this test is sensitive to violations of the normality assumption. In any case, as mentioned above, violations of the normality assumption do not seem to affect the procedure to a great extent, and neither do violations of sphericity, so discriminant analysis was performed as described.

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Complexity level	Statistic	df	Sig.	Statistic	df	Sig.
Dimension 1 men	Low	,119	20	,200*	,965	20	,642
	Intermediate	,180	20	,090	,912	20	,070
	High	,149	20	,200*	,909	20	,061
Dimension 2 men	Low	,197	20	,041	,892	20	,030
	Intermediate	,180	20	,090	,872	20	,013
	High	,254	20	,001	,801	20	,001
Dimension 3 men	Low	,174	20	,115	,922	20	,110
	Intermediate	,171	20	,127	,921	20	,103
	High	,196	20	,042	,873	20	,013
Dimension 4 men	Low	,188	20	,062	,894	20	,032
	Intermediate	,141	20	,200*	,972	20	,802
	High	,196	20	,043	,874	20	,014
Dimension 5 men	Low	,083	20	,200*	,971	20	,772
	Intermediate	,151	20	,200*	,949	20	,354
	High	,119	20	,200*	,970	20	,759
Dimension 6 men	Low	,186	20	,068	,905	20	,050
	Intermediate	,098	20	,200*	,975	20	,861
	High	,114	20	,200*	,950	20	,370
Dimension 7 men	Low	,283	20	,000	,787	20	,001
	Intermediate	,219	20	,013	,853	20	,006
	High	,127	20	,200*	,923	20	,115

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Table 5.3. Results for the normality tests carried out on men's ratings for each complexity factor

	Complexity level	Kolmogorov-Smirnov[a] Statistic	df	Sig.	Shapiro-Wilk Statistic	df	Sig.
Dimension 1 women	Low	,173	20	,118	,923	20	,113
	Intermediate	,190	20	,057	,893	20	,030
	High	,199	20	,037	,878	20	,016
Dimension 2 women	Low	,166	20	,150	,900	20	,041
	Intermediate	,186	20	,067	,871	20	,012
	High	,237	20	,004	,831	20	,003
Dimension 3 women	Low	,157	20	,200*	,919	20	,097
	Intermediate	,076	20	,200*	,989	20	,997
	High	,163	20	,170	,836	20	,003
Dimension 4 women	Low	,177	20	,100	,902	20	,045
	Intermediate	,120	20	,200*	,945	20	,294
	High	,164	20	,167	,934	20	,182
Dimension 5 women	Low	,117	20	,200*	,970	20	,751
	Intermediate	,148	20	,200*	,945	20	,297
	High	,200	20	,035	,919	20	,094
Dimension 6 women	Low	,148	20	,200*	,923	20	,114
	Intermediate	,116	20	,200*	,952	20	,404
	High	,174	20	,113	,943	20	,273
Dimension 7 women	Low	,251	20	,002	,823	20	,002
	Intermediate	,180	20	,087	,878	20	,016
	High	,179	20	,093	,901	20	,043

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Table 5.4. Results for the normality tests carried out on women's ratings for each complexity factor

Box's M	**F**	**df1**	**df2**	**Sig**
74.711	1.096	56	9280.32	.290

Table 5.5. Results for Box's test for equality of covariance matrices for men

Box's M	**F**	**df1**	**df2**	**Sig**
80.139	1.176	56	9280.32	.174

Table 5.6. Results for Box's test for equality of covariance matrices for women

We now turn to the results of the discriminant analyses. First we present the results that address the issue of whether scores on any combination of complexity dimensions can accurately predict the complexity level of the whole set of sixty stimuli. Men and women's results are presented separately. Thereafter we present the results of the analyses addressing the issue of whether complexity dimensions which accurately predict the complexity level differ for each kind of stimulus. Here, men and women's results are also presented separately.

Due to its parsimonious results, we chose Wilks' Lambda stepwise method. It indicates which of the predictor variables have the greatest discriminant power, and includes the least possible number of them in the model. The procedure is carried out according to an algorithm that includes variables according to their discriminant capacity along a series of steps. At each step this algorithm checks that all the included variables comply with the permanence criterion and, at the same time, a new variable which satisfies the entry criterion is included. The procedure ends when no variables satisfying the entry criterion remain and, at the same time, all those included comply with the permanence criterion. We fixed our entry criterion at an F value of 3.84 (5%) and the removal criterion at an F value of 2.71 (10%).

3.3.1.1. Discriminant analysis of men's complexity ratings on the seven predictor variables for all stimuli

The complexity level of each stimulus served as the grouping value, and the average of men's scores to each stimulus on each complexity dimension were entered as independent variables. As shown in table 5.7, men's scores on dimensions 3 and 4 –amount of elements and variety of elements- is the best parsimonious combination of dimensions to predict the complexity level of the whole set of stimuli. In fact, the F-tests reveal that the scores men awarded on dimensions 3 and 4 to stimuli belonging to the three complexity levels differ significantly.

Variables Entered/Removed[a,b,c,d]

Step	Entered	Wilks' Lambda							
						Exact F			
		Statistic	df1	df2	df3	Statistic	df1	df2	Sig.
1	Factor 3 men	,471	1	2	57,000	32,057	2	57,000	,000
2	Factor 4 men	,403	2	2	57,000	16,108	4	112,000	,000

At each step, the variable that minimizes the overall Wilks' Lambda is entered.

a. Maximum number of steps is 14.

b. Minimum partial F to enter is 3.84.

c. Maximum partial F to remove is 2.71.

d. F level, tolerance, or VIN insufficient for further computation.

Table 5.7. Predictor variables for men's ratings of all stimuli

Together with the standardized canonical discriminant function coefficients, Wilks' Lambda for men's discriminant scores is presented in table 5.8. This statistic expresses the proportion of total variance of discriminant scores that is not explained by differences among groups. In this case, differences among complexity levels accounts for just under 60% of the variance among discriminant scores derived from factors 3 and 4. The associated Chi-square statistic tests the null hypotheses that there are no differences between the discriminant function of stimuli belonging to the three complexity levels. The results of this test reveal there are highly significant differences between complexity levels in the results of the first discriminant function, but not the second.

	Function	
	1	2
Factor 3 hombres	1,984	-1,796
Factor 4 hombres	-1,169	2,407

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 2	,403	51,352	4	,000
2	,959	2,365	1	,124

Table 5.8. Standardized canonical discriminant function coefficients and Wilks' Lambda

As shown in table 5.9, the first discriminant function has a high eigenvalue, the quotient between the between-groups sum of squares and the within-groups sum of squares. It also shows that the first discriminant function explains 97% of the overall variance.

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	1,380[a]	97,0	97,0	,761
2	,043[a]	3,0	100,0	,202

a. First 2 canonical discriminant functions were used in the analysis.

Table 5.9. Eigenvalues and percentage of variance explained by the discriminant functions

Table 5.10 shows the correspondence between the complexity levels predicted using men's ratings on dimensions 3 and 4 and the original complexity levels to which stimuli belonged. The discriminant function correctly classified 70% of low complexity stimuli, 60% of intermediate complexity stimuli, and 75% of high complexity stimuli. Most low complexity stimuli that were erroneously classified were placed in the intermediate level. Most of the intermediate complexity stimuli that were erroneously classified were placed in the high complexity level. And most of the high complexity stimuli that were erroneously classified were placed in the intermediate level. Overall, 68.3% of the stimuli were correctly classified.

Classification Results[a]

			Predicted Group Membership			
		Complexity level	Low	Intermediate	High	Total
Original	Count	Low	14	5	1	20
		Intermediate	3	12	5	20
		High	2	3	15	20
	%	Low	70,0	25,0	5,0	100,0
		Intermediate	15,0	60,0	25,0	100,0
		High	10,0	15,0	75,0	100,0

a. 68,3% of original grouped cases correctly classified.

Table 5.10. Classification results of stimuli in three complexity levels based on dimensions 3 and 4

In order to obtain a significance value for the accuracy of this classification we calculated the Kappa index between the predicted level of complexity and the actual complexity level to which stimuli belonged. Cohen's Kappa index provides the percentage of agreement between both variables after correcting for chance. As shown in table 5.11, after correcting for chance, there is a 52.5% agreement between the actual complexity level and the predicted complexity level based on men's ratings of the whole set of stimuli on factors 3 and 4.

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Measure of Agreement	Kappa	,525	,090	5,753	,000
N of Valid Cases		60			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Table 5.11. Cohen's Kappa between predicted and actual complexity levels

3.3.1.2. Discriminant analysis of women's complexity ratings on the seven predictor variables for all stimuli

The complexity level of each stimulus served as the grouping value, and the average of women's scores to each stimulus on each complexity dimension were entered as independent variables. As shown in table 5.12, women's scores on dimensions 3 and 6 –amount of elements and variety of colours- represent the best parsimonious combination to predict the complexity level of the whole set of stimuli. In fact, the F-tests reveal that the scores women awarded on dimensions 3 and 6 to stimuli belonging to the three complexity levels differ significantly.

Variables Entered/Removed[a,b,c,d]

		Wilks' Lambda							
						Exact F			
Step	Entered	Statistic	df1	df2	df3	Statistic	df1	df2	Sig.
1	Factor 3 women	,395	1	2	57,000	43,720	2	57,000	,000
2	Factor 6 women	,332	2	2	57,000	20,598	4	112,000	,000

At each step, the variable that minimizes the overall Wilks' Lambda is entered.

a. Maximum number of steps is 14.

b. Minimum partial F to enter is 3.84.

c. Maximum partial F to remove is 2.71.

d. F level, tolerance, or VIN insufficient for further computation.

Table 5.12. Predictor variables for women's ratings of all stimuli

Together with the standardized canonical discriminant function coefficients, Wilks' Lambda for women's discriminant scores is presented in table 5.13. In this case, differences among complexity levels account for approximately 66% of the variance among discriminant scores derived from factors 3 and 6. The result of the associated Chi-square this test reveals there are highly significant differences between complexity levels in the results of the first discriminant function, but not the second.

	Function	
	1	2
Factor 3 women	1,542	-,728
Factor 6 women	-,823	1,494

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 2	,332	62,306	4	,000
2	,995	,272	1	,602

Table 5.13. Standardized canonical discriminant function coefficients and Wilks' Lambda

As shown in table 5.14, the first discriminant function has a high eigenvalue, the quotient between the between-groups sum of squares and the within-groups sum of squares. It also shows that the first discriminant function explains 99.8% of the overall variance.

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	1,998[a]	99,8	99,8	,816
2	,005[a]	,2	100,0	,069

a. First 2 canonical discriminant functions were used in the analysis.

Table 5.14. Eigenvalues and percentage of variance explained by the discriminant functions

Table 5.15 shows the correspondence between the complexity levels predicted using women's ratings on dimensions 3 and 6 and the original complexity levels to which stimuli belonged. The discriminant function correctly classified 85% of low complexity stimuli, 65% of intermediate complexity stimuli, and 80% of high complexity stimuli. All of the low complexity stimuli that were erroneously classified were predicted to belong to the intermediate level. Four of the intermediate complexity stimuli that were erroneously classified were placed in the high complexity level, and three were predicted to belong to the low complexity level. Finally, half of the high complexity stimuli that were erroneously classified were placed in the intermediate level and the other in the low complexity level. Overall, 76.7% of the stimuli were correctly classified.

Classification Results[a]

		Complexity level	Predicted Group Membership: Low	Intermediate	High	Total
Original	Count	Low	17	3	0	20
		Intermediate	3	13	4	20
		High	2	2	16	20
	%	Low	85,0	15,0	,0	100,0
		Intermediate	15,0	65,0	20,0	100,0
		High	10,0	10,0	80,0	100,0

a. 76,7% of original grouped cases correctly classified.

Table 5.15. Classification results of stimuli in three complexity levels based on dimensions 3 and 6

In order to obtain a significance value for the accuracy of this classification we calculated the Kappa index between the predicted level of complexity and the actual complexity level to which stimuli belonged. As shown in table 5.16, after correcting for chance, there is a 65% agreement between the actual complexity level and the predicted complexity level based on women's ratings of the whole set of stimuli on factors 3 and 6.

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Measure of Agreement	Kappa	,650	,082	7,132	,000
N of Valid Cases		60			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Table 5.16. Cohen's Kappa between predicted and actual complexity levels

3.3.1.3. Discriminant analysis for each stimulus category

Abstract artistic: men

The complexity level of each stimulus served as the grouping value, and the average of men's scores awarded to each of the 15 abstract artistic stimuli on each complexity dimension were entered as independent variables. As shown in table 5.17, men's scores on dimension 4 –variety of elements- represents the best parsimonious combination to predict the complexity level of the subset of abstract artistic stimuli. In fact, the F-test reveal that the scores men awarded on dimension 4 to stimuli belonging to the three complexity levels differ significantly.

Variables Entered/Removed[a,b,c,d]

Step	Entered	Wilks' Lambda							
						Exact F			
		Statistic	df1	df2	df3	Statistic	df1	df2	Sig.
1	Factor 4 men	,061	1	2	12,000	91,680	2	12,000	,000

At each step, the variable that minimizes the overall Wilks' Lambda is entered.

a. Maximum number of steps is 14.

b. Minimum partial F to enter is 3.84.

c. Maximum partial F to remove is 2.71.

d. F level, tolerance, or VIN insufficient for further computation.

Table 5.17. Predictor variables for men's ratings of abstract artistic stimuli

Together with the standardized canonical discriminant function coefficients, Wilks' Lambda for men's discriminant scores is presented in table 5.18. In this case, differences among complexity levels accounts for almost 94% of the variance among discriminant scores derived from dimension 4. The result of the associated Chi-square this test reveals there are highly significant differences between complexity levels in the results of the sole discriminant function.

	Function
	1
Factor 4 men	1,000

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	,061	33,479	2	,000

Table 5.18. Standardized canonical discriminant function coefficients and Wilks' Lambda

As shown in table 5.19, the discriminant function has a very high eigenvalue, the quotient between the between-groups sum of squares and the within-groups sum of squares. It also shows that the first discriminant function explains 100% of the overall variance.

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	15,280[a]	100,0	100,0	,969

a. First 1 canonical discriminant functions were used in the analysis.

Table 5.19. Eigenvalue and percentage of variance explained by the discriminant function

Table 5.20 shows the correspondence between the complexity levels predicted using men's ratings on dimension and the original complexity levels to which stimuli belonged. The discriminant function correctly classified all low, intermediate, and high complexity abstract artistic stimuli.

Classification Results[a]

			Predicted Group Membership			
		Complexity level	Low	Intermediate	High	Total
Original	Count	Low	5	0	0	5
		Intermediate	0	5	0	5
		High	0	0	5	5
	%	Low	100,0	,0	,0	100,0
		Intermediate	,0	100,0	,0	100,0
		High	,0	,0	100,0	100,0

a. 100,0% of original grouped cases correctly classified.

Table 5.20. Classification results of stimuli in three complexity levels based on dimension 4

In order to obtain a significance value for the accuracy of this classification we calculated the Kappa index between the predicted level of complexity and the actual complexity level to which stimuli belonged. As shown in table 5.21, after correcting for chance, there is a 100% agreement between the actual complexity level and the predicted complexity level based on men's ratings of abstract artistic stimuli on dimension 4.

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Measure of Agreement	Kappa	1,000	,000	5,477	,000
N of Valid Cases		15			

a. Not assuming the null hypothesis.
b. Using the asymptotic standard error assuming the null hypothesis.

Table 5.21. Cohen's Kappa between predicted and actual complexity levels

Abstract artistic: women

The complexity level of each stimulus served as the grouping value, and the average of women's scores to each of the 15 abstract artistic stimuli on each complexity dimension were entered as independent variables. As shown in table 5.22, women's scores on dimensions 1 and 3 –unintelligibility of the elements and variety of elements- represent the best parsimonious combination of dimensions to predict the complexity level of the subset of abstract artistic stimuli. In fact, the F-tests reveal that the scores women awarded on dimensions 1 and 3 to stimuli belonging to the three complexity levels differ significantly.

Variables Entered/Removed[a,b,c,d]

Step	Entered	Wilks' Lambda							
						Exact F			
		Statistic	df1	df2	df3	Statistic	df1	df2	Sig.
1	Factor 3 women	,094	1	2	12,000	57,970	2	12,000	,000
2	Factor 1 women	,046	2	2	12,000	20,170	4	22,000	,000

At each step, the variable that minimizes the overall Wilks' Lambda is entered.

a. Maximum number of steps is 14.

b. Minimum partial F to enter is 3.84.

c. Maximum partial F to remove is 2.71.

d. F level, tolerance, or VIN insufficient for further computation.

Table 5.22. Predictor variables for women's ratings of abstract artistic stimuli

Together with the standardized canonical discriminant function coefficients, Wilks' Lambda for women's discriminant scores is presented in table 5.23. In this case, differences among complexity levels accounts for over 95% of the variance among discriminant scores derived from dimensions 1 and 3. The result of the associated Chi-square this test reveals there are highly significant differences between complexity levels in the results of the first discriminant function, though not the second.

	Function	
	1	2
Factor 1 women	,677	,789
Factor 3 women	,944	-,435

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 2	,046	35,433	4	,000
2	,808	2,458	1	,117

Table 5.23. Standardized canonical discriminant function coefficients and Wilks' Lambda

As shown in table 5.24, the first discriminant function has a very high eigenvalue, the quotient between the between-groups sum of squares and the within-groups sum of squares. It also shows that the first discriminant function explains over 98% of the overall variance.

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	16,591[a]	98,6	98,6	,971
2	,238[a]	1,4	100,0	,439

a. First 2 canonical discriminant functions were used in the analysis.

Table 5.24. Eigenvalues and percentage of variance explained by the discriminant functions

Table 5.25 shows the correspondence between the complexity levels predicted using women's ratings on dimensions 1 and 3 and the original complexity levels to which stimuli belonged. The discriminant function correctly classified all low, and intermediate complexity abstract artistic stimuli. However, it erroneously classified one of the five high complexity abstract artistic stimuli in the intermediate level. Overall, the discriminant function based on women's scores on dimensions 1 and 3 correctly classified 93.3% of abstract artistic stimuli.

Classification Results[a]

			Predicted Group Membership			
		Complexity level	Low	Intermediate	High	Total
Original	Count	Low	5	0	0	5
		Intermediate	0	5	0	5
		High	0	1	4	5
	%	Low	100,0	,0	,0	100,0
		Intermediate	,0	100,0	,0	100,0
		High	,0	20,0	80,0	100,0

a. 93,3% of original grouped cases correctly classified.

Table 5.25. Classification results of stimuli in three complexity levels based on dimensions 1 and 3

In order to obtain a significance value for the accuracy of this classification we calculated the Kappa index between the predicted level of complexity and the actual complexity level to which stimuli belonged. As shown in table 5.26, after correcting for chance, there is a 90% agreement between the actual complexity level and the predicted complexity level based on women's ratings of abstract artistic stimuli on dimensions 1 and 3.

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Measure of Agreement	Kappa	,900	,096	4,963	,000
N of Valid Cases		15			

a. Not assuming the null hypothesis.
b. Using the asymptotic standard error assuming the null hypothesis.

Table 5.26. Cohen's Kappa between predicted and actual complexity levels

Abstract decorative: men

The complexity level of each stimulus served as the grouping value, and the average of men's scores to each of the 15 abstract decorative stimuli on each complexity dimension were entered as independent variables. As shown in table 5.27, men's scores on dimension 3 –amount of elements- represents the best parsimonious combination to predict the complexity level of the subset of abstract decorative stimuli. In fact, the F-test reveal that the scores men awarded on dimension 3 to stimuli belonging to the three complexity levels differ significantly.

Variables Entered/Removed[a,b,c,d]

		Wilks' Lambda							
						Exact F			
Step	Entered	Statistic	df1	df2	df3	Statistic	df1	df2	Sig.
1	Factor 3 men	,187	1	2	12,000	26,164	2	12,000	,000

At each step, the variable that minimizes the overall Wilks' Lambda is entered.
a. Maximum number of steps is 14.
b. Minimum partial F to enter is 3.84.
c. Maximum partial F to remove is 2.71.
d. F level, tolerance, or VIN insufficient for further computation.

Table 5.27. Predictor variables for men's ratings of abstract decorative stimuli

Together with the standardized canonical discriminant function coefficients, Wilks' Lambda for men's discriminant scores is presented in table 5.28. In this case, differences among complexity levels account for over 81% of the variance among discriminant scores derived from factor 3. The result of the associated Chi-square this test reveals there are highly significant differences between complexity levels in the results of the sole discriminant function.

	Function
	1
Factor 3 men	1,000

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	,187	20,149	2	,000

Table 5.28. Standardized canonical discriminant function coefficients and Wilks' Lambda

As shown in table 5.29, the first discriminant function has a very high eigenvalue, the quotient between the between-groups sum of squares and the within-groups sum of squares. It also shows that the first discriminant function explains over 98% of the overall variance.

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	4,361[a]	100,0	100,0	,902

a. First 1 canonical discriminant functions were used in the analysis.

Table 5.29. Eigenvalue and percentage of variance explained by the discriminant function

Table 5.30 shows the correspondence between the complexity levels predicted using men's ratings on dimension and the original complexity levels to which stimuli belonged. The discriminant function correctly classified all low complexity stimuli. Four of the five intermediately complex abstract decorative stimuli were correctly classified, while the other was predicted to belong to the high complexity level. The worse classification results relate to the high complexity stimuli, two of which were predicted to belong to the intermediate level. Overall, the discriminant function based on men's scores on dimension 3 correctly classified 80% of abstract decorative stimuli.

Classification Results[a]

			Predicted Group Membership			
		Complexity level	Low	Intermediate	High	Total
Original	Count	Low	5	0	0	5
		Intermediate	0	4	1	5
		High	0	2	3	5
	%	Low	100,0	,0	,0	100,0
		Intermediate	,0	80,0	20,0	100,0
		High	,0	40,0	60,0	100,0

a. 80,0% of original grouped cases correctly classified.

Table 5.30. Classification results of stimuli in three complexity levels based on dimension 3

In order to obtain a significance value for the accuracy of this classification we calculated the Kappa index between the predicted level of complexity and the actual complexity level to which stimuli belonged. As shown in table 5.26, after correcting for chance, there is a 70% agreement between the actual complexity level and the predicted complexity level based on men's ratings of abstract decorative stimuli on dimension 3.

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Measure of Agreement	Kappa	,700	,154	3,860	,000
N of Valid Cases		15			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Table 5.31. Cohen's Kappa between predicted and actual complexity levels

Abstract decorative: women

The complexity level of each stimulus served as the grouping value, and the average of women's scores to each of the 15 abstract decorative stimuli on each complexity dimension were entered as independent variables. As shown in table 5.32, women's scores on dimension 3 –amount of elements- represents the best parsimonious combination of factors to predict the complexity level of the subset of abstract decorative stimuli. In fact, the F-test reveal that the scores women awarded on dimension 3 to stimuli belonging to the three complexity levels differ significantly.

Variables Entered/Removed[a,b,c,d]

Step	Entered	Wilks' Lambda							
						Exact F			
		Statistic	df1	df2	df3	Statistic	df1	df2	Sig.
1	Factor 3 women	,253	1	2	12,000	17,677	2	12,000	,000

At each step, the variable that minimizes the overall Wilks' Lambda is entered.

a. Maximum number of steps is 14.

b. Minimum partial F to enter is 3.84.

c. Maximum partial F to remove is 2.71.

d. F level, tolerance, or VIN insufficient for further computation.

Table 5.32. Predictor variables for women's ratings of abstract decorative stimuli

Together with the standardized canonical discriminant function coefficients, Wilks' Lambda for women's discriminant scores is presented in table 5.33. In this case, differences among complexity levels account for almost 75% of the variance among discriminant scores derived from dimension 3. The result of the associated Chi-square this test reveals there are highly significant differences between complexity levels in the results of the sole discriminant function.

	Function
	1
Factor 3 women	1,000

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	,253	16,473	2	,000

Table 5.33. Standardized canonical discriminant function coefficients and Wilks' Lambda

As shown in table 5.34, the first discriminant function has a very high eigenvalue, the quotient between the between-groups sum of squares and the within-groups sum of squares. It also shows that the first discriminant function explains over 98% of the overall variance.

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	2,946[a]	100,0	100,0	,864

a. First 1 canonical discriminant functions were used in the analysis.

Table 5.34. Eigenvalue and percentage of variance explained by the discriminant function

Table 5.35 shows the correspondence between the complexity levels predicted using women's ratings on dimension 3 and the original complexity levels to which stimuli belonged. The discriminant function correctly classified all low complexity stimuli. Four of the five intermediately complex abstract decorative stimuli were correctly classified, while the other was predicted to belong to the high complexity level. The worse classification results relate to the high complexity stimuli, two of which were predicted to belong to the intermediate level. Overall, the discriminant function based on women's scores on dimension 3 correctly classified 80% of abstract decorative stimuli.

Classification Results[a]

		Complexity level	Predicted Group Membership Low	Intermediate	High	Total
Original	Count	Low	5	0	0	5
		Intermediate	0	4	1	5
		High	0	2	3	5
	%	Low	100,0	,0	,0	100,0
		Intermediate	,0	80,0	20,0	100,0
		High	,0	40,0	60,0	100,0

a. 80,0% of original grouped cases correctly classified.

Table 5.35. Classification results of stimuli in three complexity levels based on dimension 3

In order to obtain a significance value for the accuracy of this classification we calculated the Kappa index between the predicted level of complexity and the actual complexity level to which stimuli belonged. As shown in table 5.36, after correcting for chance, there is a 70% agreement between the actual complexity level and the predicted complexity level based on women's ratings of abstract decorative stimuli on factor 3.

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Measure of Agreement	Kappa	,700	,154	3,860	,000
N of Valid Cases		15			

a. Not assuming the null hypothesis.
b. Using the asymptotic standard error assuming the null hypothesis.

Table 5.36. Cohen's Kappa between predicted and actual complexity levels

Representational artistic: men

The complexity level of each stimulus served as the grouping value, and the average of men's scores to each of the 15 representational artistic stimuli on each complexity dimension were entered as independent variables. As shown in table 5.37, men's scores on dimensions 2, 3, 4, and 5 –disorganization, number of elements, variety of elements, and symmetry- represent the best parsimonious combination of dimensions to predict the complexity level of the subset of representational artistic stimuli. In fact, the F-tests reveal that the scores men awarded on dimensions 2, 3, 4, and 5 to stimuli belonging to the three complexity levels differ significantly.

Variables Entered/Removed[a,b,c,d]

Step	Entered	Wilks' Lambda							
						Exact F			
		Statistic	df1	df2	df3	Statistic	df1	df2	Sig.
1	Factor 3 men	,284	1	2	12,000	15,151	2	12,000	,001
2	Factor 5 men	,106	2	2	12,000	11,425	4	22,000	,000
3	Factor 2 men	,045	3	2	12,000	12,386	6	20,000	,000
4	Factor 4 men	,018	4	2	12,000	14,423	8	18,000	,000

At each step, the variable that minimizes the overall Wilks' Lambda is entered.
a. Maximum number of steps is 14.
b. Minimum partial F to enter is 3.84.
c. Maximum partial F to remove is 2.71.
d. F level, tolerance, or VIN insufficient for further computation.

Table 5.37. Predictor variables for men's rating of representational artistic stimuli

Together with the standardized canonical discriminant function coefficients, Wilks' Lambda for men's discriminant scores is presented in table 5.38. In this case, the first discriminant function leads to differences among complexity levels which account for over 98% of the variance among discriminant scores derived from factors 2, 3, 4, and 5. The result of the associated Chi-square this test reveals there are highly significant differences between complexity levels in the results of the first discriminant function. The second discriminant function also provides significantly different results when calculated for ratings awarded to stimuli belonging to the three complexity levels, though it accounts for just over 66% of the between group differences.

	Function	
	1	2
Factor 2 men	1,014	,617
Factor 3 men	1,259	-2,680
Factor 4 men	,445	3,133
Factor 5 men	-1,545	-,686

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 2	,018	42,060	8	,000
2	,337	11,411	3	,010

Table 5.38. Standardized canonical discriminant function coefficients and Wilks' Lambda

As shown in table 5.39, the first discriminant function has a very high eigenvalue, the quotient between the between-groups sum of squares and the within-groups sum of squares. It also shows that the first discriminant function explains 89.9% of the overall variance. In regards to the second discriminant function, though its eigenvalue is above 1, it is certainly much smaller than that of the first function. The variance explained by this function is very small, a mere 10.1%.

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	17,523[a]	89,9	89,9	,973
2	1,965[a]	10,1	100,0	,814

a. First 2 canonical discriminant functions were used in the analysis.

Table 5.39. Eigenvalue and percentage of variance explained by the discriminant functions

Table 5.40 shows the correspondence between the complexity levels predicted using men's ratings on dimensions 2, 3, 4 and 5, and the original complexity levels to which stimuli belonged. All representational artistic stimuli were correctly classified.

Classification Results[a]

			Predicted Group Membership			
		Complexity level	Low	Intermediate	High	Total
Original	Count	Low	5	0	0	5
		Intermediate	0	5	0	5
		High	0	0	5	5
	%	Low	100,0	,0	,0	100,0
		Intermediate	,0	100,0	,0	100,0
		High	,0	,0	100,0	100,0

a. 100,0% of original grouped cases correctly classified.

Table 5.40. Classification results of stimuli in three complexity levels based on dimensions 2, 3, 4 and 5

In order to obtain a significance value for the accuracy of this classification we calculated the Kappa index between the predicted level of complexity and the actual complexity level to which stimuli belonged. As shown in table 5.41, after correcting for chance, there is a 100% agreement between the actual complexity level and the predicted complexity level based on men's ratings of representational artistic stimuli on dimensions 2, 3, 4, and 5.

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Measure of Agreement	Kappa	1,000	,000	5,477	,000
N of Valid Cases		15			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Table 5.41. Cohen's Kappa between predicted and actual complexity levels

Representational artistic: women

The complexity level of each stimulus served as the grouping value, and the average of women's scores to each of the 15 representational artistic stimuli on each complexity dimension were entered as independent variables. As shown in table 5.42, women's scores on dimensions 3 and 5 –number of elements and symmetry- represents the best parsimonious combination of factors to predict the complexity level of the subset of representational artistic stimuli. In fact, the F-tests reveal that the scores women awarded on dimensions 3 and 5 to stimuli belonging to the three complexity levels differ significantly.

Variables Entered/Removed[a,b,c,d]

		Wilks' Lambda							
						Exact F			
Step	Entered	Statistic	df1	df2	df3	Statistic	df1	df2	Sig.
1	Factor 3 women	,261	1	2	12,000	17,009	2	12,000	,000
2	Factor 5 women	,092	2	2	12,000	12,591	4	22,000	,000

At each step, the variable that minimizes the overall Wilks' Lambda is entered.

a. Maximum number of steps is 14.

b. Minimum partial F to enter is 3.84.

c. Maximum partial F to remove is 2.71.

d. F level, tolerance, or VIN insufficient for further computation.

Table 5.42. Predictor variables for women's rating of representational artistic stimuli

Together with the standardized canonical discriminant function coefficients, Wilks' Lambda for women's discriminant scores is presented in table 5.43. In this case, the first discriminant function leads to differences among complexity levels which account for over 90% of the variance among discriminant scores derived from dimensions 3 and 5. The result of the associated Chi-square this test reveals there are highly significant differences between complexity levels in the results of the first discriminant function. The second discriminant function does not yield significantly different results when calculated for ratings awarded to stimuli belonging to the three complexity levels, and accounts for less than 15% of the between-group differences.

	Function	
	1	2
Factor 3 women	1,505	,166
Factor 5 women	-1,240	,869

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 2	,092	27,386	4	,000
2	,856	1,786	1	,181

Table 5.43. Standardized canonical discriminant function coefficients and Wilks' Lambda

As shown in table 5.44, the first discriminant function has a very high eigenvalue, the quotient between the between-groups sum of squares and the within-groups sum of squares. It also shows that the first discriminant function explains 98% of the overall variance. In regards to the second discriminant function, its eigenvalue is well below 1, and it only explains 2% of the variance.

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	8,264[a]	98,0	98,0	,944
2	,168[a]	2,0	100,0	,379

a. First 2 canonical discriminant functions were used in the analysis.

Table 5.44. Eigenvalue and percentage of variance explained by the discriminant functions

Table 5.45 shows the correspondence between the complexity levels predicted using women's ratings on dimensions 3 and 5, and the original complexity levels to which stimuli belonged. All intermediate complexity representational artistic stimuli were correctly classified. One of the five high complexity stimuli was misclassified as intermediate, as was one of the high complexity representational artistic stimuli.

Classification Results[a]

		Complexity level	Predicted Group Membership: Low	Intermediate	High	Total
Original	Count	Low	4	1	0	5
		Intermediate	0	5	0	5
		High	0	1	4	5
	%	Low	80,0	20,0	,0	100,0
		Intermediate	,0	100,0	,0	100,0
		High	,0	20,0	80,0	100,0

a. 86,7% of original grouped cases correctly classified.

Table 5.45. Classification results of stimuli in three complexity levels based on dimensions 3 and 5

In order to obtain a significance value for the accuracy of this classification we calculated the Kappa index between the predicted level of complexity and the actual complexity level to which stimuli belonged. As shown in table 5.46, after correcting for chance, there is an 80% agreement between the actual complexity level and the predicted complexity level based on women's ratings of representational artistic stimuli on dimensions 3 and 5.

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Measure of Agreement	Kappa	,800	,130	4,472	,000
N of Valid Cases		15			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Table 5.46. Cohen's Kappa between predicted and actual complexity levels

Representational decorative: men

The complexity level of each stimulus served as the grouping value, and the average of men's scores to each of the 15 representational decorative stimuli on each complexity dimension were entered as independent variables. As shown in table 5.47, men's scores on dimensions 3 –number of elements- represent the best parsimonious combination of factors to predict the complexity level of the subset of representational decorative stimuli. In fact, the F-test reveal that the scores men awarded on dimension 3 to stimuli belonging to the three complexity levels differ significantly.

Variables Entered/Removed[a,b,c,d]

Step	Entered	Wilks' Lambda							
						Exact F			
		Statistic	df1	df2	df3	Statistic	df1	df2	Sig.
1	Factor 3 men	,072	1	2	12,000	77,639	2	12,000	,000

At each step, the variable that minimizes the overall Wilks' Lambda is entered.

a. Maximum number of steps is 14.

b. Minimum partial F to enter is 3.84.

c. Maximum partial F to remove is 2.71.

d. F level, tolerance, or VIN insufficient for further computation.

Table 5.47. Predictor variables for men's rating of representational decorative stimuli

Together with the standardized canonical discriminant function coefficients, Wilks' Lambda for men's discriminant scores is presented in table 5.48. In this case, the sole discriminant function leads to differences among complexity levels which account for over 92% of the variance among discriminant scores derived from dimension 3. The result of the associated Chi-square test reveals there are highly significant differences between complexity levels in the results of the discriminant function.

	Function
	1
Factor 3 men	1,000

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	,072	31,617	2	,000

Table 5.48. Standardized canonical discriminant function coefficients and Wilks' Lambda

As shown in table 5.49, the discriminant function has a very high eigenvalue, the quotient between the between groups sum of squares and the within groups sum of squares. It also shows that the discriminant function explains 100% of the overall variance.

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	12,940[a]	100,0	100,0	,963

a. First 1 canonical discriminant functions were used in the analysis.

Table 5.49. Eigenvalue and percentage of variance explained by the discriminant functions

Table 5.50 shows the correspondence between the complexity levels predicted using men's ratings on dimension 3, and the original complexity levels to which stimuli belonged. All representational decorative stimuli were correctly classified.

Classification Results[a]

		Complexity level	Predicted Group Membership: Low	Intermediate	High	Total
Original	Count	Low	5	0	0	5
		Intermediate	0	5	0	5
		High	0	0	5	5
	%	Low	100,0	,0	,0	100,0
		Intermediate	,0	100,0	,0	100,0
		High	,0	,0	100,0	100,0

a. 100,0% of original grouped cases correctly classified.

Table 5.50. Classification results of stimuli in three complexity levels based on dimension 3

In order to obtain a significance value for the accuracy of this classification we calculated the Kappa index between the predicted level of complexity and the actual complexity level to which stimuli belonged. As shown in table 5.51, after correcting for chance, there is a 100% agreement between the actual complexity level and the predicted complexity level based on men's ratings of representational decorative stimuli on dimension 3.

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Measure of Agreement	Kappa	1,000	,000	5,477	,000
N of Valid Cases		15			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Table 5.51. Cohen's Kappa between predicted and actual complexity levels

Representational decorative: women

The complexity level of each stimulus served as the grouping value, and the average of women's scores to each of the 15 representational decorative stimuli on each complexity dimension were entered as independent variables. As shown in table 5.52, women's scores on dimensions 3 and 5 –number of elements and symmetry- represent the best parsimonious combination to predict the complexity level of the subset of representational decorative stimuli. In fact, the F-tests reveal that the scores women awarded on dimensions 3 and 5 to stimuli belonging to the three complexity levels differ significantly.

Variables Entered/Removed[a,b,c,d]

Step	Entered	Wilks' Lambda							
						Exact F			
		Statistic	df1	df2	df3	Statistic	df1	df2	Sig.
1	Factor 3 women	,097	1	2	12,000	55,595	2	12,000	,000
2	Factor 5 women	,044	2	2	12,000	20,674	4	22,000	,000

At each step, the variable that minimizes the overall Wilks' Lambda is entered.

a. Maximum number of steps is 14.

b. Minimum partial F to enter is 3.84.

c. Maximum partial F to remove is 2.71.

d. F level, tolerance, or VIN insufficient for further computation.

Table 5.52. Predictor variables for women's rating of representational decorative stimuli

Together with the standardized canonical discriminant function coefficients, Wilks' Lambda for women's discriminant scores is presented in table 5.53. In this case, the first discriminant function leads to differences among complexity levels which account for over 95% of the variance among discriminant scores derived from dimensions 3 and 5. The result of the associated Chi-square test reveals there are highly significant differences between complexity levels in the results of the first discriminant function. The second discriminant function accounts for under 10% of the variance among discriminant scores on dimensions 3 and 5. Furthermore, discriminant scores do not differ significantly among complexity levels.

	Function	
	1	2
Factor 3 women	1,496	,036
Factor 5 women	1,088	1,026

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 2	,044	35,880	4	,000
2	,908	1,105	1	,293

Table 5.53. Standardized canonical discriminant function coefficients and Wilks' Lambda

As shown in table 5.54, the first discriminant function has a very high eigenvalue, the quotient between the between-groups sum of squares and the within-groups sum of squares. It also shows that the discriminant function explains 99.5% of the overall variance. The second discriminant function has an extremely low eigenvalue and explains a mere .5% of the variance.

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	19,571[a]	99,5	99,5	,975
2	,101[a]	,5	100,0	,303

a. First 2 canonical discriminant functions were used in the analysis.

Table 5.54. Eigenvalue and percentage of variance explained by the discriminant functions

Table 5.55 shows the correspondence between the complexity levels predicted using women's ratings on dimensions 3 and 5, and the original complexity levels to which stimuli belonged. All representational decorative stimuli were correctly classified.

Classification Results[a]

			Predicted Group Membership			
		Complexity level	Low	Intermediate	High	Total
Original	Count	Low	5	0	0	5
		Intermediate	0	5	0	5
		High	0	0	5	5
	%	Low	100,0	,0	,0	100,0
		Intermediate	,0	100,0	,0	100,0
		High	,0	,0	100,0	100,0

a. 100,0% of original grouped cases correctly classified.

Table 5.55. Classification results of stimuli in three complexity levels based on dimensions 3 and 5

In order to obtain a significance value for the accuracy of this classification we calculated the Kappa index between the predicted level of complexity and the actual complexity level to which stimuli belonged. As shown in table 5.56, after correcting for chance, there is a 100% agreement between the actual complexity level and the predicted complexity level based on women's ratings of representational decorative stimuli on dimensions 3 and 5.

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Measure of Agreement	Kappa	1,000	,000	5,477	,000
N of Valid Cases		15			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Table 5.56. Cohen's Kappa between predicted and actual complexity levels

3.3.1.4. Summary table

Stimuli	Sex	PV	EV(%)	CC (%)	Kappa
All taken together	Men	3 & 4	97	68.3	.525*
	Women	3 & 6	99.8	76.7	.650*
Abstract Artistic	Men	4	100	100	1*
	Women	1 & 3	98.6	93.3	.90*
Abstract Decorative	Men	3	100	80	.70*
	Women	3	100	80	.70*
Representational Artistic	Men	2, 3, 4 & 5	89.9	100	1*
	Women	3 & 5	98	86.7	.80*
Representational Decorative	Men	3	100	100	1*
	Women	3 & 5	99.5	100	1*

*$p < .001$

PV: Predictor complexity factors.
EV: Explained variance.
CC: Correct classification.
Kappa: Agreement between the predicted and actual complexity levels.

Dimension 1: Unintelligibility of the elements.
Dimension 2: Disorganization.
Dimension 3: Amount of elements.
Dimension 4: Variety of elements.
Dimension 5: Symmetry.
Dimension 6: Variety of colours.
Dimension 7: Three-dimensional appearance.

These results suggest that the complexity levels of stimuli in the overall sample can be predicted based on men's scores on dimensions 3 and 4 –amount of elements and variety of elements, respectively. Conversely, in the case of women, the complexity levels for the overall sample of stimuli can be predicted from their ratings of the amount of elements and the variety of colours (dimensions 3 and 6). When predicting the complexity levels of stimuli belonging to each kind (AA, AD; RA, RD), the most accurate complexity dimensions vary according to the kind of stimulus and the sex of the participants. The complexity of abstract artistic stimuli is adequately predicted by men's scores to dimension 4, variety of elements, and women's ratings on dimensions 1 and 3, unintelligibility of the elements and amount of elements. Both men and women's ratings of amount of elements (dimensions 3) are the best predictors of complexity level of abstract decorative stimuli. In order to predict the complexity level of representational artistic stimuli from men's ratings to the predictor variables, dimensions 2, 3, 4, and 5, disorganization, amount and variety of elements, and symmetry, need to be taken into account. Conversely, women's ratings on dimensions 3 and 5, amount of elements and asymmetry, suffice to make adequate predictions. Finally, dimension 3, amount of elements, is necessary to predict the complexity level of representational decorative stimuli from men and women's scores. But dimension 5, asymmetry, is also required for the prediction to be accurate in the case of scores awarded by female participants. Overall, dimension 3, the amount of elements seems to be the most common predictor variable, and factor 7, three-dimensional appearance, has no predictive value at all, as well as dimension 6, variety of colours, when analyzing different kinds of stimuli separately.

3.3.2. Factor analysis

Factor analysis was performed in order to assess the relations among the seven dimensions of complexity. This procedure allows simplifying those relations by identifying underlying factors that explain the greatest possible amount of original information. Factor analysis has the advantage over other data reduction procedures of yielding a small number of easily interpretable factors.

Here we have used principal components to estimate the factorial model, one of the most common procedures in this kind of analysis. In order to aid in the interpretation of the resulting factors we have used Varimax rotation of factors. This additional step strengthens correlations among the original variables included in each factor and weakens those with variables included in other factors. The same procedure has been carried out on men and women's ratings of the 60 stimuli on the 7 complexity dimensions. These stimuli were selected, as stated in section 2.3.3, among the original set of 120, as described in sections 2.2 and 3.1.

Originally only factors with eigenvalues over 1 were extracted. This resulted in two factors which explained 48.669% and 31.854% of the variance in scores awarded by male participants and 47.351% and 31.426% in scores awarded by female participants. For both groups of participants factor 1 received high loadings from complexity dimensions 3 (amount of elements), 4 (variety of elements), 6 (variety of colours), and 7 (three-dimensional appearance). For men and women factor 2 received high loadings from dimensions 1 (unintelligibility of the elements) and 2 (disorganization). Additionally, for both groups of participants dimensions 5 (asymmetry) showed unsatisfactory relations with both factors. Inspection of its relation with additional factors revealed it was related with a factor whose eigenvalue was .975. Given the importance of the symmetry-asymmetry dimension in the study of the relation between complexity and the appreciation of beauty, outlined in the introduction, as well as the potential advantages of understanding its relation with other dimensions of complexity, it was decided to lower the factor extraction criterion from eigenvalues over 1 to eigenvalues over .97. Although it is not common to lower this threshold, the fact that the factor with the next highest eigenvalues had very low values, .212 for men and .314 for women, suggests that this choice did not prejudice the extraction of additional factors. This solution is compatible with an alternative approach to deciding on how many factors to extract, known as the scree test. This procedure involves retaining all factors with eigenvalues on the sharp descent part of the scree plot before they begin to level. For both men and women the scree test recommends extracting three factors (see figure 6.1).

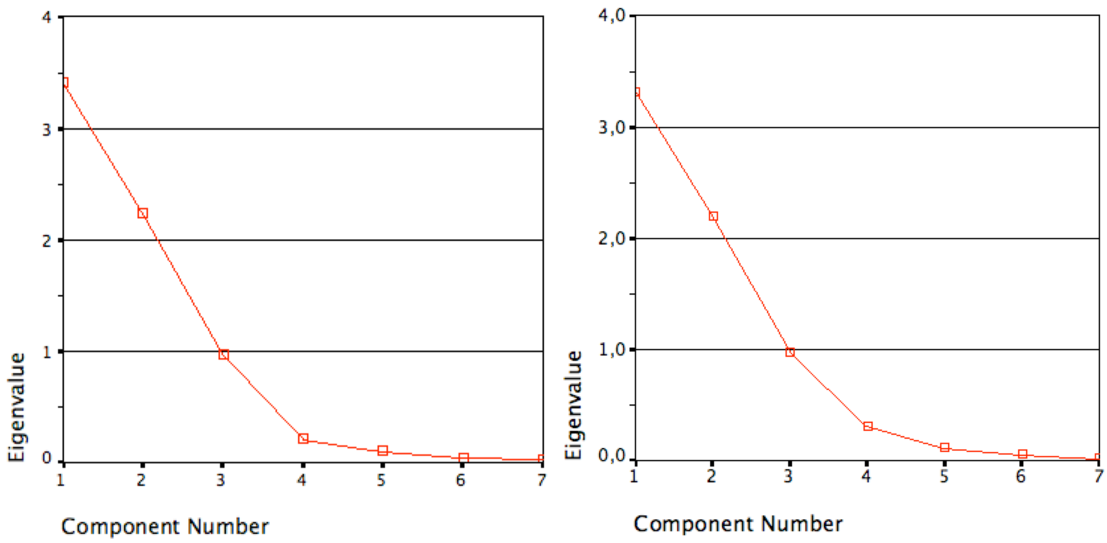


Figure 6.1. Scree plots for the eigenvalues of factors extracted from men's (left) and women's (right) ratings on the 7 complexity dimensions

Hence, in this section we present the results of factor analysis of men and women's ratings on the seven complexity dimensions by means of principal components extracting factors with eigenvalues over .97 and including a Varimax orthogonal rotation.

3.3.2.1. Factor analysis for men's rating of the 7 complexity dimensions

Mean scores awarded by men to each stimulus on each of the seven complexity dimensions were entered as variables into the *factor analysis* application of the SPSS. Varimax was chosen as the *rotation method*. The selected descriptives of the correlation matrix were *KMO* and *Bartlett's test of sphericity*, *determinant*, and *anti-image matrix*. Selected *extraction options* were to use the principal components method, to analyze the correlation matrix, and to extract factors with eigenvalues over .97, as indicated above. We begin by presenting the measures of adequacy, and then we present the results of the factor analysis.

KMO is a measure of the adequacy of the data for a factor analysis. In the case of men's scores on the seven complexity dimensions, its value is quite high, indicating that the adequacy of the data is reasonably high (see table 6.1). Batlett's procedure tests the null hypothesis that the initial variables are not correlated. These results indicate that there is a high degree of correlation among the dimensions, which is an important requirement for factor analysis. However, the fact that the distribution of scores awarded by male participants on some of the dimensions departs from normality, reduces the trustworthiness of this measure.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,736
Bartlett's Test of Sphericity	Approx. Chi-Square	475,938
	df	21
	Sig.	,000

Table 6.1. KMO measure and Bartlett's test of sphericity

Additional measures of adequacy were calculated for ratings awarded by men on the seven complexity dimensions (see table 6.2): (i) the determinant of the correlation matrix, with smaller values indicating a high correlation among the variables, a requirement of the principal component procedure, and (ii) the anti-image correlation matrix, which provide partial correlation coefficients between each pair of variables. In this second case, low values are necessary for values to share common factors. Elements in the main diagonal are akin to the KMO measure for each pair of variables, and higher values indicate a greater adequacy.

Correlation Matrix[a]

a. Determinant = 1,986E-04

Anti-image Matrices

		Dimension 1 men	Dimension 2 men	Dimension 3 men	Dimension 4 men	Dimension 5 men	Dimension 6 men	Dimension 7 men
Anti-image Covariance	Dimension 1 men	5,678E-02	-5,424E-02	-1,619E-02	1,493E-03	3,994E-02	7,734E-03	9,902E-03
	Dimension 2 men	-5,424E-02	6,056E-02	4,703E-03	2,681E-04	-3,848E-02	1,134E-03	2,175E-02
	Dimension 3 men	-1,619E-02	4,703E-03	6,642E-02	-4,896E-02	4,663E-02	-1,884E-02	-3,622E-02
	Dimension 4 men	1,493E-03	2,681E-04	-4,896E-02	6,945E-02	-4,787E-02	-4,061E-02	-3,216E-03
	Dimension 5 men	3,994E-02	-3,848E-02	4,663E-02	-4,787E-02	,888	-1,597E-02	2,250E-02
	Dimension 6 men	7,734E-03	1,134E-03	-1,884E-02	-4,061E-02	-1,597E-02	,159	-2,601E-02
	Dimension 7 men	9,902E-03	2,175E-02	-3,622E-02	-3,216E-03	2,250E-02	-2,601E-02	,270
Anti-image Correlation	Dimension 1 men	,547[a]	-,925	-,264	2,378E-02	,178	8,152E-02	8,001E-02
	Dimension 2 men	-,925	,564[a]	7,415E-02	4,134E-03	-,166	1,158E-02	,170
	Dimension 3 men	-,264	7,415E-02	,745[a]	-,721	,192	-,184	-,271
	Dimension 4 men	2,378E-02	4,134E-03	-,721	,756[a]	-,193	-,387	-2,349E-02
	Dimension 5 men	,178	-,166	,192	-,193	,281[a]	-4,257E-02	4,598E-02
	Dimension 6 men	8,152E-02	1,158E-02	-,184	-,387	-4,257E-02	,909[a]	-,126
	Dimension 7 men	8,001E-02	,170	-,271	-2,349E-02	4,598E-02	-,126	,932[a]

a. Measures of Sampling Adequacy(MSA)

Table 6.2. Determinant of the correlation matrix and anti-image matrices for men's scores on the 7 complexity dimensions

As seen in table 6.2, the determinant of the correlation matrix has a very low value, suggesting that, overall, men's ratings on the complexity dimensions are relatively correlated. More specifically, the adequacy of men's ratings on dimensions 1 and 2 is acceptable, around .55. The adequacy of their ratings on dimensions 3 and 4 is good, around .75. The adequacy of scores awarded on dimensions 6 and 7 is very good, in fact it is over .9. The worse adequacy score was obtained by complexity dimension 5, probably related with its low eigenvalue.

The results of the factor analysis of men's scores on the seven complexity dimensions appear in table 6.3. Three components met the aforementioned criteria and, hence, were extracted. The first two components explained over 48% and over 31% of the variance, respectively. Cumulative explained variance is just over 80%. The third component explains close to 14% of the variance. Thus, if this component is accepted, the overall explained variance is raised to over 94%.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3,407	48,669	48,669	3,407	48,669	48,669	3,383	48,329	48,329
2	2,230	31,854	80,523	2,230	31,854	80,523	2,218	31,687	80,016
3	,975	13,924	94,447	,975	13,924	94,447	1,010	14,431	94,447
4	,212	3,032	97,480						
5	,107	1,525	99,004						
6	4,037E-02	,577	99,581						
7	2,932E-02	,419	100,000						

Extraction Method: Principal Component Analysis.

Table 6.3. Extracted components and variance explained

Commonalities, which are presented below in table 6.4, inform about the extent to which the variables are well represented by the extracted factors. That is, the extent to which their variance is reproduced by the common factors. In the case of men's ratings on the seven complexity dimensions, all results are very positive, with values over 95%, except for dimensions 6 (90.6%) and 7 (84.9%). Hence, as a whole, the variance of the seven complexity dimensions as rated by men is accurately reproduced by the common factors.

	Initial	Extraction
Dimension 1 men	1,000	,975
Dimension 2 men	1,000	,972
Dimension 3 men	1,000	,958
Dimension 4 men	1,000	,952
Dimension 5 men	1,000	,999
Dimension 6 men	1,000	,906
Dimension 7 men	1,000	,849

Extraction Method: Principal Component Analysis.

Table 6.4. Commonalities for men's ratings on the seven complexity dimensions

Table 6.5 presents the component matrix and the rotated component matrix. After the factors had been rotated, it became very clear that the first one received high loadings from dimensions 3, 4, 6, and to a slightly lesser degree, dimension 7. Loadings from the other three dimensions were negligible. The second factor received high loadings from dimensions 1 and 2. Dimension 3 had a very slight positive loading on this factor, and dimension 7 a moderate negative loading. Finally, the only complexity dimension to load on the third factor is number 5. The remaining dimensions have negligible loadings on this factor.

	Component		
	1	2	3
Dimension 1 men	-1,600E-02	,985	6,139E-02
Dimension 2 men	-,166	,966	,111
Dimension 3 men	,928	,310	1,768E-02
Dimension 4 men	,953	,189	8,536E-02
Dimension 5 men	-8,463E-02	-,223	,970
Dimension 6 men	,949	6,298E-03	6,588E-02
Dimension 7 men	,837	-,380	-7,031E-02

Extraction Method: Principal Component Analysis.
a. 3 components extracted.

	Component		
	1	2	3
Dimension 1 men	8,669E-02	,980	-8,588E-02
Dimension 2 men	-6,016E-02	,984	-2,550E-02
Dimension 3 men	,953	,207	-8,013E-02
Dimension 4 men	,971	9,468E-02	3,359E-03
Dimension 5 men	-3,781E-02	-7,172E-02	,996
Dimension 6 men	,948	-8,786E-02	1,174E-02
Dimension 7 men	,788	-,475	-5,871E-02

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 4 iterations.

Table 6.5. Component matrix (left) and rotated component matrix (right)

Table 6.6 presents the component score coefficient matrix, which reinforces the aforementioned results. Dimensions 3, 4, 6, and 7 (amount of elements, variety of elements, variety of colours, three-dimensional appearance) have high coefficients for factor 1. Dimensions 1 and 2 (unintelligibility of the elements and disorganization) have high coefficients on the second factor. Dimension 7 has also a slight negative coefficient for the second factor. Finally, dimension 5 –asymmetry- is the sole high coefficient for the third factor.

	Component		
	1	2	3
Dimension 1 men	,044	,444	-,004
Dimension 2 men	,003	,448	,051
Dimension 3 men	,286	,110	-,018
Dimension 4 men	,292	,066	,058
Dimension 5 men	,036	,047	,999
Dimension 6 men	,282	-,018	,051
Dimension 7 men	,222	-,205	-,059

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Table 6.6. Component score coefficient matrix

3.3.2.2. Factor analysis for women's rating of the 7 complexity dimensions

Mean scores awarded by women to each stimulus on each of the seven complexity dimensions were entered as variables into the *factor analysis* application of the SPSS. Varimax was chosen as the *rotation method*. The selected descriptives of the correlation matrix were *KMO* and *Bartlett's test of sphericity*, *determinant*, and *anti-image matrix*. Selected *extraction options* were to use the principal components method, to analyze the correlation matrix, and to extract factors with eigenvalues over .97, as indicated above. We begin by presenting the measures of adequacy, and then we present the results of the factor analysis.

The KMO is a measure of the adequacy of the data for a factor analysis. In the case of women's scores on the seven complexity dimensions, its value is quite high, indicating that the adequacy of the data is reasonably high (see table 6.7). Batlett's procedure tests the null hypothesis that the initial variables are not correlated. These results indicate that there is a high degree of correlation among the dimensions, which is an important requirement for factor analysis. However, the fact that the distribution of scores awarded by female participants on some of the dimensions departs from normality, reduces the trustworthiness of this measure.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,705
Bartlett's Test of Sphericity	Approx. Chi-Square	445,430
	df	21
	Sig.	,000

Table 6.7. KMO measure and Bartlett's test of sphericity

Additional measures of adequacy were calculated for ratings awarded by women on the seven complexity dimensions (see table 6.8): (i) the determinant of the correlation matrix, with smaller values indicating a high correlation among the variables, a requirement of the principal component procedure, and (ii) the anti-image correlation matrix, which provide partial correlation coefficients between each pair of variables. In this second case, low values are necessary for values to share common factors. Elements in the main diagonal are akin to the KMO measure for each pair of variables, and higher values indicate a greater adequacy.

Correlation Matrix[a]

a. Determinant = 3,430E-04

Anti-image Matrices

		Dimension 1 women	Dimension 2 women	Dimension 3 women	Dimension 4 women	Dimension 5 women	Dimension 6 women	Dimension 7 women
Anti-image Covariance	Dimension 1 women	4,473E-02	-4,272E-02	-1,100E-02	-7,402E-03	-4,175E-03	1,999E-02	-1,009E-02
	Dimension 2 women	-4,272E-02	4,537E-02	-2,272E-04	8,502E-03	6,115E-03	-1,046E-02	3,413E-02
	Dimension 3 women	-1,100E-02	-2,272E-04	8,932E-02	-5,925E-02	7,887E-02	-3,787E-02	-6,858E-02
	Dimension 4 women	-7,402E-03	8,502E-03	-5,925E-02	,106	-8,904E-02	-5,924E-02	3,633E-03
	Dimension 5 women	-4,175E-03	6,115E-03	7,887E-02	-8,904E-02	,860	3,998E-03	1,847E-02
	Dimension 6 women	1,999E-02	-1,046E-02	-3,787E-02	-5,924E-02	3,998E-03	,186	2,895E-03
	Dimension 7 women	-1,009E-02	3,413E-02	-6,858E-02	3,633E-03	1,847E-02	2,895E-03	,330
Anti-image Correlation	Dimension 1 women	,541[a]	-,948	-,174	-,107	-2,129E-02	,219	-8,304E-02
	Dimension 2 women	-,948	,534[a]	-3,570E-03	,122	3,096E-02	-,114	,279
	Dimension 3 women	-,174	-3,570E-03	,745[a]	-,608	,285	-,294	-,399
	Dimension 4 women	-,107	,122	-,608	,757[a]	-,295	-,422	1,941E-02
	Dimension 5 women	-2,129E-02	3,096E-02	,285	-,295	,314[a]	9,999E-03	3,468E-02
	Dimension 6 women	,219	-,114	-,294	-,422	9,999E-03	,853[a]	1,169E-02
	Dimension 7 women	-8,304E-02	,279	-,399	1,941E-02	3,468E-02	1,169E-02	,852[a]

a. Measures of Sampling Adequacy(MSA)

Table 6.8. Determinant of the correlation matrix and anti-image matrices for women's scores on the 7 complexity dimensions

As seen in table 6.8, the determinant of the correlation matrix has a very low value, suggesting that overall, women's ratings on the complexity dimensions are relatively correlated. More specifically, the adequacy of women's ratings on dimensions 1 and 2 is acceptable, around .54. The adequacy of their ratings on dimensions 3 and 4 is good, around .75. The adequacy of scores awarded on dimensions 6 and 7 is very good, in fact it is over .85. The worse adequacy score was obtained by complexity dimension 5 (.31), probably related with its low eigenvalue.

The results of the factor analysis of women's scores on the seven complexity dimensions appear in table 6.9. Three components met the aforementioned extraction criteria and were extracted. The first two components explained over 47% and over 31% of the variance, respectively. Cummulative explained variance is just over 78%. The third component explains close to 14% of the variance. Thus, if this component is accepted, the overall explained variance is raised to over 92%.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3,315	47,351	47,351	3,315	47,351	47,351	3,290	47,005	47,005
2	2,200	31,426	78,776	2,200	31,426	78,776	2,182	31,168	78,172
3	,975	13,934	92,710	,975	13,934	92,710	1,018	14,538	92,710
4	,314	4,479	97,190						
5	,116	1,652	98,842						
6	5,824E-02	,832	99,674						
7	2,283E-02	,326	100,000						

Extraction Method: Principal Component Analysis.

Table 6.9. Extracted components and variance explained

Commonalities, which are presented below in table 6.10 inform about the extent to which the variables are well represented by the extracted factors. That is, the extent to which their variance is reproduced by the common factors. In the case of women's ratings on the seven complexity dimensions, most of the results are very positive, with values over 95%. Under this threshold we find dimensions 4 (93.2%), 6 (87.1%) and 7 (78.9%). Hence, overall, the variance of the seven complexity dimensions as rated by women is accurately reproduced by the common factors.

	Initial	Extraction
Dimension 1 women	1,000	,973
Dimension 2 women	1,000	,978
Dimension 3 women	1,000	,951
Dimension 4 women	1,000	,932
Dimension 5 women	1,000	,995
Dimension 6 women	1,000	,871
Dimension 7 women	1,000	,789

Extraction Method: Principal Component Analysis.

Table 6.10. Commonalities for women's ratings on the seven complexity dimensions

Table 6.11 presents the component matrix and the rotated component matrix. After the factors had been rotated, it became very clear that the first one received high loadings from dimensions 3, 4, 6, and to a slightly lesser degree, dimension 7. Loadings from the other three dimensions were negligible. The second factor received high loadings from dimensions 1 and 2. Dimensions 3 and 4 had very slight positive loadings on this factor, and dimension 7 a moderate negative loading. Finally, the only complexity dimension to load on the third factor is number 5. The remaining dimensions have negligible or very low loadings on this factor.

	Component		
	1	2	3
Dimension 1 women	,185	,965	8,872E-02
Dimension 2 women	7,847E-02	,982	8,561E-02
Dimension 3 women	,962	,161	1,084E-03
Dimension 4 women	,956	2,485E-02	,136
Dimension 5 women	-,140	-,222	,962
Dimension 6 women	,922	-,128	6,513E-02
Dimension 7 women	,752	-,461	-,106

Extraction Method: Principal Component Analysis.
a. 3 components extracted.

	Component		
	1	2	3
Dimension 1 women	8,947E-02	,980	-6,549E-02
Dimension 2 women	-1,785E-02	,987	-6,183E-02
Dimension 3 women	,938	,247	-,105
Dimension 4 women	,955	,133	4,745E-02
Dimension 5 women	-4,603E-02	-8,705E-02	,993
Dimension 6 women	,933	-3,157E-02	2,453E-03
Dimension 7 women	,786	-,400	-,104

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 3 iterations.

Table 6.11. Component matrix (left) and rotated component matrix (right)

Table 6.12 presents the component score coefficient matrix, which reinforces the aforementioned results. Dimensions 3, 4, 6, and 7 (amount of elements, variety of elements, variety of colours, three-dimensional appearance) have high coefficients for factor 1. Dimensions 1 and 2 (unintelligibility of the elements and disorganization) have high coefficients on the second factor. Dimension 7 has also a moderately high negative coefficient for the second factor. Finally, dimension 5, asymmetry, is the sole high coefficient for the third factor.

	Component		
	1	2	3
Dimension 1 women	,016	,450	,023
Dimension 2 women	-,016	,455	,021
Dimension 3 women	,280	,099	-,034
Dimension 4 women	,295	,059	,111
Dimension 5 women	,040	,045	,991
Dimension 6 women	,287	-,022	,050
Dimension 7 women	,239	-,202	-,097

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Table 6.12. Component score coefficient matrix

3.3.3. Exploratory study of the relation between complexity dimensions and beauty ratings.

In the introduction we suggested that a possible reason for the lack of agreement among studies of the relation between complexity and aesthetic preference was the use of different concepts and measurements of complexity. Although the present study was not designed to address this issue experimentally, but only in an exploratory fashion, it could be the case that the seven complexity factors that we have considered here might have different effects on the ratings of the beauty of visual stimuli. In this section we will use the data we collected to explore this possibility in a very preliminary manner.

Curve estimation tests were carried out taking each of the seven complexity factors separately as independent variables and the beauty scores as the dependent variable. The fit of linear, quadratic, and cubic functions was assessed. The results of this analysis are provided below for each of the factors, along with a plot of beauty scores as a function of each of them. The significant function is overlaid on the graphs. When more than one or no solution turned out to reach significance, only the solution with the lowest significance value was plotted. When all significance values were equal, only the function with the highest F value was plotted. This procedure was carried out separately for men and women, and the results for both groups are presented sequentially.

3.3.3.1. Curve fit between men's complexity factors and beauty scores

Complexity dimension 1: Unintelligibility of the elements

The curve fit procedure indicated that the only function to reach significance is the cubic one. Figure 7.1 shows that the highest beauty scores awarded by men were received by those stimuli that were later rated as low or high on unintelligibility of the elements present in the picture. Stimuli rated with an intermediate unintelligibility of the elements tended to receive the lowest beauty scores.

Independent: HOMBRES1

Dependent	Mth	Rsq	d.f.	F	Sigf	b0	b1	b2	b3
BELLHOM	LIN	,019	58	1,10	,300	2,9642	-,0573		
BELLHOM	QUA	,046	57	1,37	,261	3,6212	-,4146	,0397	
BELLHOM	CUB	,210	56	4,96	,004	,2533	2,4575	-,6561	,0502

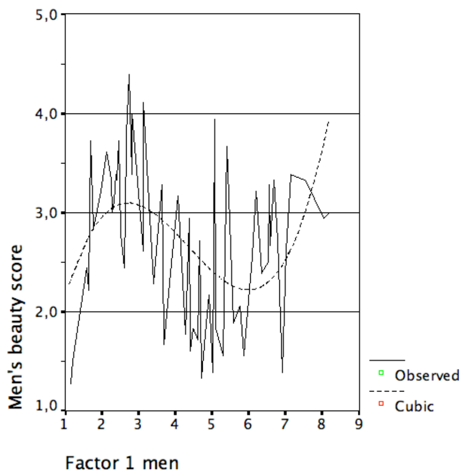


Figure 7.1. Curve fit between men's scores on "Unintelligibility of the elements" and "Beauty"

Complexity dimension 2: Disorganization

In this case, linear, quadratic and cubic functions fit the relation between men's scores on complexity dimension 2, disorganization, and beauty. However, the quadratic function reached the best significance levels. In a similar way to unintelligibility of the elements, low and high scores on disorganization were associated to the highest beauty scores. However, beauty ratings associated with higher scores on the present complexity dimension were slightly lower than beauty ratings associated with the lower scores on disorganization (see figure 7.2).

Independent: HOMBRES2

Dependent	Mth	Rsq	d.f.	F	Sigf	b0	b1	b2	b3
BELLHOM	LIN	,084	58	5,29	,025	3,1979	-,1046		
BELLHOM	QUA	,157	57	5,29	,008	4,2580	-,7303	,0695	
BELLHOM	CUB	,173	56	3,91	,013	3,0316	,3523	-,1956	,0192

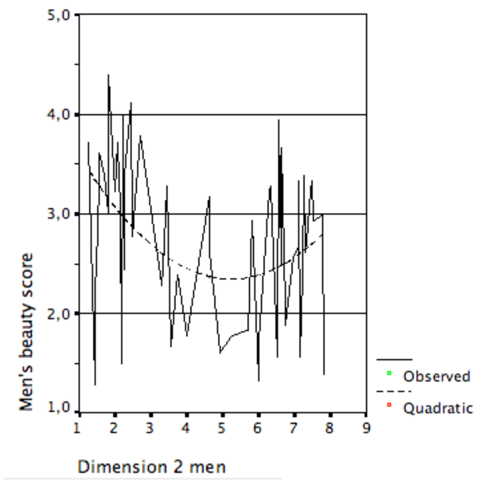


Figure 7.2. Curve fit between men's scores on "Disorganization" and "Beauty"

Complexity dimension 3: Amount of elements

Here, linear, quadratic, and cubic functions fit the relation between men's scores on amount of elements and beauty. Given that all significance levels are the same, only the linear function has been plotted. Overall, higher beauty scores were awarded by men to stimuli rated to have more elements, and lower beauty scores were awarded to stimuli with fewer elements (see figure 7.3).

Independent: HOMBRES3

Dependent	Mth	Rsq	d.f.	F	Sigf	b0	b1	b2	b3
BELLHOM	LIN	,432	58	44,08	,000	1,4558	,2646		
BELLHOM	QUA	,433	57	21,79	,000	1,5956	,1911	,0079	
BELLHOM	CUB	,438	56	14,52	,000	2,0541	-,2230	,1101	-,0074

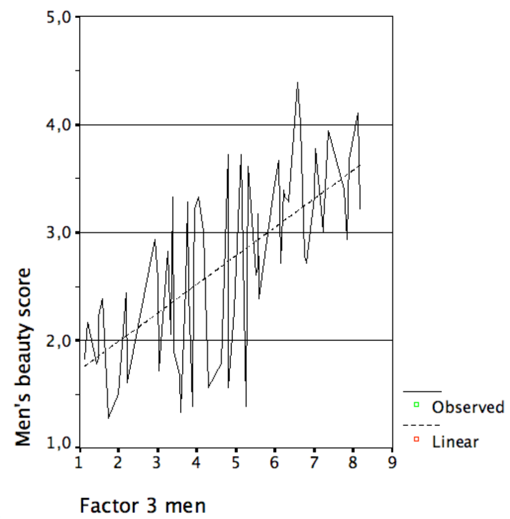


Figure 7.3. Curve fit between men's scores on "Amount of elements" and "Beauty"

Complexity dimension 4: Element heterogeneity

Here, linear, quadratic, and cubic functions again fit the relation between men's scores on variety of elements and beauty. Given that all significance levels are the same, only the linear function has been plotted. Overall, higher beauty scores were awarded by men to stimuli rated to have more elements, and lower beauty scores were awarded to stimuli with fewer elements (see figure 7.4).

Independent: HOMBRES4

Dependent	Mth	Rsq	d.f.	F	Sigf	b0	b1	b2	b3
BELLHOM	LIN	,493	58	56,39	,000	1,4018	,3037		
BELLHOM	QUA	,493	57	27,71	,000	1,3842	,3135	-,0011	
BELLHOM	CUB	,500	56	18,69	,000	2,1621	-,3719	,1712	-,0129

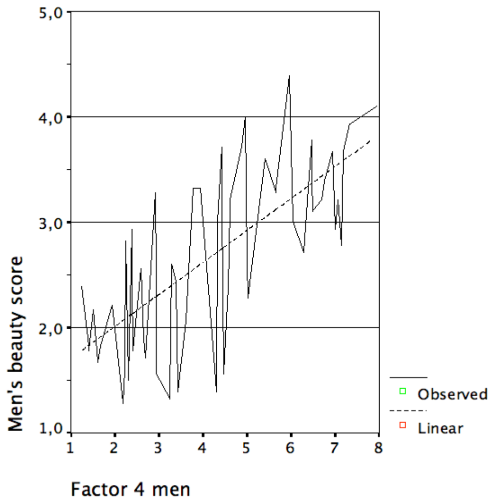


Figure 7.4. Curve fit between men's scores on "Element heterogeneity" and "Beauty"

Complexity dimension 5: Asymmetry

There is no satisfactory relation between men's rating of asymmetry and beauty. None of the three functions reached significance. We have chosen to plot the one with the best significance: the quadratic function. In this case, men seem to have awarded higher beauty scores to stimuli rated as intermediately asymmetric than to those stimuli rated as very symmetric or very asymmetric (see figure 7.5).

Independent: HOMBRES5

Dependent	Mth	Rsq	d.f.	F	Sigf	b0	b1	b2	b3
BELLHOM	LIN	,003	58	,17	,678	2,8837	-,0320		
BELLHOM	QUA	,057	57	1,73	,187	,6215	,8698	-,0839	
BELLHOM	CUB	,057	56	1,13	,343	1,0481	,6118	-,0349	-,0029

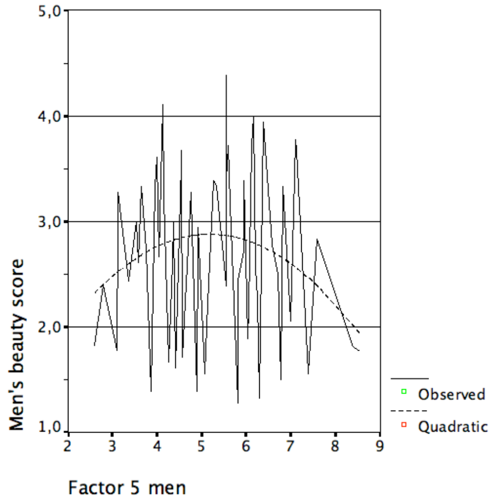


Figure 7.5. Curve fit between men's scores on "Asymmetry" and "Beauty"

Complexity dimension 6: Colour variety

Here, linear, quadratic, and cubic functions again fit the relation between men's scores on colour variety and beauty. Given that all significance levels are the same, only the linear function has been plotted. Overall, higher beauty scores were awarded by men to stimuli rated to have a broader range of colours, and lower beauty scores were awarded to stimuli with fewer colours (see figure 7.6).

Independent: HOMBRES6

Dependent	Mth	Rsq	d.f.	F	Sigf	b0	b1	b2	b3
BELLHOM	LIN	,471	58	51,62	,000	1,3790	,2998		
BELLHOM	QUA	,472	57	25,46	,000	1,4959	,2350	,0074	
BELLHOM	CUB	,474	56	16,81	,000	1,8597	-,1013	,0934	-,0065

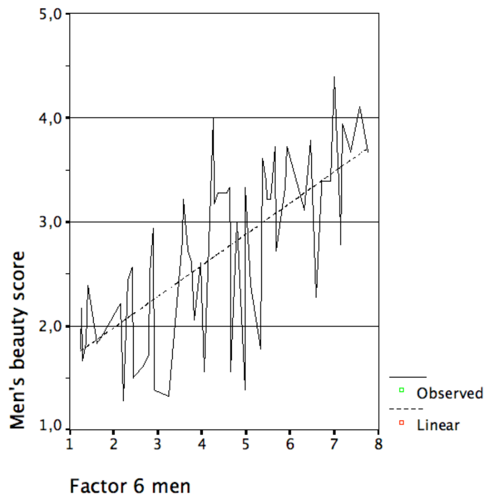
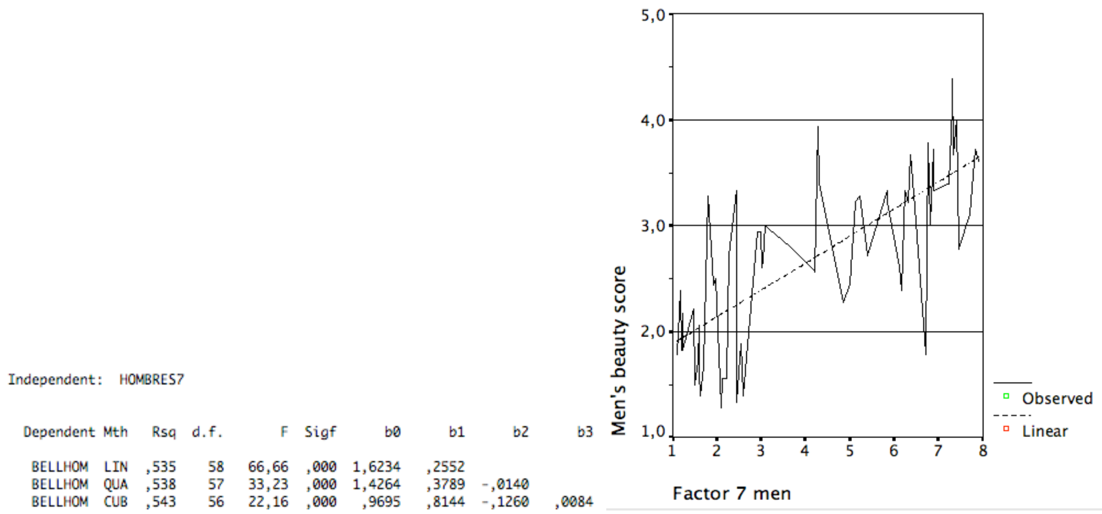


Figure 7.6. Curve fit between men's scores on "Colour variety" and "Beauty"

Complexity dimension 7: Three-dimensional appearance

Linear, quadratic, and cubic functions again fit the relation between men's scores on three-dimensional appearance and beauty. Given that all significance levels are the same, only the linear function has been plotted. Overall, men awarded higher beauty scores to stimuli rated to have a greater three-dimensional appearance than to those rated as having a lower three-dimensional appearance (see figure 7.7).


Independent: HOMBRES7

Dependent	Mth	Rsq	d.f.	F	Sigf	b0	b1	b2	b3
BELLHOM	LIN	,535	58	66,66	,000	1,6234	,2552		
BELLHOM	QUA	,538	57	33,23	,000	1,4264	,3789	-,0140	
BELLHOM	CUB	,543	56	22,16	,000	,9695	,8144	-,1260	,0084

Figure 7.7. Curve fit between men's scores on "Three-dimensional appearance" and "Beauty"

3.3.3.2. Curve fit between women's complexity factors and beauty scores

Complexity dimension 1: Unintelligibility of the elements

The curve fit procedure indicated that the linear, quadratic and cubic functions reach significance, though the latter one's significance value is the smallest. Figure 7.8 shows that the highest beauty scores awarded by women were received by those stimuli that were later rated as very low or very high on unintelligibility of the elements present in the picture. Stimuli rated with an intermediate unintelligibility of the elements received the lowest beauty scores. For women, however, this tendency is not as marked as for men.

Independent: MUJERES1

Dependent	Mth	Rsq	d.f.	F	Sigf	b0	b1	b2	b3
BELLMUJ	LIN	,078	58	4,88	,031	3,1157	-,0960		
BELLMUJ	QUA	,119	57	3,84	,027	3,7518	-,4680	,0423	
BELLMUJ	CUB	,185	56	4,23	,009	1,8586	1,2482	-,3906	,0321

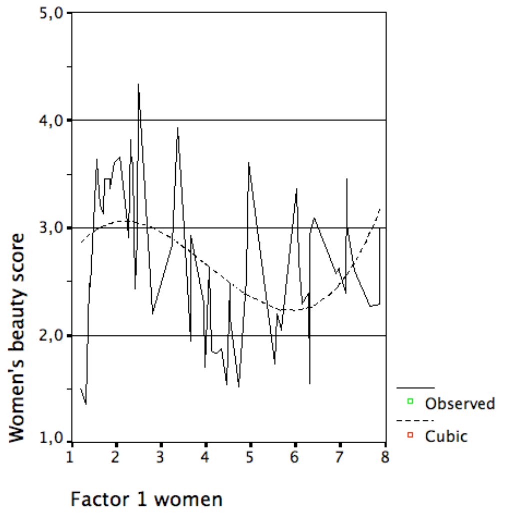


Figure 7.8. Curve fit between women's scores on "Unintelligibility of the elements" and "Beauty"

Complexity dimension 2: Disorganization

In this case, linear, quadratic and cubic functions showed an adequate fit the relation between women's scores on complexity dimension 2, disorganization, and beauty. However, the quadratic function reached the best significance levels. In a similar way to unintelligibility of the elements, low and high scores on disorganization were associated to the highest beauty scores. However, beauty ratings associated with higher scores on the present complexity dimension were lower than beauty ratings associated with the lower scores on disorganization (see figure 7.9).

Independent: MUJERES2

Dependent	Mth	Rsq	d.f.	F	Sigf	b0	b1	b2	b3
BELLMUJ	LIN	,150	58	10,24	,002	3,3411	-,1403		
BELLMUJ	QUA	,170	57	5,84	,005	3,9427	-,4792	,0384	
BELLMUJ	CUB	,201	56	4,69	,005	1,8490	1,2521	-,3756	,0300

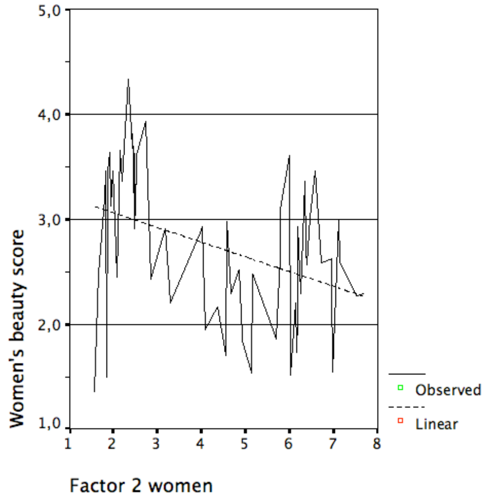


Figure 7.9. Curve fit between women's scores on "Disorganization" and "Beauty"

Complexity dimension 3: Amount of elements

Here, linear, quadratic, and cubic functions fit the relation between women's scores on amount of elements and beauty. Given that all significance levels are the same, only the linear function has been plotted. Overall, higher beauty scores were awarded by women to stimuli rated to have more elements, and lower beauty scores were awarded to stimuli with fewer elements (see figure 7.10).

Independent: MUJERES3

Dependent	Mth	Rsq	d.f.	F	Sigf	b0	b1	b2	b3
BELLMUJ	LIN	,262	58	20,56	,000	1,8536	,1814		
BELLMUJ	QUA	,273	57	10,68	,000	1,5180	,3600	-,0193	
BELLMUJ	CUB	,273	56	7,02	,000	1,3642	,4994	-,0538	,0025

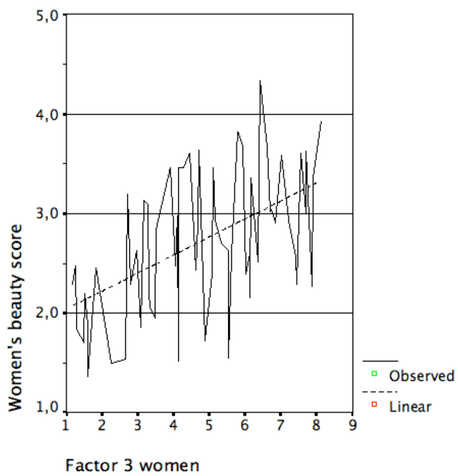


Figure 7.10. Curve fit between women's scores on "Amount of elements" and "Beauty"

Complexity dimension 4: Element heterogeneity

Here, linear, quadratic, and cubic functions again fit the relation between women's scores on variety of elements and beauty. Given that all significance levels are the same, only the linear function has been plotted. Overall, women awarded higher beauty scores to stimuli rated to have more elements, and lower beauty scores to stimuli with fewer elements (see figure 7.11).

Independent: MUJERES4

Dependent	Mth	Rsq	d.f.	F	Sigf	b0	b1	b2	b3
BELLMUJ	LIN	,343	58	30,27	,000	1,7329	,2213		
BELLMUJ	QUA	,343	57	14,87	,000	1,7352	,2200	,0001	
BELLMUJ	CUB	,348	56	9,95	,000	2,1798	-,1800	,1008	-,0075

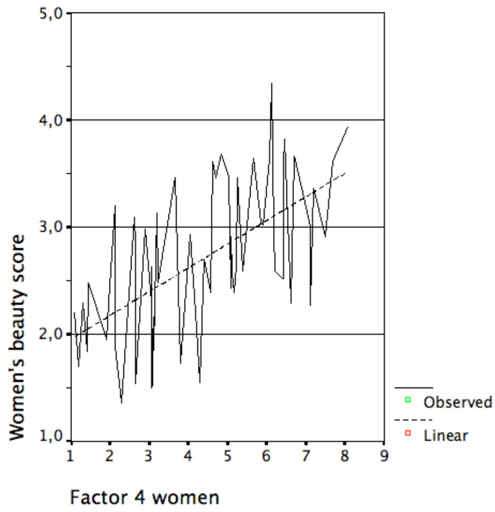


Figure 7.11. Curve fit between women's scores on "Element heterogeneity" and "Beauty"

Complexity dimension 5: Asymmetry

There is no satisfactory relation between women's rating of asymmetry and beauty. None of the three functions reached significance. We have chosen to plot the one with the best significance: the quadratic function. In this case, women seem to have awarded higher beauty scores to stimuli rated as intermediately asymmetric than to those stimuli rated as very symmetric or very asymmetric (see figure 7.12).

Independent: MUJERES5

Dependent	Mth	Rsq	d.f.	F	Sigf	b0	b1	b2	b3
BELLMUJ	LIN	,000	58	6,5E-03	,936	2,6878	,0058		
BELLMUJ	QUA	,061	57	1,84	,168	,1972	,9942	-,0923	
BELLMUJ	CUB	,062	56	1,24	,305	1,3061	,3266	,0353	-,0078

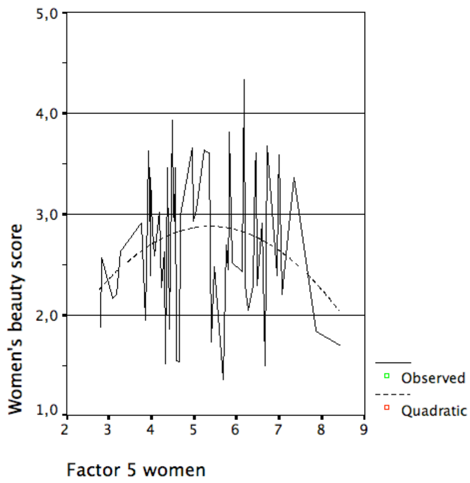


Figure 7.12. Curve fit between women's scores on "Asymmetry" and "Beauty"

Complexity dimension 6: Colour variety

Here, linear, quadratic, and cubic functions again fit the relation between women's scores on colour variety and beauty. Given that all significance levels are the same, only the linear function has been plotted. Overall, higher beauty scores were awarded by women to stimuli rated to have a broader range of colours, and lower beauty scores were awarded to stimuli with fewer colours (see figure 7.13).

Independent: MUJERES6

Dependent	Mth	Rsq	d.f.	F	Sigf	b0	b1	b2	b3
BELLMUJ	LIN	,402	58	38,92	,000	1,6446	,2383		
BELLMUJ	QUA	,403	57	19,20	,000	1,7344	,1872	,0059	
BELLMUJ	CUB	,403	56	12,59	,000	1,6603	,2608	-,0134	,0015

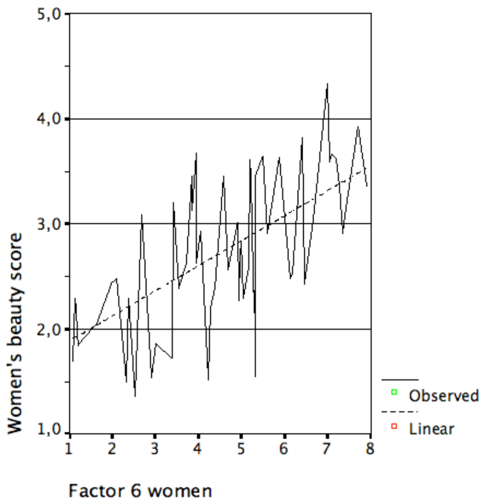


Figure 7.13. Curve fit between women's scores on "Colour variety" and "Beauty"

Complexity dimension 7: Three-dimensional appearance

Linear, quadratic, and cubic functions again fit the relation between women's scores on three-dimensional appearance and beauty. Given that all significance levels are the same, only the linear function has been plotted. Overall, women awarded higher beauty scores to stimuli rated to have a greater three-dimensional appearance than to those rated as having a lower three-dimensional appearance (see figure 7.14).

Independent: MUJERES7

Dependent	Mth	Rsq	d.f.	F	Sigf	b0	b1	b2	b3
BELLMUJ	LIN	,571	58	77,36	,000	1,5580	,2623		
BELLMUJ	QUA	,573	57	38,17	,000	1,6743	,1962	,0074	
BELLMUJ	CUB	,579	56	25,68	,000	1,0799	,7368	-,1318	,0106

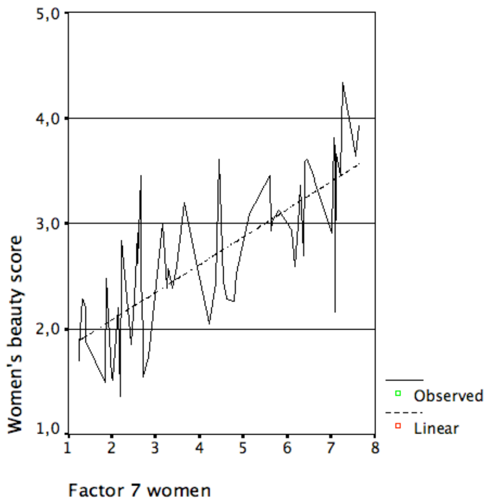
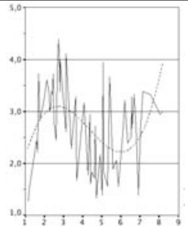
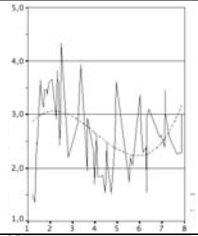
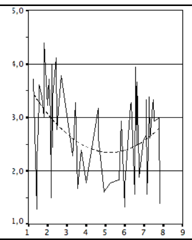
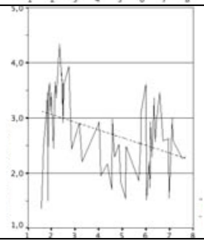
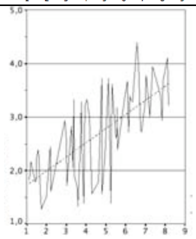
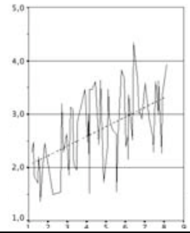
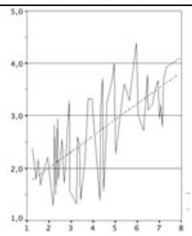
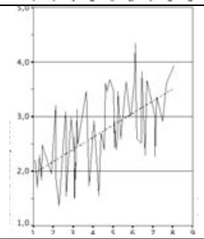
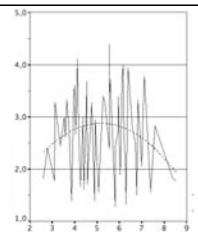
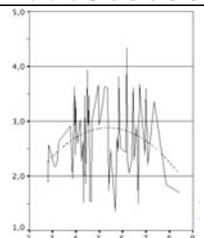
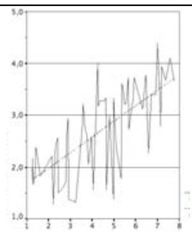
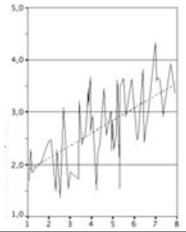
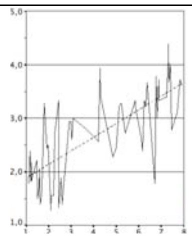
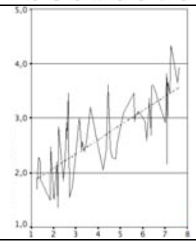


Figure 7.14. Curve fit between women's scores on "Three-dimensional appearance" and "Beauty"

3.3.3.3. Summary table

The following table summarizes the results of relating men and women's beauty ratings with their scores on each complexity dimension. Two issues stand out at a glance. First, that trends for men and women are very similar. Second, that trends for dimensions 1 and 2 are virtually identical, as are trends for dimensions 3, 4, 6, and 7. The relation between dimension 5 and beauty ratings is different to all the rest.

Dimension	Men	Women
1 **Unintelligibility of the elements**		
2 **Disorganization**		
3 **Amount of elements**		
4 **Element heterogeneity**		
5 **Asymmetry**		
6 **Colour variety**		
7 **Three-dimensional appearance**		

4

Discussion

4.1

The influence of complexity on aesthetic preference

Abstract

In this section we discuss the results of our tests of hypotheses I.I, I.II, I.III and II. Our results suggest that both men and women prefer highly complex stimuli to simple ones, artistic to decorative stimuli, and representational to abstract stimuli. However, closer inspection of the data revealed that the effects of complexity were driven mainly by the scores awarded to representational decorative stimuli. We feel that these results support our initial assumption that divergence among the results of studies carried out to test Berlyne's predicted relation between complexity and aesthetic preference could, to a certain extent, be due to their use of different kinds of materials. However, our results do not support our initial prediction that the composition of the groups of participants in relation to sex might have also played a role in the aforementioned divergence.

Daniel Berlyne was one of the most influential researchers in empirical aesthetics. His work integrated some aspects of Fechner's legacy with behavioural science, neuroscience, and information theory. One of his most lasting contributions was his study of the role of collative variables, particularly complexity, on aesthetic preference. As we saw in the introduction to the present work, Berlyne's framework predicted that, given a choice of visual stimuli varying in complexity, people would prefer intermediately complex pictures than very simple or very complex ones. Since its formulation, there have been many attempts to test this prediction. Some studies have found that indeed, participants preferred intermediate levels of complexity. However, a substantial portion of the studies that have examined this question have found that aesthetic preference increases with complexity.

The main objective of the present work was to determine the causes of the discrepancies in studies testing Berlyne's predicted relation between complexity and preference. We hypothesized that, to a certain point, the use of different kinds of materials, such as abstract or representational stimuli, and reproductions of artworks or non-artistic pictures, could explain the divergence in results. We also suggested that the composition of participant groups in relation to sex could lead to studies arriving at different results. Finally, we argued that the use of different definitions and measures of "complexity" could have also played a part in the lack of congruence in the reviewed results. In order to test these hypotheses, we designed a study in which male and female participants were asked to rate the beauty of abstract, representational, artistic, and decorative visual stimuli varying in complexity. Thereafter, they were also asked to rate visual stimuli varying in complexity on a series of possible dimensions of complexity.

In this subsection we will discuss the results in relation to the first two hypotheses, those that have to do with the role of the kind of stimulus and the participants' sex on the relation between the complexity of those stimuli and the aesthetic preference expressed by those participants. We will discuss the results relating to the influence of the conception of complexity for the subsequent subsection.

The results yielded by our statistical tests revealed that both men and women awarded higher beauty scores to highly complex visual stimuli than to simple ones. In addition, male and female participants found representational stimuli to be more beautiful than the abstract ones. Finally, both groups of participants rated the beauty of artistic stimuli higher than decorative stimuli. However, when the analysis was carried out separately for each type of stimulus, it turned out that the influence of complexity on aesthetic preference we just noted was not felt for any of the stimuli types, except for representational decorative images. In fact, the results suggest that the great difference in aesthetic preference for very complex and simple representational decorative stimuli might actually be driving the aforementioned main effects, together with other triple interactions (commented in Annex D).

Closer inspection of the data and the stimuli suggests a possible explanation for the strong influence of complexity on aesthetic preferences for representational decorative stimuli. Boxplots in figure 4.3 and tables 4.3 and 4.4 clearly show that both men and women rated highly complex representational decorative stimuli as beautiful as artistic representational stimuli. The comparison of low complexity and high complexity representational decorative stimuli (see Annex A, images 1221 to 1220 and images 3221 to 3220, respectively) reveals a clear difference between both groups of stimuli. Low complexity representational decorative stimuli are simple or schematic drawings or photographs of individual objects, such as a car, a biker, bananas, a pencil, and so on. Conversely, high complexity representational decorative stimuli are, for the most part, paintings or photographs of natural sceneries, such as landscapes or seascapes. Hence, it seems that the beauty ratings awarded by our participants without artistic training reflect a tendency to consider the art-looking postcards or illustratioins as artistic and to reject simple depictions of individual objects. This suggests that our category of decorative stimuli could probably be subdivided into a category of what Lindauer (1990) and Winston and Cupchik (1992) might consider cheap or popular art and a category of what we could call icons or objects.

On the other hand, the fact that all of our results were virtually identical for men and women, suggest that, contrary to what we predicted, the role of sex seems to be small in the mediation of the influence of complexity on aesthetic preference. The fact that we were unable to find any evidence that the influence of complexity on aesthetic preference differs for men and women suggests that the composition of participant groups in relation to sex is not a relevant factor behind the diverging results of prior studies examining the relation between complexity and aesthetic preference.

Our results, thus, support prior studies that found a linear relation between the complexity of non-artistic representational stimuli and aesthetic preference, suggesting that people prefer complex representational decorative over simple ones (Francès, 1976; Heath *et al.*, 2000; Stamps, 2002). Our results are contrary to Berlyne's (1963) finding that aesthetic preference for non-artistic representational stimuli decreased with complexity, and to studies finding an inverted U distribution for this kind of images (Imamoglu, 2000; Nasar, 2002). Additionally, we found no evidence to support the notion that complexity influences people's aesthetic preference of artistic stimuli, as suggested by Krupinski and Locher (1988), Messinger (1998), Neperud and Marschalek (1988), Nicki and colleagues (1981), Nicki and Moss (1975), Osborne and Farley (1970), Saklofske (1975), and Wohlwill (1968). Finally, we found no evidence for the influence of complexity on aesthetic preference for non-artistic abstract images that had been noted by Aitken (1974), Day (1967), Eisenman (1967), Munsinger and Kessen (1964), and Nicki and Gale (1977).

Our finding of different effects of complexity on aesthetic preference as a function of stimuli type suggests that the composition of the materials used in studies testing Berlyne's prediction is a factor that can explain why they have arrived at diverging results. Hence, it would seem that the role of complexity on aesthetic preference is mediated by the kind of visual stimuli used to study the relation between these two variables.

However, although our results showed that complexity was an important determinant of people's aesthetic preference for non-artistic representational visual stimuli, the fact remains that for the other kinds of stimuli used in the present study, aesthetic preference was unrelated to complexity. This suggests that other variables might have played a larger role than we previously suspected. These uncontrolled variables might include the degree of prototypicality of the stimuli, certain personality traits and cognitive style of the participants, their informal experience with art, and so on.

Additionally, it is possible that a single general measure of complexity is simply an invalid concept. With few exceptions, attempts to explore the relation between complexity and aesthetic preference have made use of a single measure of complexity, most often the number of elements (angles, lines, intersections, geometrical figures, and so on). This means that they have not controlled other features that possibly have an impact on the perceived complexity of the stimuli. We explore this possibility in the next subsection.

4.2

The concept of complexity

Abstract

In this section we discuss the results of our tests of hypotheses III.I, III.II, and III.III. These results suggest, first, that men and women base their judgments of complexity of visual stimuli on different features. Furthermore, the kind of stimuli also plays a role in determining the relevant features on which participants base their general complexity ratings. Second, there seem to be three main factors behind these ratings: the amount and variety of elements, their organization, and symmetry. We suggest that these three factors could be related with different perceptual and cognitive processes, and that a general concept of complexity is invalid because it masks the different contributions of these three forms of complexity. Finally, the three complexity factors seem to be related differently with beauty ratings.

Berlyne and colleagues (1968) distinguished various features of visual stimuli that contributed to the subjective impression of complexity. These included the amount of elements, their heterogeneity, the irregularity of their shapes, the irregularity of their disposition, the degree with which the different elements are perceived as a unit, asymmetry, and incongruence. Since this initial classification there has not been much work aimed at determining whether these features impact subjective complexity in the same way and to the same extent. In addition, there has been little research on the relation among the complexity features themselves. It could be, for instance, that Berlyne and colleagues' (1968) complexity features were completely independent, or, conversely, that some of them were more closely related than others. Finally, there has been no attempt at determining whether different complexity features affect aesthetic preference in the same way or to the same extent. In fact, most research in empirical aesthetics and visual perception has regarded complexity as a one-dimensional concept. Although many studies have dealt with the relation between complexity and aesthetic preference, their specification of complexity has not always emphasized the same aspect of complexity. Whereas some studies have conceived complexity as the amount of elements in a stimulus –lines, angles, turns, and so on- other have regarded it as the degree of asymmetry, or the degree of incongruity. This obviously creates problems when comparing their results, which may differ precisely because complexity refers to different things in different cases.

Here we have tentatively explored the conceptual structure of complexity ratings in three ways: (i) by trying to ascertain whether any of the dimensions is more salient that others as a function of the sex of the participants and the kind of stimuli when performing judgments of complexity, (ii) by exploring how the complexity dimensions are related among themselves, and (iii) by exploring how each of them is related to beauty ratings. In what follows, we discuss the results of these three explorations and we then finish with a general discussion.

4.2.1. Relevance of complexity dimensions for complexity judgments

In order to study the relative importance of complexity dimensions on the ratings of visual stimuli on subjective complexity we performed a series of discriminant analyses. The results of these analyses revealed that the complexity level of each kind of visual stimuli could be predicted very reliably from solely one or two dimensions. However, the predictive dimensions varied according to the sex of the participants and the kind of stimulus.

Specifically, the only instance in which more than two dimensions were required to reach an accurate prediction was that constituted by men's ratings of artistic representational stimuli, for which four dimensions were required. Overall, and in agreement with Berlyne and colleagues' (1968) results, the dimension which most often appeared among the predictor variables, alone or in combination with others, was the amount of elements. When we studied the contribution of the complexity dimensions to the rating of complexity of the different stimuli types, it became clear that the variety of their colours and their three-dimensional appearance was of little relevance. This is in agreement with Hall's (1969) results, which suggested that the variety of colours did not represent an important factor when rating the complexity of linear stimuli. Two other results were striking. First, the heterogeneity of elements was among the reliable predictors of men's complexity rating of artistic stimuli, both abstract and representational. Conversely, it did not appear among the predictors of their rating of decorative stimuli, neither abstract nor representational. Second, amount of elements and asymmetry predict women's complexity ratings of representational stimuli, both artistic and decorative. Conversely, asymmetry does not appear to be an adequate predictor of women's complexity rating of abstract stimuli.

These tentative results suggest hypotheses that require future experimental testing under rigorously controlled conditions and with stimuli specifically manipulated to this end:

- The amount of elements has a great influence on men and women's ratings of complexity of artistic and decorative abstract and representational stimuli.
- The variety of colours and the three-dimensional appearance have little influence on men and women's ratings of complexity of artistic and decorative abstract and representational stimuli.
- The heterogeneity of elements is a good predictor of men's rating of artistic but not decorative stimuli.
- Asymmetry is a good predictor of women's rating of representational but not abstract stimuli.

4.2.2. Relations among complexity dimensions

We studied the relation between the seven complexity dimensions by means of factor analysis, which allows simplifying those relations by identifying underlying factors that explain the greatest possible amount of original information. Factor analysis has the advantage over other data reduction procedures of yielding a small number of easily interpretable factors. We carried out separate analyses for men and women's ratings, although the final results were very similar. The present discussion, hence, applies to both sets of results.

Our results indicated the existence of two factors that explained most of the variance, and a third one which we included to account for asymmetry. The first factor received high loadings from the following dimensions: amount of elements, element heterogeneity, variety of colours, and three-dimensional appearance. The second factor received high loadings from unintelligibility of the elements and disorganization. And the third factor, as we just mentioned, received high loadings only from asymmetry. We refer these three factors as *elements* –which has to do with the amount and variety of the elements-, *organization* –related with how the elements are grouped to form identifiable objects and how these are organized into a coherent scene-, and *asymmetry*.

Based on men's ratings, *elements* accounted for 48.33% of the variance, *organization* accounted for 31.69% of the variance, and *asymmetry* for 14.43%. Overall, thus, the three factors accounted for 94.45% of the variance of men's ratings on the seven complexity dimensions. When the calculations are based on women's ratings, *elements* accounted for 47.01% of the variance, *organization* explained 31.17%, whereas *asymmetry* explained 14.54%. Overall, the three factors explained 92.71% of the variance of women's ratings on the seven complexity dimensions. Hence, loadings on factors based on men and women's ratings are very similar.

These results are in line with prior studies. For instance Berlyne and colleagues' (1968) factor analysis indicated the existence of two main factors, one related with the amount of elements and another which was a composite of various of the dimensions he had taken into account, and named it unity versus articulation into easily recognizable parts. It stands out that these two factors are very similar, or even equivalent, to our *elements* and *organization* factors. However, in contrast to our results, his first factor accounted for between 70 and 90% of the variance. This difference in the relevance of the amount of elements on complexity ratings might be due to the fact that the stimuli used by Berlyne and colleagues (1968) were simple line drawings in which the constituting elements were much more salient that in most of the stimuli used in the present study.

Other studies have also found subjective complexity to depend on two kinds of features. Nicki and Moss (1975) interpreted their results suggesting there might be two kinds of complexity factors, a "perceptual" one related with the number and variety of elements, and a "cognitive" one related with the amount of associations or cognitive tags elicited by stimuli. Chipman (1977) distinguished between a qualitative component of complexity judgments, determined largely by the amount of elements, and a structural component, related with symmetry, the repetition of motifs and other organizational processes. Chipman (1977) made a very interesting suggestion. She noted that the first factor, related to the amount of elements, seems to set an upper threshold of perceived complexity and the second one can act reducing this impression. By varying presentation times Ichikawa (1985) found experimental data to back this.

Thus, our results add further support to the idea that two or three processes contribute to the formation of subjective visual complexity. Probably the most important one is the determination of the number and variety of elements. The second one refers to the difficulty with which the elements are identified and organized into a coherent scene. Although previous studies have subsumed asymmetry within organizational processes, our results showed this was not an adequate solution for our data, and hence, we chose to include it as a separate factor. The temporal sequence of cognitive processes related with these factors remains to be elucidated, though based on Ichikawa's (1985) results, a plausible hypotheses is that the different features are processed in parallel, but that those related with *elements* are faster than those related with *organization*, which finish later.

4.2.3. Relation between complexity dimensions and beauty ratings

The final part of this study was a tentative exploration of the possibility that the different dimensions of complexity are related in different ways to beauty ratings. If this were the case, it could explain some of the diverging results reviewed in the introduction, which manipulated different features of the stimuli to create their complexity levels. In order to address this issue we plotted men and women's beauty ratings against their rating of each of the complexity dimensions.

This can only be regarded as a very tentative exploration because stimuli were not manipulated independently on each of the complexity dimensions. Despite this limitation, our results revealed that complexity dimensions were not related in the same way to beauty.

Dimensions 1 and 2, unintelligibility of the elements and disorganization, seem to have a U-shaped or descending relation to beauty. Specifically, stimuli receiving extremely low values on this dimensions were rated as more beautiful than those receiving intermediate and high scores. In contrast, dimensions 3, 4, 6, and 7, amount of elements, element heterogeneity, variety of colours, and three-dimensional appearance, have a linear relation to beauty: images considered to be most beautiful were also rated higher on these four dimensions. Finally, our results suggest that dimension 5, asymmetry, seems to have an inverted U shape relation to beauty: images rated as intermediately asymmetric were considered to be more beautiful than those rated as extremely asymmetric or extremely symmetric.

This grouping of dimensions according to their relation with beauty ratings mirrors their loadings on the three factors we commented above. Complexity dimensions related with the factor *elements* have a linear relation to beauty. Complexity dimensions related with the factor *organization* have a U shaped relation to beauty. *Asymmetry* has an inverted U shaped relation to beauty.

Is it possible that the diversity of relations between complexity and beauty that have been found in previous studies owes to their emphasis on different factors? Our review of the literature suggests that this might be the case. Out of the studies we reviewed in the introduction to this work, we selected those that utilized some sort of specific complexity measure, and we left out those that assessed complexity by means of a general complexity rating scale. Out of the studies we were left with, six designed or employed stimuli which varied along the *elements* factor (Aitken, 1974; Day, 1967; Heath *et al.*, 2000; Nicki, 1972; Nicki & Moss, 1975; Stamps, 2002), five designed or used stimuli which varied along the *organization* factor (Krupinski & Locher, 1988; Neperud & Marschalek, 1988; Nicki *et al.*, 1981; Nicki & Moss, 1975; Osborne & Farley, 1970), one used stimuli varying only in *asymmetry* (Krupinski & Locher, 1988), three used stimuli which varied in *asymmetry* as well as *elements* (Eisenman, 1967; Imamoglu, 2000; Munsinger & Kessen, 1964), and one used stimuli varying in all three factors (Francès, 1976). If our reasoning were sound, we would expect those studies that have varied complexity by manipulating the amount or variety of elements to have found an increasing relation between complexity and preference. We would expect to find that studies manipulating complexity by means of organizational features obtained decreasing or U-like distributions between complexity and preference. Finally, we would expect prior studies that specified complexity along a symmetry-asymmetry dimension to have produced the expected inverted U distribution of preferences over complexity.

In order to test this retrospective prediction we discarded the study by Francès (1976) due to its combined use of measures related with the three factors. We also pooled the studies that had conceived complexity as asymmetry or the combination of asymmetry and number of elements into a single category. For each of the fifteen studies, we summarized its main conclusion as supporting an increasing, inverted-U, or decreasing, relation of preference and complexity. Table 8.1 shows the crosstabulation of the main factors manipulated by these studies with their main conclusion, together with the corresponding Chi-square test.

		Main factor			
		Elements	Organization	Symmetry	Total
Result	Increasing	5	1		6
	Inverted U	1		3	4
	Decreasing		4	1	5
Total		6	5	4	15

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15,329[a]	4	,004
Likelihood Ratio	17,646	4	,001
Linear-by-Linear Association	4,528	1	,033
N of Valid Cases	15		

a. 9 cells (100,0%) have expected count less than 5. The minimum expected count is 1,07.

Table 8.1. Crosstabulation of the main factor manipulated by previous studies and their resultant relation between beauty and complexity

The results of the Chi-square test are highly significant, suggesting that the choice of complexity factor among *Elements*, *Organization*, and *Symmetry*, has an impact on the shape of the resulting distribution of beauty over complexity. It is important to note that just as our results had suggested, most studies manipulating the number or variety of elements found an increasing relation between complexity and preference, most of those manipulating organizational features had found a descending relation, and most of those that had manipulated symmetry found an inverted U distribution. Additionally, directional measures were calculated in order to assess the strength of the association, which are presented in table 8.2.

			Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Nominal by Nominal	Lambda	Symmetric	,667	,180	2,657	,008
		Result Dependent	,667	,181	2,535	,011
		Main factor Dependent	,667	,181	2,535	,011
	Goodman and Kruskal tau	Result Dependent	,517	,185		,006[c]
		Main factor Dependent	,517	,185		,006[c]
	Uncertainty Coefficient	Symmetric	,542	,130	4,131	,001[d]
		Result Dependent	,542	,130	4,131	,001[d]
		Main factor Dependent	,542	,130	4,131	,001[d]

a. Not assuming the null hypothesis.
b. Using the asymptotic standard error assuming the null hypothesis.
c. Based on chi-square approximation
d. Likelihood ratio chi-square probability.

Table 8.2. Directional measures of association between manipulated complexity factor and main result

Hence, there is a strong relation between the way in which previous studies have specified complexity and their resulting distribution of beauty scores as a function of complexity. Moreover, as the measures of association show, the kind of distribution can be predicted from the complexity factor manipulated by the experimenter with an acceptable degree of accuracy.

4.3

General conclusions

Abstract

This work explored several possible reasons for the diverging results of studies aimed to clarify the relation between visual complexity and aesthetic preference. Our results suggested that the use of different kinds of stimuli might have led to some of those divergences. However, contrary to our original assumption, the proportion of men and women participating in those studies seems to have played a very small role. Finally, we suggest that the main reason behind the lack of agreement on the influence of complexity on aesthetic preference is the use and manipulation of different kinds of complexity.

This work was carried out with the purpose of determining the reasons for the divergence in the results of studies testing Berlyne's hypothesized inverted U relation between complexity and aesthetic preference of visual stimuli. We had originally conjectured that differences in the proportion of male and female participants, in the composition of materials, and in the definition and measurement of visual complexity among these studies could explain why Berlyne's prediction has received such mixed support.

Our results, however, suggest that the proportion of male and female participants might have had little effect on the results of the studies reviewed in the introduction. Furthermore, our results also lend limited support to the possibility that the use of different kinds of visual stimuli, such as artistic vs. decorative, or abstract vs. representational, might have led to the aforementioned divergent results. We have also suggested that the role of individual differences in personality, cognitive style, and informal artistic experience might be more relevant than we originally surmised.

The results yielded by our study suggest that the most probable cause behind the diverging results is the different definitions of complexity on which the researchers grounded their studies. We found that complexity is better understood as a multidimensional concept. People tend to base their rating of the complexity of visual stimuli on different aspects, depending on their sex and the kind of stimulus. Our results suggest that there are three main kinds of aspects: (i) those related with the amount and variety of elements, (ii) those related with object recognition and scene organization, and (iii) asymmetry. These three aspects of complexity seem to be related in different ways to general ratings of the complexity and to ratings of beauty of visual stimuli, though this needs to be experimentally tested. We have shown that it is possible that prior studies have designed or used stimuli that emphasized different particular aspects of complexity. These differences seem to have conditioned the diverging relations between complexity and aesthetic preference found by the studies we reviewed in the introduction to this work.

Resumen

(Spanish summary)

De todas las aportaciones de Daniel Berlyne a la estética experimental, la que ha tenido un impacto más duradero fue su hipótesis de que las personas tenderían a preferir estímulos visuales de complejidad intermedia por encima de estímulos muy complejos o muy simples. Desde entonces se han llevado a cabo un gran número de estudios que han pretendido verificar esta propuesta. Mientras que los resultados de algunos de ellos han corroborado la hipotetizada relación entre complejidad visual y preferencia estética, otros han hallado que la preferencia aumenta con la complejidad de manera lineal. El objetivo principal de este trabajo es explorar las posibles razones de esta divergencia entre los resultados de los mencionados estudios. Contemplamos tres posibilidades: (i) el uso de materiales distintos en cuanto a su grado de realismo y calidad artística, (ii) la composición diferente de los grupos de participantes en cuanto al sexo, y (iii) distintas concepciones y formas de medir la complejidad visual de los estímulos. Nuestros resultados sugieren que el tipo de materiales y la composición de los grupos de participantes han jugado un papel limitado en la divergencia de resultados entre los estudios anteriores. Por el contrario, nuestros resultados apuntan a que el factor más relevante ha sido la adopción de distintas concepciones de complejidad en los diversos estudios.

1. Introducción

Las cuestiones relacionadas con el arte y la estética se han debatido continuamente desde que fueron planteadas inicialmente por los filósofos de la antigua Grecia. Hasta hace relativamente poco, las respuestas a estas preguntas, así como las que atañen a otros fenómenos psicológicos, estaban basadas casi exclusivamente en las experiencias de los propios autores. En el caso del arte y la estética, estas experiencias eran sus propias reacciones al contemplar obras artísticas y la observación cotidiana de las reacciones de otros espectadores. Este método constituye una base extremadamente pobre para asentar teorías explicativas, y deja un gran número de temas sin plantear, que a menudo no se detectan hasta que se aplican métodos más novedosos y rigurosos.

La aplicación de métodos experimentales para la verificación de hipótesis relacionadas con el arte y la estética comenzó con los trabajos de Gustav Fechner, considerado también como fundador del campo de la psicofísica. En su libro *Elementos de Estética*, Fechner (1876) describía varios experimentos en los que se estudiaron las respuestas estéticas de muestras de participantes representativos de diversas poblaciones a diversos tipos de materiales visuales. Las reflexiones e introspecciones de un único individuo fueron sustituidas por promedios de respuestas dadas por grupos de participantes, y en lugar de estudiar una obra de arte en profundidad se empezaron a usar numerosos objetos para determinar atributos colectivos relacionados con determinadas respuestas.

Los nuevos métodos experimentales introducidos por Fechner permitieron la formulación rigurosa de hipótesis y su comprobación en condiciones controladas. Uno de los puntos de mayor interés de esta estética experimental fue desarrollar un método que permitiera cuantificar la medida estética de un abanico amplio de objetos. En esta línea, es bien conocida la aportación del matemático Birkhoff (1932) en la que introducía una fórmula matemática que permitía calcular la medida estética (M) de objetos visuales en virtud del orden (O) y la complejidad (C): $M = {}^{O}/_{C}$ De esta manera, cuanto más ordenados y sencillos sean los estímulos visuales, mayor será su medida estética.

A pesar de que Birkhoff (1932) acompañó esta fórmula de unas precisas definiciones de orden y complejidad y ejemplos para un amplio número de polígonos, él mismo no llevó a cabo experimentos para validar que la relación entre estos dos componentes era, en efecto, una medida adecuada de la cualidad estética de los objetos. Experimentos realizados con posterioridad produjeron resultados contradictorios. El estudio más amplio realizado para esclarecer la validez de esta relación halló una correlación entre la medida estética calculada con la fórmula y las puntuaciones asignadas por participantes sin educación artística de 0,04, y de 0,28 en el caso de participantes con educación artística (Eysenck y Castle, 1970b). En busca de una alternativa más satisfactoria, Eysenck (1941b) estudió las respuestas dadas por participantes en una tarea de preferencia estética a un amplio número de figuras geométricas. Sus resultados sugirieron que distintas características de estos objetos, efectivamente relacionados con la complejidad y el orden, podían usarse para predecir las preferencias de sujetos humanos por ellas. Sin embargo, la relación entre estas características no era la que había formulado Birkhoff (1932). En una simplificación de su fórmula original, Eysenck (1942) sugirió, que la contribución de la complejidad a la preferencia estética no era negativa, sino positiva: $M = O \cdot C$

Dos décadas más tarde Daniel Berlyne inició un programa de investigación, conocido como *Estética Psicobiológica*, que tiene claras implicaciones en relación a los determinantes del juicio estético. Su objetivo final era detallar un conjunto de leyes hedónicas que pudieran explicar las preferencias de las personas, así como del resto de animales, por ciertos tipos de estímulos. Basándose en los hallazgos neurobiológicos sobre los sistemas motivacionales y emocionales propuso que el estado motivacional de un organismo está relacionado con la actividad de tres sistemas neuronales: (i) un sistema primario de refuerzo, (ii) un sistema de aversión y (iii) un sistema secundario de refuerzo, que opera inhibiendo el sistema de aversión. La actividad de los tres sistemas depende del grado de activación del organismo, que a su vez depende, en cierta medida, de la configuración de los estímulos procedentes del medio. Las propiedades de los estímulos que tienden a aumentar la activación, es decir, el grado con el que pueden inducir un estado de alerta en el organismo, se conoce como potencial de activación. Son tres las clases de variables que determinan, principalmente mediante la cantidad de información que transmiten al organismo, este potencial de activación (Berlyne, 1971): (i) variables psicofísicas, como el brillo, la saturación, el tamaño o la longitud de onda predominante; (ii) variables ecológicas, que incluyen todos aquellos elementos que puedan haber adquirido asociaciones con eventos o actividades biológicamente relevantes; (iii) variables colativas, como la novedad, sorpresa, complejidad, ambigüedad o la asimetría.

El sistema primario de refuerzo es el más sensible a la activación del organismo, por lo que incrementos moderados de activación durante un estado de activación relativamente baja suelen resultar placenteros. El umbral del sistema de aversión es algo más elevado, por lo que si la activación continúa creciendo se pone en funcionamiento, contrarrestando los efectos del sistema primario de refuerzo o, si la activación es muy elevada, sobrepasándolos. Para cada grado de activación del organismo, el tono hedónico resultante se puede calcular mediante la suma algebraica de las curvas de actividad del sistema primario de refuerzo y de aversión (ver figura 9.1).

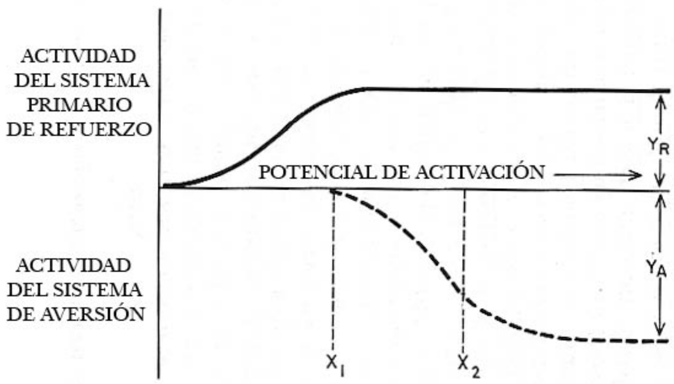


Figura 9.1. Actividad de los sistemas primario de refuerzo y aversivo en función del potencial de activación

De esta manera, los incrementos moderados de la activación del organismo a partir del punto de reposo incrementan el valor hedónico positivo hasta un nivel dado, a partir del cual incrementos en el potencial de activación no modifican la actividad del sistema primario de refuerzo. En cierto momento (X_1), y como resultado de la puesta en marcha del sistema aversivo, al haberse superado el umbral de potencial de activación, los incrementos de activación producen un decremento del valor hedónico global, pudiendo llegar a resultar en un estado hedónico negativo si la activación sobrepasa determinado umbral (X_2) igual a la actividad del sistema primario de refuerzo (ver figura 9.2).

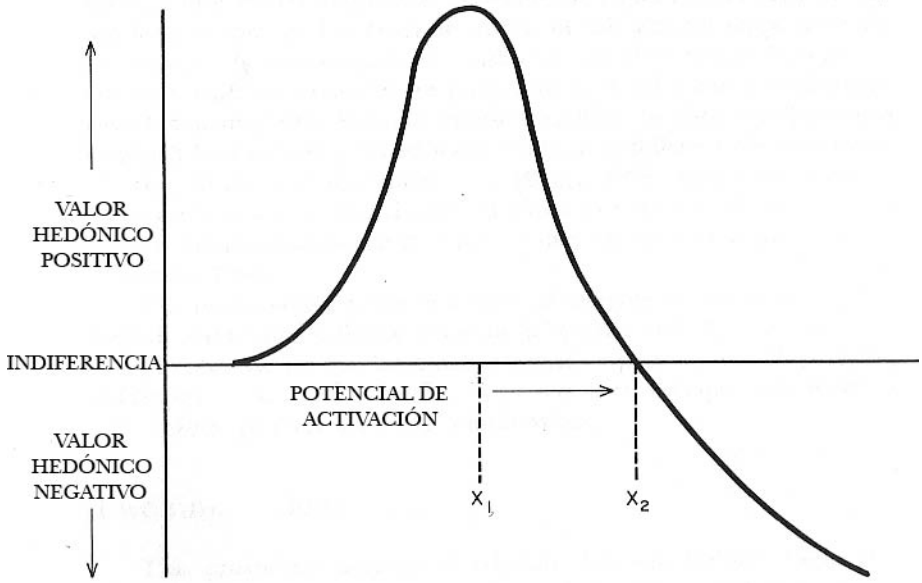


Figura 9.2. Valor hedónico resultante en función del potencial de activación

Desde este punto de vista, el valor hedónico de un estímulo depende del nivel de actividad que es capaz de inducir y del nivel de activación actual del organismo. Dado que los organismos tienden a buscar el punto óptimo de valor hedónico, tenderán a exponerse en mayor o menor medida a los diferentes estímulos en función de su potencial de activación.

En relación con la estética y el arte, Berlyne propuso que los juicios sobre el interés y agrado de una imagen, o un sonido, depende, de manera primordial, del juicio de la complejidad de ese estímulo (Berlyne, 1963; Berlyne, Ogilvie, y Parham, 1968), que a la vez está relacionado con factores tales como la regularidad del patrón, la cantidad de elementos que forman la escena, su heterogeneidad o la irregularidad de las formas (Berlyne, 1970). Así pues, en condiciones normales, es decir, de activación media, es de esperar que las personas prefieran obras de arte de complejidad intermedia sobre estímulos de complejidad baja o alta.

Berlyne (1971) afirmó explícitamente que el valor hedónico no quedaba determinado directamente los por factores objetivos de complejidad, sino por la complejidad subjetiva. La segunda depende indudablemente de la primera (Attneave, 1957; Chipman, 1977; Chipman y Mendelson, 1979; Hall, 1969), en cuanto varía, en cierta medida, de acuerdo con el número de elementos y la redundancia que hay en una imagen, pero es de esperar que la complejidad que percibe cada individuo dependa de la manera en la que organice perceptivamente la escena. En efecto, se ha constatado que la complejidad subjetiva, tal y como indicaba Berlyne (1971), no depende sólo de la cantidad de elementos, o de su disimilitud, sino de cómo cada una de las personas organiza esos elementos para formar una escena coherente (Hogeboom y van Leeuwen, 1997; Strother y Kubovy, 2003).

Con la finalidad de contrastar esta hipótesis en relación con estímulos visuales, la investigación sobre las preferencias estéticas y los juicios de belleza se ha llevado a cabo principalmente con materiales simples que pueden ser manipulados experimentalmente: objetos geométricos (Aitken, 1974; Katz, 2002; Vitz, 1966), o imágenes generadas artificialmente (Heath, Smith, y Lim, 2000; Ichikawa, 1985; Markovic y Gvozdenovic, 2001; Stamps III, 1998). Si bien es cierto que no se puede negar que el uso de materiales sencillos permite un mejor control de las variables relativas a los estímulos, en la mayoría de los estudios no queda clara la implicación de procesos cognitivos relacionados con la estética durante la realización de la tarea que se propone al participante. Los experimentos en los que se pide a los sujetos que valoren estéticamente figuras geométricas no están, con seguridad, captando la esencia del juicio estético. Algunos estudios han pretendido contrastar el modelo de Berlyne utilizando estímulos artísticos, aunque normalmente se han incluido materiales de una sola clase, como cuadros abstractos (Krupinski y Locher, 1988; Nicki y Moss, 1975; Osborne y Farley, 1970), obras de arte cubistas (Nicki, Lee, y Moss, 1981), imágenes figurativas (Messinger, 1998) o retratos (Saklofske, 1975). Además, en la mayoría de los casos, el número de participantes era bajo (en algunos experimentos tan pocos como 8 por condición) o el número de estímulos era muy bajo (en ocasiones sólo 5). Adicionalmente, la metodología que se ha utilizado en la inmensa mayoría de esas investigaciones es de tipo correlacional.

Por otro lado, estos estudios llegan a conclusiones contradictorias. Unos hallan la esperada distribución de preferencias en forma de u invertida, mientras que otros hallan que la preferencia por los estímulos crece, o decrece, linealmente con su complejidad. Es posible que esta disparidad se deba a diferencias en el material utilizado, a la inclusión de distinto número de hombres y mujeres en las muestras de participantes, o al uso de distintas concepciones y formas de manipular la complejidad de las imágenes, además de algunos problemas en los diseños experimentales, como el no controlar variables psicofísicas, o el grado de celebridad de las diferentes obras de arte. En definitiva, actualmente no se ha contrastado satisfactoriamente la hipótesis de Berlyne con estímulos artísticos, ni sabemos si la complejidad está relacionada con la preferencia de manera diferente en función de los estilos artísticos, el sexo y distintas formas de complejidad.

Sin embargo, existe un problema adicional referido a la poca claridad con la que se ha considerado el propio concepto de complejidad visual. Berlyne (1971) afirmó explícitamente que el valor hedónico de un estímulo no venía determinado por los rasgos objetivos de complejidad, sino por la complejidad subjetiva. La segunda guarda, sin duda, alguna relación con la primera (Attneave, 1957; Chipman, 1977; Chipman y Mendelson, 1979; Hall, 1969), en tanto que varía, en cierta medida, con aspectos como el número de elementos, o la redundancia de un estímulo visual. Sin embargo, la complejidad percibida por cada individuo depende de la manera en la que organice la escena (Hogeboom y van Leeuwen, 1997; Strother y Kubovy, 2003). Por ejemplo, el estudio de Attneave (1957) mostró que aunque aproximadamente el 80% de la varianza de los juicios subjetivos de complejidad de polígonos venía explicada por el número de giros, habían dos resultados que ilustraban la relativa independencia entre las medidas objetivas y subjetivas de complejidad. En primer lugar, aunque los polígonos construidos a partir de matrices con más puntos contienen más información que los polígonos construidos a partir de matrices con menos puntos, esta variable no tuvo efectos apreciables sobre el juicio de complejidad realizado por los participantes. Segundo, a pesar de que los giros curvos contienen más información que los vértices (en los que no existe información sobre el radio del giro), este factor tampoco tuvo efectos sobre los juicios de complejidad. Estos resultados llevaron al autor a concluir que "la cantidad de información contenida en un estímulo (desde el punto de vista del experimentador) puede variarse en gran medida sin cambiar la complejidad aparente del estímulo" (Attneave, 1957, p 225).

Se han realizado muchos otros experimentos para clarificar el concepto de complejidad visual y la relación entre rasgos objetivos y juicios subjetivos. A pesar de que la mayoría de estudios de la relación entre complejidad y belleza han usado una única medida de complejidad, lo cierto es que la bibliografía sugiere que tales medidas pueden careced de validez. Por ejemplo, Berlyne y colaboradores (1968) distinguieron entre varias formas de complejidad: irregularidad de la disposición de los elementos, cantidad de elementos, su heterogeneidad, la irregularidad de las formas, el grado en el que distintos elementos se perciben como una unidad, y la incongruencia. Rump (1968) halló que las puntuaciones dadas por sus participantes a estímulos visuales en escalas de asimetría, numerosidad y heterogeneidad no correlacionaban significativamente, por lo que podrían referirse a formas de complejidad completamente diferentes. Es más, Rump (1968) sugirió que las personas podrían otorgar puntuaciones diversas en escalas generales de complejidad en función de la característica a la que prestasen más atención. Estas conclusiones fueron más tarde extendidas por Kreitler *et al.* (1974) a los mismos materiales y dimensiones utilizados por Berlyne *et al.* (1968).

El interesante estudio de Chipman (1977) sugiere que habría dos grandes formas de complejidad: una cuantitativa relacionada con el número de elementos y una estructural que tendría que ver con la simetría y la organización. La primera de estas formas determinaría el límite superior de la complejidad de los estímulos, mientras que la segunda actuaría reduciendo en distinta medida esa impresión. Los estudios de Chipman y Mendelson (1979) y Francès (1976) demuestran que las diversas formas de complejidad tienen cursos de desarrollo distintos, y que son susceptibles a la educación en distinta medida. Esto sugiere que los procesos perceptivos y cognitivos relacionados con las distintas formas de complejidad podrían variar, cuestionando la validez de las medidas generales de complejidad.

El objetivo principal de la tesis que se propone es la de clarificar las razones por las que los resultados de los estudios que han tratado de verificar la relación entre preferencia y complejidad en forma de U invertida predicha por Berlyne (1971) han resultado ser divergentes. Aquí proponemos tres posibles factores que explicarían esta discrepancia:

1. El uso de materiales diferentes para testar la mencionada hipótesis (estímulos abstractos frente a representacionales, artísticos frente a decorativos).

2. La composición de los grupos de participantes en cuanto al sexo.

3. La adopción de distintas definiciones del concepto de complejidad y el desarrollo de distintos modos de operativizar, medir, y manipular este concepto.

Para cumplir nuestro objetivo diseñamos un experimento, descrito más abajo, dirigido a testar las siguientes hipótesis nulas:

I.I. La preferencia estética de los participantes será igual para estímulos visuales de complejidad baja, intermedia y alta.

I.II La preferencia estética para estímulos abstractos y representacionales será igual.

I.III. La preferencia estética para estímulos artísticos y decorativos será igual.

II. La preferencia estética de hombres y mujeres por estímulos visuales diversos será igual.

III.I. El sexo de los participantes y el tipo de estímulo no influyen en los rasgos que usan los participantes para juzgar la complejidad de estímulos visuales.

III.II. Todos los rasgos de complejidad son reducibles a una única medida.

III.III. Todos los rasgos de complejidad están relacionados con la preferencia estética de la misma manera.

Una de las cuestiones más controvertidas en el campo de la estética experimental es el de poder estudiar la preferencia estética en condiciones de laboratorio. Sin embargo, basándonos en los trabajos de Eysenck (1942), Marty *et al.* (2003) y Jacobsen *et al.* (2004), que mostraron mediante métodos diversos que las puntuaciones de la belleza era la mejor aproximación a la preferencia estética, en este trabajo tomaremos como medida de la preferencia estética precisamente las puntuaciones otorgadas por los participantes en una escala de belleza.

A pesar de que algunos estudios han sugerido que ciertos rasgos de personalidad, como el conservadurismo, la apertura o la búsqueda de sensaciones (Feist y Brady, 2004; Furnham y Walker, 2001), y ciertos estilos cognitivos (Tobacyk *et al.*, 1981), pueden tener influencia sobre la preferencia estética, lo cierto es que en la mayor parte de estos estudios estas relaciones o no son significativas, o explican una proporción muy baja de la varianza de las puntuaciones en preferencia estética (Hardiman y Zernich, 1977; Heinrichs y Cupchik, 1985). Se ha sugerido, incluso, que las débiles relaciones entre las mencionadas diferencias individuales y la preferencia estética pueden deberse más a la experiencia con actividades artísticas que con rasgos de personalidad en sí (Furnham y Chamorro-Premuzic, 2004; Hekkert y Wieringen, 1996a). De hecho, existe una gran cantidad de literatura que demuestra que la educación artística tiene un gran peso sobre la preferencia estética (Barron y Welsh, 1952; Cela-Conde *et al.*, 2002; Hekkert *et al.*, 1994; Munsinger y Kessen, 1964; Neperud, 1986; Nodine *et al.*, 1993; Silvia, 2005; Winston y Cupchik, 1992). Otra de las variables que se han apuntado como relevantes en preferencia estética es el sexo (Bernard, 1972; Furnham y Walter, 2001; Polzella, 2000). Aunque estos estudios han hallado algunas diferencias entre los estilos preferidos por hombres y mujeres, otros no han halado tales diferencias (Farrel y Rogers, 1982; Lindauer, 1990). Por estos motivos, en este estudio se controlarán las variables de educación y sexo de los participantes, pero no sus rasgos de personalidad y otras diferencias individuales.

2. Método

Participantes

Todos los participantes en este estudio eran estudiantes en la *Universitat de les Illes Balears* que cursaban cuarto o quinto de las licenciaturas de psicología, filosofía, o historia. Aquellos que informaron haber recibido educación formal de ate o historia del arte fueron excluidos. Tomaron parte en el estudio dos grupos de participantes. El primero de ellos lo hizo en la primera fase de creación de un conjunto de estímulos para ser usado en la segunda y tercera fases. En estas últimas, en las que se pusieron a prueba nuestras hipótesis, tomó parte el segundo grupo de participantes.

Descripción de la muestra de participantes implicados en la preparación de los materiales

Un total de 240 personas participaron en la selección de una muestra adecuada de estímulos visuales para ser usada en el posterior experimento en el que se pusieron a prueba nuestras hipótesis. Esta muestra estaba integrada por 112 hombres (46,7%) y 128 mujeres (53,3%). Las edades de estos participantes iban de 18 a 44 años, con una media de 22,03 y una desviación estándar de 3,75.

Descripción de la muestra de participantes implicados en la verificación de nuestras hipótesis

En la segunda y tercera fases participaron 94 personas, 38 hombres (40,4%) y 56 mujeres (59,6%). Del total de participantes, 84 estudiaban psicología (89,4%), 9 eran estudiantes de filosofía (9,6%) y uno estudiaba historia (1,1%). Mientras que las mujeres representaban el 64,3% de estudiantes de psicología, en el caso de filosofía eran únicamente un 22,2%. El único estudiante de historia era varón. La edad de los participantes estaba comprendida entre los 18 y 46 años, con una media de 22,41 y desviación estándar de 4,1. El conjunto de participantes varones resultó ser algo más mayor que el de mujeres (23,24 años frente a 21,86, respectivamente).

Materiales

Estímulos visuales

El conjunto inicial de estímulos visuales estaba formado por más de 1500 imágenes digitalizadas, incluyendo estímulos abstractos y representacionales, artísticos y no artísticos. La distinción entre estímulos abstractos y representacionales se hizo de acuerdo al criterio habitual de ausencia y presencia de contenido explícito, respectivamente. La distinción entre estímulos artísticos y no artísticos, que aquí denominaremos decorativos, es análoga a la que hicieron Winston y Cupchik (1992) entre *High Art* y *Popular Art*. Desde este punto de vista, la diferencia estriba en que las obras decorativas enfatizan los aspectos placenteros del tema representado, mientras que las obras artísticas exploran un abanico más amplio de emociones y buscan conseguir un equilibrio entre el contenido y el estilo. Específicamente, en nuestro caso los estímulos artísticos eran reproducciones de piezas catalogadas creadas por artistas célebres y exhibidas en museos. Siguiendo las recomendaciones de Heinrichs y Cupchik (1985), incluimos imágenes pertenecientes a diversos estilos y escuelas, como realismo, cubismo, impresionismo. Para ello se usó como guía el compendio *Movements in Modern Art* de la *Tate Gallery, London*, añadiendo además reproducciones de obras americanas y europeas de los siglos XVII y XVIII. Los estímulos decorativos incluían postales, fotografías de paisajes, artefactos, escenas urbanas, etc., tomadas de la serie de libros *Boring Postcards, Phaidon Press,* Londres, fotografías tomadas por nosotros mismos, junto con imágenes de la colección *Master Clips Premium Image Collection* (ISMI, San Rafael, CA), utilizadas en diseño industrial, la ilustración de libros, etc.

Selección y modificación de los estímulos

El conjunto original de materiales fue sometido a una serie de modificaciones destinadas a eliminar la influencia de variables extrañas. Para evitar la influencia de otras variables colativas, como la novedad, o la celebridad de las obras de arte, se incluyeron solo trabajos poco conocidos. Para evitar la influencia de variables ecológicas se eliminaron aquellos estímulos que contenían claras ilustraciones de figuras y caras humanas, así como aquellos que representaban escenas que pudieran evocar reacciones emocionales. Para evitar la influencia de variables psicofísicas, se ajustó la resolución de todos los estímulos a 150 ppp y su tamaño a 9 x 12 centímetros. Se ajustó el espectro de color de todas las imágenes, modificando los valores extremos de iluminación y sombra para alcanzar un tono global que permitiera el mejor detalle. Aquellos estímulos que contenían grandes proporciones de píxeles claros u oscuros fueron eliminados. La luminancia de cada uno de los estímulos restantes se ajustó a entre 370 y 390 lx, y los estímulos que no pudieron modificarse razonablemente bien para acomodarse a este intervalo fueron eliminados. Finalmente, se eliminó la firma de todos aquellos estímulos que la llevaran. Este proceso de modificación y eliminación se llevó a cabo tal que quedaron 800 imágenes, 200 de las cuales eran abstractas artísticas, 200 eran abstractas decorativas, 200 eran representacionales artísticas, y 200 eran representacionales decorativas.

Material informático

Todos los estímulos se presentaron mediante un programa informático implementado sobre ordenadores Compaq EVO300 Pentium IV / 1,7 GHz en un entorno Windows 2000 SP4. Cuando los participantes ejecutaban el programa se encontraban primero con una pantalla en la que se les pedía que rellenaran información principalmente demográfica: nombre y apellidos, edad, sexo, estudios y la fecha. Tras cumplimentar esta sección, el programa les llevaba a una pantalla en la que se les presentaba las instrucciones de la tarea que tenían que realizar. Como se detallará más abajo en la sección de procedimiento, en la primera fase de este estudio la tarea consistía en puntuar la complejidad de los estímulos, en la segunda se les pidió que puntuaran la belleza de los estímulos, y finalmente, en la tercera fase, la tarea consistió en puntuar cada estímulo en una serie de siete dimensiones de complejidad. Las instrucciones aparecían escritas sobre la pantalla y se leyeron en voz alta. Una vez leídas y entendidas las instrucciones, los participantes hacían clic sobre *comenzar*. En este momento aparecía una pantalla de enmascaramiento durante 2 segundos, tras la cual aparecía el primer estímulo. Todos los estímulos se presentaban dentro de un marco gris. En el segmento superior del marco aparecía un breve recordatorio de la tarea que se les había pedido. En el segmento inferior aparecía un recordatorio de la escala que debían usar.

Basándonos en estudios previos que habían mostrado que el tiempo de exposición no ejerce una influencia significativa sobre la preferencia estética (McWhinnie, 1993; Smith, Bousquet, Chang y Smith, 2006), se decidió no imponer un límite temporal a las respuestas de los participantes. Así, cada participante vio cada uno de los estímulos hasta que optó por una respuesta. En las fases primera y tercera su respuesta consistía en apretar una tecla del ordenador entre el 1 al 9 y del 1 al 5 en la segunda. Si los participantes apretaban otra tecla no se producía reacción por parte del programa. En cambio, si la respuesta era adecuada aparecía en la pantalla durante 1,5 segundos, tras los cuales volvía a aparecer la pantalla de enmascaramiento durante 2 segundos. Este mismo patrón se repitió para cada uno de los 100, 120 y 60 estímulos de las fases primera, segunda y tercera, respectivamente (ver más abajo, en la sección de procedimiento). El programa de ordenador registraba toda la información demográfica dada por los participantes y cada una de sus respuestas a los estímulos en cada fase.

Procedimiento

De cara a someter a prueba las hipótesis listadas al final de la introducción, estructuramos el presente trabajo en tres fases. La primera tenía como objeto la creación de un conjunto de estímulos adecuado para poner a prueba las mencionadas hipótesis. La segunda fase se diseñó para evaluar las hipótesis sobre la relación entre la complejidad y la preferencia estética, específicamente las hipótesis I.I, I.II, I.III, y II, mediante una tarea de preferencia estética usando el conjunto de estímulos creado en la primera fase. Finalmente, el objetivo de la tercera fase fue el de examinar las hipótesis relacionadas con la estructura conceptual de la complejidad visual: las hipótesis III.I, III.II, III.III.

Creación de un conjunto adecuado de estímulos

El someter a pruebas las hipótesis I.I, I.II y I.III requería un conjunto de estímulos que varíen en complejidad, y que incluyese estímulos abstractos y representacionales, artísticos y decorativos. Nuestro objetivo en esta primera fase era obtener 120 estímulos visuales divididos por igual en tres niveles de complejidad: baja, intermedia y alta. Cada uno de estos niveles debía incluir 10 estímulos abstractos artísticos (AA), 10 abstractos decorativos (AD), 10 representacionales artísticos (RA) y 10 representacionales decorativos (RD).

Los 240 participantes en esta fase fueron divididos en 8 grupos de 30 personas, intentando en lo posible equiparar cada uno en relación al sexo. El conjunto de 800 estímulos fue dividido en 8 conjuntos de 100, mediante un procedimiento aleatorio estratificado, tal que había 25 estímulos de cada tipo (AA, AD, RA, RD). Cada conjunto de estímulos se aleatorizó y presentó a los participantes de cada grupo en el mismo orden. Por tanto, se pidió a los participantes de cada grupo que puntuaran la complejidad de un conjunto distinto de 100 imágenes (25 AA, 25 AD, 25 RA, 25 RD) en una escala Likert de 9 puntos. Con la intención de no sesgar las respuestas de los participantes hacia un determinado aspecto de complejidad, el experimentador no dio ninguna definición explícita de complejidad a los participantes. Simplemente clarificó que estaba relacionado con las imágenes y su contenido, y no con lo difícil que parecía haberlas producido, y enfatizó que lo que se buscaba era la primera impresión subjetiva asociada a cada estímulo.

Los 8 grupos de participantes llevaron a cabo el procedimiento en distintos días a la misma hora de la mañana en una sala iluminada modestamente y bien aislada del ruido. Los 30 participantes de cada grupo se sentaron en ordenadores distintos y recibieron las instrucciones colectivamente por parte del experimentador, quien respondió a cualquier duda antes de empezar. La presentación de los estímulos y el registro de las respuestas fue completamente individual.

Una vez que los 8 grupos habían realizado esta tarea, se recogieron sus respuestas. Para cada uno de los 800 estímulos se calcularon dos estadísticos: el promedio de las puntuaciones otorgadas por los 30 participantes, y su desviación estándar. La primera medida fue considerada como la puntuación de complejidad de cada estímulo, mientras que la segunda se consideró como la medida de acuerdo de los participantes en cuanto a esa puntuación.

La selección de los estímulos para cada nivel de complejidad se basó en su puntuación de complejidad y la medida de acuerdo. Esta selección se realizó por separado para cada tipo de estímulo (AA, AD, RA, RD), de acuerdo con el procedimiento que se explica a continuación. Se ordenaron cada uno de los cuatro conjuntos de 200 imágenes de acuerdo a su puntuación de complejidad. Para la selección de los estímulos de baja complejidad el experimentador comenzó en la parte inferior de la lista (aquellos con la menor puntuación en complejidad). Si la desviación estándar estaba por debajo de 0,8 el estímulo fue seleccionado, mientras que si era 0,81 o mayor el estímulo fue descartado y la operación se realizó con el estímulo inmediatamente superior en puntuación de complejidad. Este procedimiento se llevó a cabo con cada uno de los cuatro tipos de estímulos hasta que se hubieron seleccionado 10 de cada. Para seleccionar los estímulos de alta complejidad se siguió el mismo procedimiento, excepto que se empezó en la parte superior de la lista y la selección se hizo en un sentido descendente. De nuevo, se finalizó cuando se tenían 10 estímulos de cada tipo. Para seleccionar los estímulos de complejidad intermedia se calculó la mediana de complejidad para cada tipo de estímulo, punto que sirvió al experimentador para iniciar su selección de estímulos, usando los mismos criterios que se han mencionado arriba, sólo que se alternó hacia arriba y hacia abajo en la lista para la selección o rechazo de los estímulos. Cuando se hubieron seleccionado 10 estímulos de cada tipo se dio por concluido el proceso de selección de los estímulos.

Se siguió este procedimiento con el objeto de maximizar las diferencias entre los niveles de complejidad y minimizar las diferencias en la complejidad de los estímulos de cada nivel. La elección de imágenes cuya puntuación de complejidad mostrara una baja desviación estándar tenía el fin de seleccionar sólo estímulos para los que la gente mostrara un elevado acuerdo en cuanto a su complejidad. Así, nuestra muestra de 120 estímulos para poner a prueba nuestras hipótesis estaba compuesta por estímulos que realmente pertenecieran a niveles distintos de complejidad, dentro de los cuales eran prácticamente indistinguibles en cuanto a esta característica. Es más, nos aseguramos un alto grado de acuerdo entre participantes en cuanto a esta distribución.

Preferencia estética

El objetivo de esta fase era poner a prueba las hipótesis I.I, I.II, I.III y II, tal y como se detallaron al final de la introducción. Estas hipótesis se refieren a la relación entre la complejidad y la preferencia estética, el grado de abstracción y la preferencia estética, la cualidad artística y la preferencia estética, y el sexo y la preferencia estética. Se pidió, pues, a los 94 participantes descritos arriba que puntuaran la belleza de los 120 estímulos seleccionados en la fase anterior en una escala Likert de 5 puntos. Los estímulos se aleatorizaron y se presentaron en el mismo orden a todos los participantes. Tomaron parte en esta fase al mismo tiempo en una sala moderadamente iluminada y aislada del ruido. Los participantes se sentaron delante de distintos ordenadores y escucharon las instrucciones colectivamente antes de empezar. Se dieron las siguientes instrucciones de forma escrita y oral:

> A continuación se presentará una serie de imágenes. Tu tarea consiste en puntuar, de acuerdo a tu propio criterio, la belleza de cada una de las imágenes. Por favor usa la siguiente escala de puntuación:
>
> 1: muy fea   2: fea   3: indiferente   4: bella   5: muy bella
>
> Por favor trata de utilizar el valor 3 lo menos posible. Si has entendido las instrucciones, puedes empezar la prueba.

A continuación el experimentador contestó a cualquier duda antes de empezar el procedimiento. La presentación de estímulos era individual, así como las respuestas de los participantes. Una vez que los participantes hubieron acabado su tarea, se recogieron las puntuaciones. Para cada estímulo se calculó el promedio de las puntuaciones dadas por los hombres y las puntuaciones dadas por las mujeres, las dos variables dependientes contempladas en el análisis de la varianza. Se tomaron en cuenta tres variables independientes: (i) Complejidad, ordinal con tres niveles (baja, intermedia, alta), (ii) Abstracción, nominal con dos niveles (abstractos, representacionales), (iii) Arte, nominal con dos niveles (artísticos, decorativos). Así, habían 120 casos (los estímulos), tres variables independientes (Complejidad, Abstracción, Arte) y dos variables dependientes (puntuaciones de belleza dadas por los hombres, puntuaciones de belleza dadas por las mujeres). Para evitar complicar en exceso el diseño experimental se decidió no incluir el sexo como una variable independiente, y llevar a cabo el procedimiento por separado para hombres y mujeres. Esto significaba que la prueba de la influencia de esta variable fue, sólo indirecta y exploratoria, puesto que nuestro diseño permitía únicamente determinar si la influencia de las variables independientes sobre las puntuaciones de hombres y mujeres era comparable. Ilustramos nuestro diseño experimental en el siguiente cuadro:

		Complejidad					
Abstracción	**Arte**	Baja		Intermedia		Alta	
Abstractos	Artísticos	*pbh*	*pbm*	*pbh*	*pbm*	*pbh*	*pbm*
	Decorativos	*pbh*	*pbm*	*pbh*	*pbm*	*pbh*	*pbm*
Representacionales	Artísticos	*pbh*	*pbm*	*pbh*	*pbm*	*pbh*	*pbm*
	Decorativos	*pbh*	*pbm*	*pbh*	*pbm*	*pbh*	*pbm*

pbh: puntuación en belleza hombres *pbm: puntuación belleza mujeres*

Dimensiones de la complejidad visual

El objetivo de esta tercera fase era poner a prueba las hipótesis III.I, III.II y III.III, enunciadas al final del apartado de introducción. Estas hipótesis se refieren a la influencia de diferentes rasgos de los estímulos visuales sobre los juicios de complejidad, las relaciones entre esos rasgos, y su relación con la preferencia estética. Para llevar a cabo estas pruebas se seleccionaron 60 de los estímulos utilizados en la fase anterior. Para cada una de las cuatro categorías de estímulos en cada nivel de complejidad se escogieron 5 imágenes. Se calculó para cada uno de los 12 subgrupos la mediana de complejidad. Se eligió el estímulo correspondiente a ese valor y los dos correspondientes a los dos valores siguientes, tanto por arriba como por abajo.

Basándonos en nuestra revisión de la literatura sobre complejidad visual y su influencia sobre la preferencia estética, seleccionamos siete dimensiones de complejidad que creímos relacionadas con rasgos distintos de la complejidad visual. Estas dimensiones eran:

Dimensión 1: Ininteligibilidad de los elementos. Dificultad con la que se identifican los elementos

Dimensión 2: Desorganización. Dificultad con la que los elementos forman una escena coherente

Dimensión 3: Cantidad de elementos. Cuantía de elementos

Dimensión 4: Variedad de elementos. Heterogeneidad de los elementos

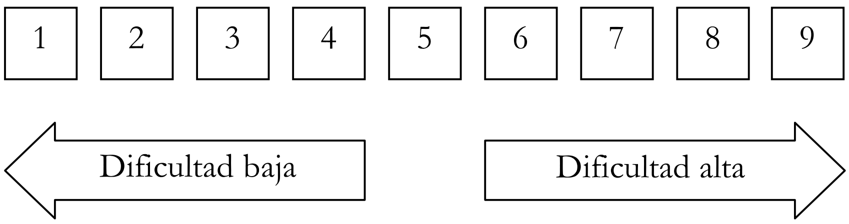
Dimensión 5: Asimetría. Desequilibrio de la imagen.

Dimensión 6: Diversidad de colores. Heterogeneidad de los colores presentes en la imagen.

Dimensión 7: Apariencia de tridimensionalidad. Aspecto tridimensional de la imagen.

En esta tercera y última fase participaron las mismas 94 personas que en la fase anterior. En este caso se les pidió que puntuaran cada estímulo sobre una escala Likert de 9 puntos cada una de las dimensiones detalladas arriba. Todos los estímulos del subconjunto de 60 fueron puntuados separadamente en cada escala y presentados en un orden aleatorio distinto cada vez. Antes de puntuar los estímulos en cada dimensión concreta, los participantes recibieron instrucciones escritas y habladas. A continuación se presenta un ejemplo de las instrucciones dadas antes de que los participantes puntuaran la primera dimensión (en cursiva aparece la parte de las instrucciones que varió de una escala a otra):

> A continuación se presentarán una serie de imágenes. Tu tarea consiste en puntuar, de acuerdo con **tu propio criterio**, *la dificultad con la que se identifican los elementos representados en cada una de las imágenes.* Realiza tu valoración de acuerdo a la siguiente escala:



> Procura utilizar la valoración 5 lo menos posible. Si has entendido las instrucciones, puedes empezar la prueba.

Al igual que en la fase anterior, los participantes que tomaron parte en este procedimiento lo hicieron al mismo tiempo en una sala iluminada moderadamente y aislada del ruido. Se sentaron frente a ordenadores distintos, la presentación de estímulos y las respuestas eran individuales, pero recibieron las instrucciones colectivamente antes de empezar. Aunque no había límite de tiempo para responder, el experimentador animó a los participantes a responder basándose en su primera impresión subjetiva de cada estímulo. Las imágenes se presentaron dentro de un marco gris, en cuyo segmento superior aparecía un breve recordatorio de la tarea que debían realizar, y en el inferior la escala que debían utilizar para puntuar.

Después de que los participantes acabaran sus tareas, se recogieron las puntuaciones que habían dado. Para cada estímulo se calculó el promedio de las puntuaciones dadas por hombres y mujeres, por separado, en cada una de las siete dimensiones. Así, se recogieron 14 variables dependientes: las puntuaciones de los hombres en la dimensión 1, las puntuaciones de las mujeres en la dimensión 1, las puntuaciones de los hombres en la dimensión 2, las puntuaciones de las mujeres en la dimensión 2, y así sucesivamente para las 7 dimensiones.

Estas variables se usaron de formas diversas para poner a prueba las hipótesis III.I (referida a la importancia de cada dimensión sobre las puntuaciones generales de complejidad), III.II (referida a la relación entre las dimensiones) y III.III (referente a la relación entre las dimensiones de complejidad y las puntuaciones de belleza).

Para poner a prueba la hipótesis III.I se llevaron a cabo varios análisis discriminantes. Esta técnica permite averiguar cuál o cuáles de entre una serie de variables cuantitativas predicen los valores de una variable ordinal con la mayor precisión. En este caso, esta variable ordinal era el nivel de complejidad (bajo, intermedio, alto) y las predictoras eran las siete dimensiones de complejidad. Se llevó a cabo el estudio referido al subconjunto de 60 imágenes y además para cada tipo de estímulo (AA, AD, RA, RD) por separado. Esto se hizo usando primero las puntuaciones otorgadas por hombres y luego por las otorgadas por las mujeres. En cada caso, el nivel de complejidad de cada estímulo se usó como la variable agrupadora, y las puntuaciones de hombres o mujeres en cada una de las dimensiones de complejidad se usaron como variables independientes.

Para poner a prueba la hipótesis III.II se llevaron a cabo dos análisis factoriales. Este procedimiento permite la simplificación de las relaciones entre variables al identificar factores subyacentes que explican la mayor cantidad posible de información original. El análisis factorial tiene la ventaja sobre otros procedimientos de reducción de datos que produce un número pequeño de factores fácilmente interpretables. Se llevaron a cabo análisis separados para las puntuaciones de hombres y mujeres en las siete dimensiones de complejidad.

Finalmente, se desarrolló una evaluación inicial y exploratoria de la hipótesis III.III mediante una serie de pruebas de ajuste de curvas. Tomamos cada una de las siete dimensiones de complejidad por separado como variables independientes y las puntuaciones de belleza recogidas en la fase anterior como la variable dependiente. Se evaluó el ajuste de funciones lineales, cuadráticas y cúbicas para las puntuaciones otorgadas por los hombres y las mujeres por separado.

3. Resultados

Creación de los tres niveles de complejidad

El objetivo de esta primera parte de este estudio era crear un conjunto de estímulos con tres niveles de complejidad que puedan ser usados para evaluar los efectos de la complejidad sobre la preferencia estética, así como clarificar cuáles son los rasgos principales que determinan las puntuaciones generales de complejidad y las relaciones entre ellos y con la preferencia estética.

El resultado de la selección de 120 estímulos de entre los 800 iniciales, tal y como se describió arriba produjo la distribución de imágenes resumida en la tabla 9.1:

Nivel de complejidad	Artísticos				Decorativos			
	Estilo	**n**	**m**	**s**	**Estilo**	**n**	**m**	**s**
Alta	**A**	10	4,66	0,15	**A**	10	2,98	0,44
	R	10	4,37	0,16	**R**	10	3,75	0,19
Intermedia	**A**	10	3,47	0,06	**A**	10	2,09	0,04
	R	10	3,49	0,03	**R**	10	2,52	0,15
Baja	**A**	10	2,48	0,20	**A**	10	1,19	0,03
	R	10	2,68	0,12	**R**	10	1,40	0,08

Tabla 9.1. Composición de los grupos de complejidad

Las dos fases siguientes requerían que hubiera diferencias reales entre las diferentes clases de estímulos pertenecientes a los tres niveles en cuanto a su complejidad. Para verificar el cumplimiento de este requisito se realizaron una serie de pruebas de Kruskal-Wallis[2]. Como muestra la tabla 9.2, en la que se presentan los resultados de estas pruebas, existen diferencias significativas entre las puntuaciones de complejidad de los estímulos incluidos en los tres niveles. Esto es así para todas las clases de estímulos (AA, AD, RA, RD) como para las agrupaciones en abstractos, representacionales, artísticos, decorativos, como para todas las clases tomadas conjuntamente.

[2] Se optó por la vía no paramétrica al no cumplirse los supuestos de aplicación de las pruebas paramétricas. Véase la sección 3.1 de la versión inglesa para más detalles.

Estímulos	Rango medio de los niveles de complejidad			χ^2	g.l.	*p*
	Baja	Interm	alta			
AA	5,50	15,50	25,50	25,94	2	< ,001
AD	5,50	15,50	25,50	25,97	2	< ,001
RA	5,50	15,50	25,50	26,02	2	< ,001
RD	5,50	15,50	25,50	25,88	2	< ,001
Abstractos	16,17	29,50	45,83	28,97	2	< ,001
Representacionales	14,80	26,83	49,88	41,76	2	< ,001
Artísticos	10,50	30,50	50,50	52,78	2	< ,001
Decorativos	10,50	30,83	50,17	51,67	2	< ,001
Todos	29,56	57,13	94,81	71,02	2	< ,001

Tabla 9.2. Resultados de las pruebas Kruskal-Wallis de diferencias entre niveles de complejidad para cada tipo de estímulos

De cara a determinar si las diferencias detectadas mediante las pruebas anteriores se producían entre los niveles de complejidad bajo e intermedio, intermedio y alto, así como bajo y alto, se llevaron a cabo una serie de contrastes mediante la prueba U de Mann-Whitney. Los resultados de estos contrastes se muestran en la tabla 9.3. Como se ve, para todos los tipos de estímulos y todas las combinaciones, aparecen diferencias significativas de complejidad entre los estímulos incluidos en los niveles de complejidad baja e intermedia, entre los estímulos incluidos en los niveles de complejidad intermedia y alta, así como entre los estímulos de complejidad baja y alta. Podemos concluir, por tanto, que los objetivos de la primera fase están cumplidos con los estímulos seleccionados[3].

---

[3] Las reproducciones de cada uno de estos 120 estímulos, así como su puntuación de complejidad y las puntuaciones de belleza otorgadas por hombres y mujeres pueden hallarse en el anexo A.

Estímulos	Contrastes			Z	*p*
		Rm1	Rm2		
AA	1-2	5,5	15,5	3,811	< 0,001
	1-3	5,5	15,5	3,782	< 0,001
	2-3	5,5	15,5	3,811	< 0,001
AD	1-2	5,5	15,5	3,820	< 0,001
	1-3	5,5	15,5	3,800	< 0,001
	2-3	5,5	15,5	3,803	< 0,001
RA	1-2	5,5	15,5	3,832	< 0,001
	1-3	5,5	15,5	3,788	< 0,001
	2-3	5,5	15,5	3,823	< 0,001
RD	1-2	5,5	15,5	3,795	< 0,001
	1-3	5,5	15,5	3,791	< 0,001
	2-3	5,5	15,5	3,790	< 0,001
Abstractos	1-2	15,5	25,5	2,711	0,006
	1-3	11,18	29,83	5,049	<0,001
	2-3	14,5	26,5	3,252	< 0,001
Representacionales	1-2	14,8	26,2	3,093	0,002
	1-3	10,5	30,5	5,414	< 0,001
	2-3	11,13	29,88	5,084	< 0,001
Artísticos	1-2	10,5	30,5	5,465	< 0,001
	1-3	10,5	30,5	5,413	< 0,001
	2-3	10,5	30,5	5,464	< 0,001

Decorativos	1-2	10,5	30,5	5,421	< 0,001
	1-3	10,5	30,5	5,416	< 0,001
	2-3	10,82	30,17	5,240	< 0,001
Todos	1-2	28,63	52,38	4,578	< 0,001
	1-3	21,44	59,56	7,339	< 0,001
	2-3	25,25	55,75	5,879	< 0,001

Tabla 9.3. Resultados de los contrastes entre niveles de complejidad para cada tipo de estímulo. Rm1 y Rm2 se refieren al rango medio del miembro primero y segundo de cada pareja.

Influencia de las variables independientes sobre la preferencia estética

En la tabla 9.4 se presentan los estadísticos descriptivos de las puntuaciones de preferencia estética otorgadas por los participantes varones a cada tipo de estímulo en los tres niveles de complejidad.

Complejidad	Abstracción	Arte	n	m	s	Max	Min	Rng
Baja	**Abs**	**A**	10	2,64	0,61	3,89	1,86	2,03
		D	10	1,80	0,22	2,21	1,42	0,79
	Rep	**A**	10	3,45	0,46	3,95	2,41	1,54
		D	10	2,14	0,46	2,92	1,51	1,41
Intermedia	**Abs**	**A**	10	2,71	0,44	3,39	2,17	1,22
		D	10	1,19	0,40	2,78	1,53	1,25

	Rep	**A**	10	3,58	0,59	4,49	2,67	1,82
		D	10	2,82	0,70	3,93	1,72	2,21
Alta	**Abs**	**A**	10	3,01	0,41	3,84	2,58	1,26
		D	10	1,78	0,13	1,89	1,51	0,38
	Rep	**A**	10	3,62	0,61	4,49	2,87	1,62
		D	10	3,66	0,57	4,30	2,53	1,77

Tabla 9.4. Estadísticos descriptivos de las puntuaciones otorgadas por los hombres a cada tipo de estímulo en los tres niveles de complejidad (Abs: Abstractos, Rep: Representacionales, A: Artísticos, D: Decorativos)

En la tabla 9.5 se presentan los estadísticos descriptivos de las puntuaciones de preferencia estética otorgadas por las mujeres a cada tipo de estímulo en los tres niveles de complejidad.

Complejidad	Abstracción	Arte	n	m	s	Max	Min	Rng
Baja	**Abs**	**A**	10	2,72	0,45	3,46	2,18	1,28
		D	10	1,87	0,25	2,29	1,41	,88
	Rep	**A**	10	3,37	0,42	3,86	2,43	1,43
		D	10	2,08	0,59	3,09	1,36	1,73
Intermedia	**Abs**	**A**	10	2,81	0,48	3,52	2,29	1,23
		D	10	2,16	0,55	3,38	1,52	1,86
	Rep	**A**	10	3,41	0,53	4,34	2,52	1,82
		D	10	2,68	0,77	3,64	1,50	2,14
Alta	**Abs**	**A**	10	2,90	0,54	3,79	2,27	1,52

		D	10	2,29	0,47	3,09	1,55	1,54
	Rep	**A**	10	3,47	0,55	4,32	2,64	1,68
		D	10	3,47	0,60	4,25	2,29	1,96

Tabla 9.5. Estadísticos descriptivos de las puntuaciones otorgadas por las mujeres a cada tipo de estímulo en los tres niveles de complejidad (Abs: Abstractos, Rep: Representacionales, A: Artísticos, D: Decorativos)

El estudio de la normalidad y de la homogeneidad de la varianza mostró que no se puede asumir el cumplimiento ninguno de estos dos supuestos del análisis de la varianza[4]. Por tanto, se optó por realizar el estudio de la influencia de las variables independientes (Complejidad, Abstracción, Arte) sobre las dependientes (preferencia estética de hombres, preferencia estética de mujeres) mediante pruebas no paramétricas. A continuación se presentan los resultados de estas pruebas para los efectos principales y, después, para las interacciones[5].

Estudio de efectos principales

Complejidad

Llevamos a cabo una prueba de Kruskal-Wallis para estudiar la influencia de la variable Complejidad sobre las puntuaciones de belleza otorgadas por hombres y mujeres a los 120 estímulos. Los resultados indican que la complejidad tiene un efecto significativo sobre las puntuaciones de belleza que dieron tanto hombres ($\chi 2$ = 8,962, $p<0,05$) como mujeres ($\chi 2$ = 8,939, $p<0,05$). Para determinar los niveles entre los que aparecen estas diferencias se llevaron a cabo

[4] Los resultados de estas pruebas pueden consultarse en las secciones 3.2.2 y 3.2.3 de la versión inglesa de este estudio.

[5] Una presentación más detallada de estos resultados puede encontrarse en la sección 3.2.3 del presente estudio.

una serie de contrastes por medio de pruebas no paramétricas de Mann-Whitney. La corrección de la significación para comparaciones múltiples sitúa el nivel en

$$\alpha = \frac{0,05}{6} = 0,0083$$

Los resultados de estos contrastes mostraron que no había diferencias significativas entre las puntuaciones de belleza dadas a estímulos de complejidad baja e intermedia, tanto en el caso de los hombres (Z = 1,448, *ns*) como el de las mujeres (Z = 1,574, *ns*). Tampoco aparecieron diferencias significativas entre las puntuaciones dadas a estímulos de complejidad intermedia y alta (Z = 1,795, *ns*; Z= 1,516, *ns*; para hombres y mujeres respectivamente). En cambio, las diferencias entre las puntuaciones de belleza dadas a estímulos de baja y alta complejidad sí resultaron ser significativas, tanto para hombres (Z = 2,859, $p<0,0083$) como para mujeres (Z = 2,930, $p<0,0083$). En ambos casos los participantes prefirieron los estímulos de alta complejidad por encima de los estímulos de complejidad baja.

Abstracción

Llevamos a cabo una prueba de Mann-Whitney para estudiar la influencia de la variable Abstracción sobre las puntuaciones de belleza otorgadas por hombres y mujeres a los 120 estímulos. Los resultados indican que las puntuaciones de belleza recibidas por los estímulos representacionales eran significativamente mayores que las recibidas por los estímulos abstractos, tanto en el caso de los hombres (Z = 5,658, $p<0,001$) como de las mujeres (Z = 4,646, $p<0,001$).

Arte

Llevamos a cabo una prueba de Mann-Whitney para estudiar la influencia de la variable Arte sobre las puntuaciones de belleza otorgadas por hombres y mujeres a los 120 estímulos. Los resultados indican que las puntuaciones de belleza recibidas por los estímulos artísticos eran significativamente mayores que las recibidas por los estímulos decorativos, tanto en el caso de los hombres (Z = 5,381, $p<0,001$) como de las mujeres (Z = 5,160, $p<0,001$).

Estudio de las interacciones

Dado que aparecieron interacciones triples, no comentaremos aquí los resultados relacionados con las interacciones dobles, aunque estos resultados figuran en el anexo C. Por tanto, nos concentraremos aquí en los resultados referidos a las interacciones triples, específicamente a los efectos de la complejidad dentro de cada nivel de Abstracción x Arte. Dado que esta fase del trabajo tiene como principal interés el de estudiar los efectos de la complejidad para cada tipo de estímulos, no comentaremos el resto de interacciones triples, que quedan recogidas en el anexo D. En la tabla 9.6 se presentan, de forma resumida, los resultados de nuestro análisis de las interacciones triples.

		χ2 Kruskal-Wallis		**Significación**	
		Hombres	**Mujeres**	**Hombres**	**Mujeres**
Abstractos	**Artísticos**	4,257	0,795	*ns*	*ns*
	Decorativos	0,254	4,611	*ns*	*ns*
Representacionales	**Artísticos**	0,214	0,051	*ns*	*ns*
	Decorativos	16,235	13,194	$p<0,001$	$p<0,001$

Tabla 9.6. Resultado del análisis de las interacciones triples.
Corrección por comparaciones múltiples: $\alpha = \frac{0,05}{12} = 0,0042$

Por tanto, nuestros resultados sugieren que la complejidad influye sobre la preferencia estética únicamente de estímulos representacionales decorativos, tanto en el caso de los hombres como en el de las mujeres ($p<0,001$). Con la finalidad de determinar los niveles entre los que se producían estas diferencias llevamos a cabo una serie de contrastes entre las puntuaciones dadas a estímulos representacionales decorativos pertenecientes a los tres niveles de complejidad mediante pruebas de Mann-Whitney. Como se puede apreciar en la tabla 9.7, tanto para los hombres como para las mujeres, las puntuaciones otorgadas a los estímulos representacionales decorativos de alta complejidad son significativamente mayores que las dadas a los estímulos de la misma clase de baja complejidad (p<0,001).

Estímulos representacionales decorativos	**Niveles de complejidad contrastados (Mann-Whitney)**					
	Baja-intermedia		**Intermedia-alta**		**Baja-alta**	
	Z	p	Z	p	Z	p
Hombres	1,816	*ns*	2,307	*ns*	3,326	<0,001
Mujeres	2,155	*ns*	2,419	*ns*	2,704	<0,001

Tabla 9.7. Contraste entre las puntuaciones dadas a los estímulos representacionales decorativos en los tres niveles de complejidad por hombres y mujeres. Corrección por comparaciones múltiples: $\alpha = \frac{0,05}{6} = 0,0083$

Resumen

En análisis de efectos principales reveló que las tres variables independientes tenían una influencia significativa sobre las puntuaciones de belleza otorgadas por los hombres y las mujeres. Específicamente, los estímulos de alta complejidad recibieron puntuaciones más altas que los estímulos de baja complejidad (p<0,001), los estímulos representacionales recibieron mayores puntuaciones de belleza que los estímulos abstractos (p<0,001), y los estímulos artísticos fueron valorados como más bellos que los decorativos (p<0,001). Sin embargo, el estudio de las interacciones sugiere que estos resultados se pueden explicar por las puntuaciones dadas a un único tipo de estímulos. En concreto, los estímulos representacionales decorativos de alta complejidad fueron puntuados como más bellos que los estímulos representacionales decorativos de baja complejidad (p<0,001), tanto por los hombres como por las mujeres.

El concepto de complejidad visual

En esta sección se presentan los resultados relacionados con el concepto de complejidad visual. Específicamente, hemos desglosado este concepto en una serie de dimensiones más operativas para tratas las siguientes cuestiones: (i) ¿cuáles de estas dimensiones son las mejores predoctoras de las puntuaciones generales de complejidad para cada tipo de estímulo?, (ii) ¿cómo están relacionadas entre ellas estas dimensiones?, (iii) ¿cómo se relacionan estas dimensiones con las puntuaciones de belleza otorgadas en la fase anterior? Para explorar estas cuestiones, recordemos, habíamos seleccionado 60 de los 120 estímulos utilizados en la sección anterior, tal y como se ha descrito arriba.

Relevancia de las dimensiones de complejidad

La primera de las cuestiones planteadas en relación con el concepto de complejidad se refiere a la posibilidad de que los hombres y las mujeres se fijen en aspectos distintos a la hora de juzgar la complejidad de diferentes tipos de estímulos visuales. Para estudiar esta cuestión hemos realizado una serie de análisis discriminantes, que permiten determinar cuál o cuáles, de entre una serie de variables independientes, predicen mejor la pertenencia de un estímulo a una de varias posibles categorías. En nuestro caso, estamos interesados por averiguar si las puntuaciones otorgadas por hombres y mujeres en alguna de las 7 dimensiones de complejidad pueden usarse para predecir el nivel de complejidad (bajo, intermedio, alto) al que pertenecen diversos tipos de estímulos (AA, AD, RA, RD). En la tabla 9.8 se presenta un resumen de estos resultados[6]:

Estímulos	**Grupo**	**DP**	**VE(%)**	**CC (%)**	**Kappa**
Todos	Hombres	3 y 4	97	68,3	0,525*
	Mujeres	3 y 6	99,8	76,7	0,650*
Abstractos artísticos	Hombres	4	100	100	1*
	Mujeres	1 y 3	98,6	93,3	0,90*
Abstractos decorativos	Hombres	3	100	80	0,70*
	Mujeres	3	100	80	0,70*
Representacionales artísticos	Hombres	2, 3, 4 y 5	89,9	100	1*
	Mujeres	3 y 5	98	86,7	0,80*
Representacionales decorativos	Hombres	3	100	100	1*
	Mujeres	3 y 5	99,5	100	1*

Tabla 9.8. Resumen de los análisis discriminantes **p<0,001*

DP: Dimensiones con valor predictivo
VE: Varianza explicada
CC: Clasificación correcta
Kappa: Acuerdo entre los niveles predicho y real

Dimensión 1: Ininteligibilidad de los elementos
Dimensión 2: Desorganización
Dimensión 3: Cantidad de elementos
Dimensión 4: Variedad de elementos
Dimensión 5: Asimetría
Dimensión 6: Variedad de colores
Dimensión 7: Apariencia tridimensional

[6] Para una información más detallada sobre estos resultados puede consultarse la sección 3.3.1 de la versión en inglés de este trabajo.

Estos resultados indican que las puntuaciones que otorgaron los hombres al conjunto de 60 estímulos en las dimensiones 3 y 4 (cantidad de elementos y variedad de elementos) pueden usarse para predecir el nivel de complejidad al que pertenece cada uno de los estímulos. En el caso de las mujeres las dimensiones predictivas son la 3 y la 6 (cantidad de elementos y variedad de colores). También indican, sin embargo, que para estímulos diversos (AA, AD, RA, RD), las variables predictoras son distintas, y que el sexo juega un papel importante.

Relaciones entre las dimensiones de complejidad

En esta sección se presentan los resultados referidos la hipótesis III.II, en la que se planteaban las relaciones entre las dimensiones de complejidad. Para ello nos hemos servido del análisis factorial a través del método de componentes factoriales para estimar el modelo factorial. Además, para facilitar la interpretación de los factores resultantes hemos aplicado una rotación de factores Varimax. Este paso adicional refuerza las correlaciones entre las variables originales incluidas en cada factor y debilita aquellas entre variables incluidas en factores distintos. Hemos seguido el mismo procedimiento por separado para las puntuaciones dadas por hombres y mujeres en las 7 dimensiones de complejidad a los 60 estímulos, seleccionados de entre el conjunto original de 120, como se explicó más arriba.

Para determinar el número de factores a extraer seguimos el procedimiento conocido como el test de sedimentación. De acuerdo con este procedimiento, se deben extraer todos los factores con valores propios situados en la parte pronunciada de la pendiente de la gráfica de sedimentación, antes de que empiece a reducirse la pendiente. Tanto en el caso de los hombres como el de las mujeres este procedimiento recomienda la extracción de tres factores (véase figura 9.3). A pesar de que en ambos casos el tercer valor propio está por debajo de 1 (0,975) se decidió mantener el criterio recomendado por el test de sedimentación, dado que en un estudio preliminar se reveló que la dimensión de complejidad 5, asimetría, únicamente saturaba de forma satisfactoria en este tercer factor. Creemos que esta decisión queda justificada por el relevante papel que ha jugado la asimetría en el estudio de la relación entre complejidad y preferencia estética, así como el hecho de que los valores propios de los siguientes cuatro factores eran muy inferiores a 1.

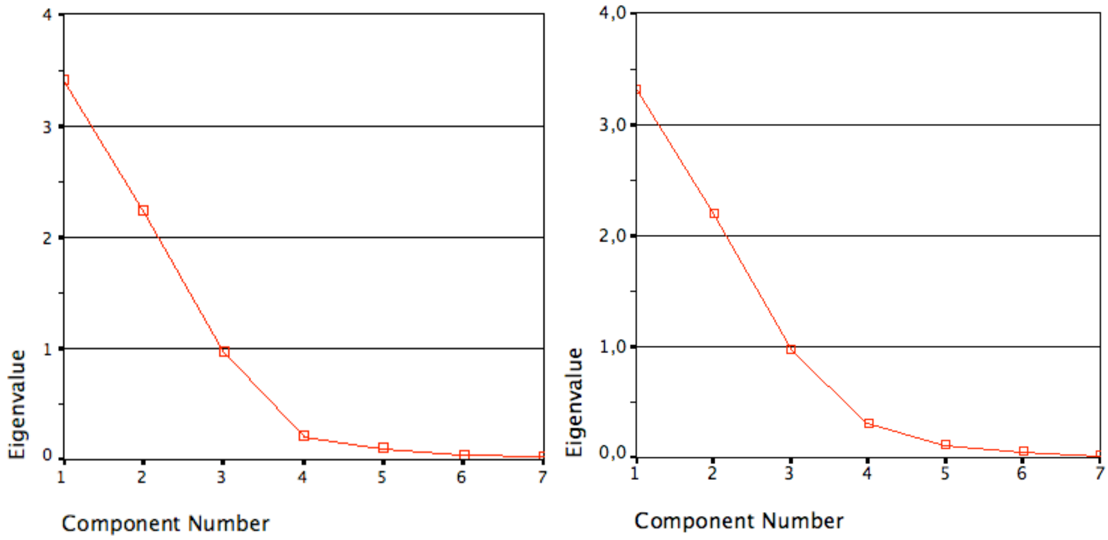


Figura 9.3. Gráficos de sedimentación para los valores propios de los 7 factores iniciales extraídos de las puntuaciones en las 7 dimensiones de complejidad otorgados por hombres (izquierda) y mujeres (derecha).

Así pues, en esta sección presentamos los resultados del análisis factorial de las puntuaciones otorgadas por hombres y mujeres a las 7 dimensiones de complejidad mediante componentes principales incluyendo una rotación ortogonal Varimax y extrayendo tres factores[7].

Análisis factorial de las puntuaciones dadas por los hombres

En la tabla 9.9 aparecen los resultados del análisis factorial de las puntuaciones dadas por los hombres a los 60 estímulos en las 7 dimensiones de

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[7] Las medidas de adecuación de los datos al procedimiento de análisis factorial para hombres y mujeres se presentan en las secciones 3.3.2.1 y 3.3.2.2, respectivamente, de la versión inglesa de este estudio.

complejidad. Como se ve, los dos primeros componentes explicaron más del 48% y del 31% de la varianza, respectivamente. De forma acumulada explicaron algo más del 80%, mientras que el tercer componente explica cerca del 14%, con lo que el modelo completo explica más del 94% de la varianza.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3,407	48,669	48,669	3,407	48,669	48,669	3,383	48,329	48,329
2	2,230	31,854	80,523	2,230	31,854	80,523	2,218	31,687	80,016
3	,975	13,924	94,447	,975	13,924	94,447	1,010	14,431	94,447
4	,212	3,032	97,480						
5	,107	1,525	99,004						
6	4,037E-02	,577	99,581						
7	2,932E-02	,419	100,000						

Extraction Method: Principal Component Analysis.

Tabla 9.9. Componentes extraídos y varianza explicada

Las comunalidades, presentadas en la tabla 9.10, informan sobre el grado con el que las variables originales, las 7 dimensiones de complejidad, están bien representadas por los factores extraídos. Es decir, el grado con el que su varianza es reproducida por los factores comunes. En el caso de las puntuaciones dadas por los hombres en las siete dimensiones de complejidad, todas los resultados son muy positivos, con valores superiores al 95%, excepto las dimensiones 6 (90.6%) y 7 (84.9%). Por tanto, en general, la varianza de las puntuaciones de los hombres en las siete dimensiones de complejidad se reproduce bien por los factores comunes.

	Initial	Extraction
Dimension 1 men	1,000	,975
Dimension 2 men	1,000	,972
Dimension 3 men	1,000	,958
Dimension 4 men	1,000	,952
Dimension 5 men	1,000	,999
Dimension 6 men	1,000	,906
Dimension 7 men	1,000	,849

Extraction Method: Principal Component Analysis.

Tabla 9.10 Comunalidades para las puntuaciones dadas por los hombres en las 7 dimensiones de complejidad

En la tabla 9.11 se muestran la matriz de componentes y la matriz de componentes rotada. Tras la rotación se hizo muy patente que el primer factor recibía saturaciones de las dimensiones 3, 4, 6, y en menor grado de la 7, mientras que la saturación del resto de dimensiones era despreciable. El segundo factor recibió saturaciones positivas de las dimensiones 1 y 2. La dimensión 3 resultó tener una saturación positiva muy baja en este factor, y la dimensión 7 una saturación moderada negativa. Finalmente, la única dimensión de complejidad que saturaba en el tercer factor era la 5, mientras que la saturación del resto de dimensiones era despreciable.

	Component		
	1	2	3
Dimension 1 men	-1,600E-02	,985	6,139E-02
Dimension 2 men	-,166	,966	,111
Dimension 3 men	,928	,310	1,768E-02
Dimension 4 men	,953	,189	8,536E-02
Dimension 5 men	-8,463E-02	-,223	,970
Dimension 6 men	,949	6,298E-03	6,588E-02
Dimension 7 men	,837	-,380	-7,031E-02

Extraction Method: Principal Component Analysis.
a. 3 components extracted.

	Component		
	1	2	3
Dimension 1 men	8,669E-02	,980	-8,588E-02
Dimension 2 men	-6,016E-02	,984	-2,550E-02
Dimension 3 men	,953	,207	-8,013E-02
Dimension 4 men	,971	9,468E-02	3,359E-03
Dimension 5 men	-3,781E-02	-7,172E-02	,996
Dimension 6 men	,948	-8,786E-02	1,174E-02
Dimension 7 men	,788	-,475	-5,871E-02

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 4 iterations.

Tabla 9.11 Matriz de componentes (izquierda) y matriz de componentes rotada (derecha)

La tabla 9.12 presenta la matriz de coeficientes, confirmando los resultados que acabamos de mencionar. Los coeficientes de las dimensiones 3, 4, 6, y 7 (cantidad de elementos, variedad de elementos, variedad de colores, apariencia tridimensional) para el factor 1 son altos. Las dimensiones 1 y 2 (ininteligibilidad de los elementos y desorganización) tienen altos coeficientes en el segundo factor. La dimensión 7 tiene también un pequeño coeficiente negativo en este segundo factor. Finalmente, la dimensión 5 (asimetría) tiene el único coeficiente alto para el tercer factor.

	Component		
	1	2	3
Dimension 1 men	,044	,444	-,004
Dimension 2 men	,003	,448	,051
Dimension 3 men	,286	,110	-,018
Dimension 4 men	,292	,066	,058
Dimension 5 men	,036	,047	,999
Dimension 6 men	,282	-,018	,051
Dimension 7 men	,222	-,205	-,059

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Tabla 9.12. Matriz de coeficientes

Análisis factorial de las puntuaciones dadas por las mujeres

Los resultados del análisis factorial de las puntuaciones dadas por las mujeres a las siete dimensiones de complejidad aparecen en la tabla 9.13. Los dos primeros componentes explicaron más del 47% y del 31% de la varianza, respectivamente. Así, ambos explican algo más del 78% de la varianza. El tercer componente explica cerca del 14%, lo que hace un total de 92% de la varianza explicada por los tres factores.

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3,315	47,351	47,351	3,315	47,351	47,351	3,290	47,005	47,005
2	2,200	31,426	78,776	2,200	31,426	78,776	2,182	31,168	78,172
3	,975	13,934	92,710	,975	13,934	92,710	1,018	14,538	92,710
4	,314	4,479	97,190						
5	,116	1,652	98,842						
6	5,824E-02	,832	99,674						
7	2,283E-02	,326	100,000						

Extraction Method: Principal Component Analysis.

Tabla 9.13. Componentes extraídos y varianza explicada

En cuanto a las comunalidades, en el caso de las puntuaciones de las mujeres en las 7 dimensiones de complejidad, la mayoría de los resultados son muy positivos, con valores superiores al 95%. Por debajo de este umbral encontramos las dimensiones 4 (93.2%), 6 (87.1%) y 7 (78.9%). Por tanto, en general, podemos decir que la varianza de las puntuaciones otorgadas por las mujeres en las siete dimensiones de complejidad, es reproducida aceptablemente por los factores comunes (ver tabla 9.14).

	Initial	Extraction
Dimension 1 women	1,000	,973
Dimension 2 women	1,000	,978
Dimension 3 women	1,000	,951
Dimension 4 women	1,000	,932
Dimension 5 women	1,000	,995
Dimension 6 women	1,000	,871
Dimension 7 women	1,000	,789

Extraction Method: Principal Component Analysis.

Tabla 9.14 Comunalidades para las puntuaciones dadas por las mujeres en las 7 dimensiones de complejidad

En la tabla 9.15 se muestran la matriz de componentes y la matriz de componentes rotada. Al igual que en el caso de los hombres, tras la rotación se hizo muy patente que el primero de ellos recibía saturaciones de las dimensiones 3, 4, 6, y en menor grado de la 7, mientras que la saturación del resto de dimensiones era despreciable. El segundo factor recibió saturaciones positivas de las dimensiones 1 y 2. La dimensión 3 resultó tener una saturación positiva muy baja en este factor, y la dimensión 7 una saturación moderada negativa. Finalmente, la única dimensión de complejidad que saturaba en el tercer factor era la 5, mientras que la saturación del resto de dimensiones era despreciable.

	Component		
	1	2	3
Dimension 1 women	,185	,965	8,872E-02
Dimension 2 women	7,847E-02	,982	8,561E-02
Dimension 3 women	,962	,161	1,084E-03
Dimension 4 women	,956	2,485E-02	,136
Dimension 5 women	-,140	-,222	,962
Dimension 6 women	,922	-,128	6,513E-02
Dimension 7 women	,752	-,461	-,106

Extraction Method: Principal Component Analysis.
a. 3 components extracted.

	Component		
	1	2	3
Dimension 1 women	8,947E-02	,980	-6,549E-02
Dimension 2 women	-1,785E-02	,987	-6,183E-02
Dimension 3 women	,938	,247	-,105
Dimension 4 women	,955	,133	4,745E-02
Dimension 5 women	-4,603E-02	-8,705E-02	,993
Dimension 6 women	,933	-3,157E-02	2,453E-03
Dimension 7 women	,786	-,400	-,104

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 3 iterations.

Tabla 9.15 Matriz de componentes (izquierda) y matriz de componentes rotada (derecha)

La tabla 9.16 presenta la matriz de coeficientes, que, de nuevo, al igual que en el caso de los hombres, muestra que los coeficientes de las dimensiones 3, 4, 6, y 7 (cantidad de elementos, variedad de elementos, variedad de colores, apariencia tridimensional) para el factor 1 son altos. Las dimensiones 1 y 2 (ininteligibilidad de los elementos y desorganización) tienen altos coeficientes en el segundo factor. La dimensión 7 tiene también un pequeño coeficiente negativo en este segundo factor. Finalmente, la dimensión 5 (asimetría) tiene el único coeficiente alto para el tercer factor.

	Component		
	1	2	3
Dimension 1 women	,016	,450	,023
Dimension 2 women	-,016	,455	,021
Dimension 3 women	,280	,099	-,034
Dimension 4 women	,295	,059	,111
Dimension 5 women	,040	,045	,991
Dimension 6 women	,287	-,022	,050
Dimension 7 women	,239	-,202	-,097

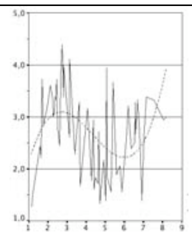
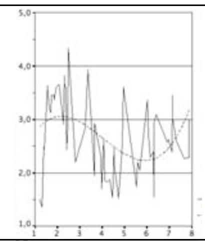
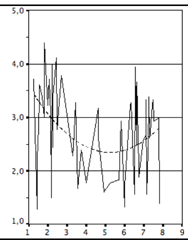
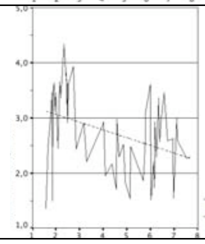
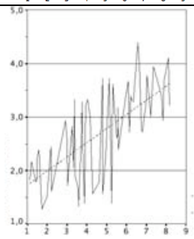
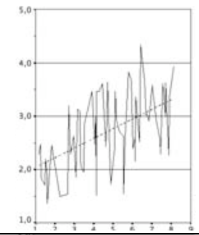
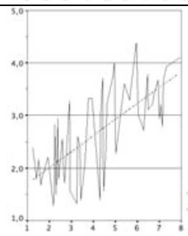
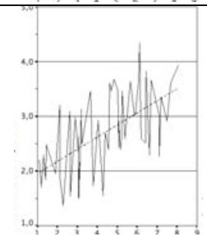
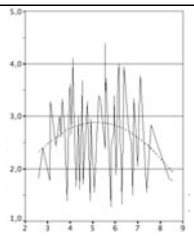
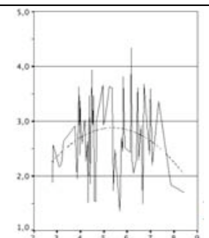
Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Tabla 9.16. Matriz de coeficientes

Estudio exploratorio de la relación entre las dimensiones de complejidad y la preferencia estética

En la introducción sugerimos que un posible motivo para la falta de acuerdo entre los estudios que exploraron la relación entre la complejidad y la preferencia estética era el uso de distintos conceptos y mediciones de complejidad. Aunque el presente estudio no fue diseñado para tratar este tema de forma experimental, sino solo de forma exploratoria, podría darse el caso de que los siete factores de complejidad que hemos considerado tengan distintos efectos sobre las puntuaciones de la belleza de los estímulos visuales. En esta sección presentamos los resultados de nuestra utilización de los datos recogidos para explorar esta posibilidad de forma muy preliminar.

Se llevaron a cabo pruebas de estimación de curvas tomando cada una de los siete factores por separado como variables independientes y las puntuaciones de belleza como la variable dependiente. Se examinó el ajuste de las funciones lineal, cuadrática y cúbica. La relación entre cada uno de los factores y las puntuaciones de preferencia estética se muestran de forma gráfica, con la función significativa superpuesta. En el caso en que más de una de las funciones, o ninguna, produjese un ajuste significativo, hemos superpuesto la solución de mayor significación. Cuando todos los valores de significación eran iguales, hemos superpuesto sólo la función con el mayor valor de F. Este procedimiento se realizó por separado para hombres y mujeres, y los resultados se resumen en la tabla 9.17[8]:

Dimensión	Hombres	Mujeres
1		
2		
3		
4		
5		

[8] Una descripción más detallada del procedimiento y de los resultados de este análisis puede consultarse en la sección 3.3.3 de la versión inglesa de este trabajo.

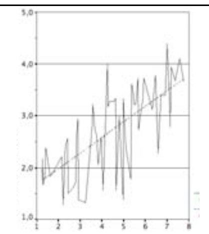
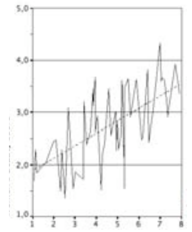
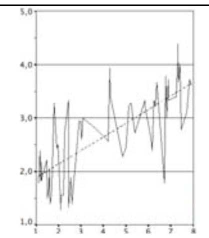
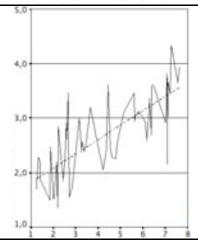
6		
7		

Tabla 9.17. Resumen del estudio exploratorio de la relación entre cada una de las dimensiones de complejidad y la preferencia estética de hombres y mujeres

4. Discusión

Relación entre la complejidad visual y la preferencia estética

Daniel Berlyne fue uno de los investigadores más influyentes en el campo de la estética experimental. Su trabajo integró algunos de los aspectos del legado de Fechner con las ciencias del comportamiento, neurociencia y la teoría de la información. Una de sus contribuciones más duraderas fue el estudio de la influencia de las variables colativas sobre la preferencia estética, en particular de la complejidad. Como se ha visto en la introducción a este trabajo, el marco teórico de Berlyne predecía que las personas preferirían estímulos visuales de complejidad intermedia por encima de los muy simples o muy complejos. Desde la formulación de esta hipótesis se han llevado a cabo numerosos estudios para ponerla a prueba. A pesar de que, ciertamente, algunos estudios han verificado que sus participantes prefirieron estímulos visuales de complejidad intermedia, muchos de estos trabajos han hallado que la preferencia aumenta con la complejidad.

El principal objetivo del presente estudio era determinar las causas de las discrepancias entre los resultados de los estudios que han puesto a prueba la hipótesis de Berlyne. Propusimos que, hasta cierto punto, el uso de distintos tipos de materiales, como estímulos abstractos o representacionales, reproducciones de obras de arte o imágenes no artísticas, podía explicar la divergencia en los resultados. También propusimos que la composición de los participantes en relación al sexo podía producir diferencias en los resultados. Finalmente, hemos explorado la posibilidad de que el uso de distintas definiciones y medidas operativas de "complejidad" podrían haber jugado un importante papel en esta falta de congruencia entre los resultados de la bibliografía revisada.

En relación a la primera de nuestras explicaciones, el uso de materiales diversos, los resultados de nuestras pruebas estadísticas mostraron que tanto hombres como mujeres otorgaron mayores puntuaciones de belleza a los estímulos de alta complejidad que a los de baja complejidad, a los representacionales que a los abstractos, y a los artísticos que a los decorativos. Sin embargo, cuando se analizó la influencia de la complejidad para cada tipo de estímulo por separado, quedó patente que la influencia de la complejidad sobre la preferencia estética no era significativa, excepto para las imágenes representacionales decorativas. Un examen detenido de los datos y los estímulos sugiere una posible explicación de la fuerte influencia de la complejidad sobre la preferencia estética de los estímulos representacionales y decorativos. Se ve que tanto los hombres como las mujeres puntuaron la belleza de los estímulos representacionales decorativos de alta complejidad al mismo nivel que cuando puntuaron la belleza de los estímulos artísticos representacionales. La comparación de los estímulos representacionales decorativos de baja y alta complejidad (véase anexo A, imágenes 1221 a 1220 y 3221 a 3220, respectivamente) revela una clara diferencia entre ambos grupos de estímulos. Los estímulos representacionales decorativos de baja complejidad son dibujos o fotos simples o esquemáticos de objetos individuales, como un coche, un ciclista, plátanos, un lápiz, etc. Por el contrario, los estímulos representacionales decorativos son, en su mayoría, pinturas o fotografías de paisajes naturales, montañas, escenas marinas, etc. Por tanto, parece que las puntuaciones de belleza otorgadas por nuestros participantes sin formación artística reflejan una tendencia a considerar las postales de apariencia artística como obras de arte y a rechazar ilustraciones simples de objetos individuales. Esto sugiere que nuestra categoría de estímulos decorativos podría probablemente subdividirse en una categoría de lo que Lindauer (1990) y Winston y Cupchik (1992) considerarían arte barato o popular, y una categoría que podríamos denominar de objetos o iconos.

Estos resultados respaldan estudios anteriores que hallaron una relación lineal entre la complejidad de estímulos representacionales no artísticos y la preferencia estética, apuntando que las personas prefieren estímulos representacionales decorativos complejos a los simples (Francès, 1976; Heath *et al.*, 2000; Stamps, 2002). Nuestros resultados son contrarios a los de Berlyne (1963), que apuntaban a que la preferencia por los estímulos representacionales no artísticos decrecía con la complejidad, y a los estudios que hallaron una distribución en forma de U invertida para este tipo de imágenes (Imamoglu, 2000; Nasar, 2002). Por otro lado no hallamos apoyo para la noción de que la complejidad influye sobre la preferencia estética de estímulos artísticos, como sugirieron Krupinski y Locher (1988), Messinger (1998), Neperud y Marschalek (1988), Nicki y colaboradores (1981), Nicki y Moss (1975), Osborne y Farley (1970), Saklofske (1975), y Wohlwill (1968). Finalmente, tampoco hallamos evidencia de que la complejidad influyera sobre la preferencia estética de estímulos abstractos no artísticos, como habían apuntado Aitken (1974), Day (1967), Eisenman (1967), Munsinger y Kessen (1964), y Nicki y Gale (1977).

El hallazgo de que la complejidad tiene efectos diferentes sobre la preferencia estética dependiendo del tipo de estímulos sugiere que la composición de los materiales utilizados en los estudios que han puesto a prueba la hipótesis de

Berlyne pone de manifiesto que, al menos en parte, este puede ser un factor que explique por qué llegaron a resultados tan dispares. Parece, por tanto, que el papel de la complejidad en la preferencia estética está mediado por el tipo de estímulo visual utilizado para estudiar la relación entre estas dos variables. Por otro lado, el hecho de que todos nuestros resultados fueran iguales para hombres y mujeres sugiere que, en contra de nuestras suposiciones originales, el papel del sexo parece ser pequeño en la mediación de la influencia de la complejidad sobre la preferencia estética. El que no hayamos hallado evidencia alguna de que la influencia de la complejidad sobre la preferencia estética difiere en hombres y mujeres indica que la composición de los grupos de participantes en relación al sexo no es un factor relevante en la explicación de la divergencia de los resultados obtenidos por anteriores estudios que examinaron la relación entre complejidad y preferencia estética.

Sin embargo, aunque nuestros resultados mostraron que la complejidad era un determinante importante de la preferencia estética de las personas por estímulos visuales representacionales no artísticos, lo cierto es que para los otros tres tipos de estímulos usados en este estudio la preferencia estética no guardó relaciones significativas con la complejidad. Esto hace pensar que otras variables pueden haber jugado un papel más relevante que lo que supusimos originalmente. Estas variables no controladas incluyen el grado de tipicidad de los estímulos, ciertos rasgos de personalidad o estilos cognitivos de nuestros participantes, así como su experiencia informal con el arte, etc. Además, es posible que una única medida de complejidad sea, sencillamente, un concepto inválido. Con pocas excepciones, los intentos de explorar la relación entre la complejidad y la preferencia estética han empleado una única medida de complejidad, en la mayor parte el número de elementos (ángulos, líneas, intersecciones, figuras geométricas, etc.). Esto significa que no han controlado otros rasgos que podrían tener influencia sobre la complejidad percibida del estímulo. Exploramos esta posibilidad a continuación.

El concepto de complejidad visual

Berlyne y colaboradores (1968) distinguieron varios rasgos de los estímulos que contribuían a la impresión subjetiva de complejidad, incluyendo la cantidad de elementos, su heterogeneidad, la irregularidad de sus formas, la irregularidad de su disposición, el grado con el que los diferentes elementos se perciben como una unidad, la asimetría, y la incongruencia. Desde esta clasificación inicial no se ha hecho mucho trabajo para determinar si estos rasgos influyen sobre la complejidad subjetiva del mismo modo y en el mismo grado. Asimismo, tampoco han habido muchos estudios que hayan investigado cómo se relacionan estos rasgos entre sí ni con la preferencia estética. De hecho, la mayor parte de los estudios realizados dentro del campo de la estética experimental han considerado la complejidad como un concepto unidimensional. En este trabajo hemos explorado tentativamente la estructura conceptual de la complejidad de tres maneras: (i) tratando de determinar si alguna o algunas de las dimensiones es más saliente que otras en función del sexo y del tipo de estímulo a la hora de puntuar la complejidad, (ii) explorando cómo se relacionan las dimensiones de complejidad entre ellas, y (iii) explorando cómo cada una de ellas está relacionada con las puntuaciones de belleza.

Relevancia de las dimensiones en los juicios de complejidad

De cara a estudiar la importancia relativa de las dimensiones de complejidad en la tarea de puntuar la complejidad de estímulos visuales llevamos a cabo una serie de análisis discriminantes. Los resultados de estos análisis mostraron que el nivel de complejidad de los estímulos de cada tipo podían ser, en la mayor parte de los cases, predichos con un alto grado de exactitud a partir de las puntuaciones en una o dos de las dimensiones. Sin embargo, estas dimensiones variaban en función del sexo y del tipo de estímulo.

Específicamente, el único caso en el que requirieron más de dos dimensiones para llegar a una predicción exacta es el de las puntuaciones dadas por los hombres a los estímulos representacionales artísticos, para los que se requirieron cuatro dimensiones. En general, y de acuerdo con los resultados de Berlyne y colaboradores (1968), la dimensión que apareció con mayor frecuencia ente las variables predictoras, sola o en combinación con otras, era el número de elementos. Cuando se estudió la contribución de las dimensiones de complejidad a las puntuaciones de complejidad de los distintos tipos de estímulo, se hizo claro que la variedad de colores y la apariencia tridimensional eran muy poco relevantes, lo que está de acuerdo con los resultados obtenidos por Hall (1969). Dos resultados adicionales merecen ser destacados aquí. En primer lugar, para los hombres la heterogeneidad de los elementos apareció entre los predoctores fiables de las puntuaciones de complejidad de los estímulos artísticos, tanto abstractos como representacionales. Por el contrario, no apareció entre las predictoras de su puntuación de los estímulos decorativos, ni abstractos ni representacionales. En segundo lugar, las puntuaciones de las mujeres dadas a la cantidad de elementos y la asimetría predicen la pertenencia de estímulos representacionales, tanto artísticos como decorativos, a los tres niveles de complejidad. Sin embargo, la asimetría parece jugar un papel mucho menor en la predicción de la complejidad de los estímulos abstractos.

Relaciones entre las dimensiones de complejidad

Estudiamos la relación entre las siete dimensiones de complejidad mediante un análisis factorial. Dado que los resultados partiendo de las puntuaciones dadas por los hombres y las mujeres son muy similares, los discutiremos conjuntamente. Nuestros resultados indican la existencia de tres factores que explicaban la mayor parte de la variancia. El primer factor recibió altas saturaciones de las siguientes dimensiones: cantidad de elementos, heterogeneidad de elementos, variedad de colores, y apariencia tridimensional. En el segundo factor saturaban las dimensiones de ininteligibilidad de los elementos y desorganización. Finalmente, el tercer factor recibía saturación de una única dimensión: asimetría. Podríamos llamar a estos tres factores *elementos* –relacionado con la cantidad y variedad de los elementos-, *organización* –que tiene que ver con cómo se agrupan los elementos para formar objetos identificables y cómo estos se organizan en una escena coherente-, y *asimetría*.

En función de las puntuaciones otorgadas por los hombres, el factor *elementos* explicó el 48,33% de la varianza, *organización* el 31,69%, y *asimetría* el 14,43%. En general, pues, los tres factores explican el 94,45% de la varianza de las puntuaciones de los hombres en las 7 dimensiones de complejidad. Cuando los cálculos se basan en las puntuaciones otorgadas por las mujeres, *elementos* explicaba el 47,01% de la varianza, *organización* el 31,17%, y *asimetría* el 14,54%. En conjunto, los tres factores explicaron el 92,71% de la varianza de las puntuaciones otorgadas por las mujeres en las siete dimensiones de complejidad.

Estos resultados están en línea con los de estudios anteriores. Por ejemplo, el análisis factorial realizado por Berlyne *et al.* (1968) indicó la existencia de dos factores principales, uno relacionado con la cantidad de elementos y otro que era un compuesto de varias dimensiones que habían tenido en cuenta, y al que denominaron unidad frente a articulación en partes fácilmente reconocibles. Las similitudes entre estos dos factores y nuestros *elementos* y *organización* salta a la vista. Sin embargo, en contraste con nuestros resultados, el primer factor de Berlyne *et al.* (1968) explicaba entre un 70 y un 90% de la varianza. Esta diferencia en la relevancia de la cantidad de los elementos para las puntuaciones de complejidad puede deberse al hecho de que los estímulos usados por Berlyne *et al.* (1968) eran dibujos lineales simples en los que los elementos constituyentes eran mucho más salientes que en la mayoría de los estímulos usados en el presente estudio.

Otros estudios también han hallado que las puntuaciones subjetivas de complejidad dependen de dos tipos de características. Nicki y Moss (1975) interpretaron sus resultados sugiriendo que podrían haber dos tipos de factores de complejidad, uno "perceptivo", relacionado con el número y variedad de elementos, y uno "cognitivo", relacionado con la cantidad de asociaciones o términos elicitados por el estímulo. Chipman (1977) distinguió entre un componente cualitativo de los juicios de complejidad, determinado en gran medida por la cantidad de elementos, un componente estructural, relacionado con la simetría, la repetición de motivos y otros procesos organizativos. Chipman (1977) sugirió que el primer factor, relacionado con la cantidad de elementos, fija un umbral máximo de complejidad percibido, y que el segundo actúa reduciendo esta impresión. Al variar los tiempos de presentación, Ichikawa (1985) proporcionó datos experimentales que respaldaban esta hipótesis.

Así, nuestros resultados aportan un nuevo apoyo a la idea de que dos o tres procesos distintos contribuyen a la formación de la complejidad visual subjetiva. Probablemente el más importante de estos procesos es la determinación del número y variedad de elementos. El segundo se refiere a la dificultad con la que estos elementos se identifican y organizan para formar una escena coherente. Aunque los estudios anteriores han incluido la asimetría dentro de los procesos organizacionales, nuestros análisis revelaron que esta solución no era adecuada para nuestros datos. La secuencia temporal de los procesos cognitivos relacionados con estos factores queda por dilucidarse, aunque basándonos en los resultados de Ichikawa (1985), es plausible que los distintos rasgos se procesen en paralelo, pero que los relacionados con el factor *elementos* sean más rápidos que los relacionados con *organizacón*, que acaban más tarde.

Relación entre las dimensiones de complejidad y la preferencia estética

En la última parte de este trabajo se realizó una exploración tentativa de la posibilidad de que las diferentes dimensiones de complejidad estén relacionadas de formas distintas con las puntuaciones de belleza. De ser así, podría explicar la divergencia en los resultados de los estudios revisados en la introducción, que manipularon distintos rasgos de los estímulos para crear sus niveles de complejidad. Para investigar esta posibilidad relacionamos las puntuaciones dadas en cada una de las dimensiones de complejidad con las de belleza otorgadas por hombres y mujeres. Esto sólo puede considerarse como una exploración muy tentativa porque los estímulos no fueron manipulados independientemente en cada uno de las dimensiones de complejidad. A pesar de estas limitaciones, nuestros resultados sugieren que las variaciones de complejidad en cada una de las dimensiones pueden tener efectos distintos sobre la preferencia estética.

Las dimensiones 1 y 2, ininteligibilidad de los elementos y desorganización, parecen estar relacionadas con la belleza según una función descendente o en forma de U. Específicamente, los estímulos que recibieron puntuaciones muy bajas en estas dimensiones de complejidad fueron las más apreciados que los estímulos que recibieron puntuaciones intermedias o altas. Por el contrario, las dimensiones 3, 4, 6 y 7, cantidad de elementos, heterogeneidad de los elementos, variedad de colores y apariencia tridimensional guardan una relación lineal con la belleza: las imágenes consideradas como más bellas son las que recibieron puntuaciones más altas en estas dimensiones. Finalmente, nuestros resultados sugieren que la preferencia estética es una función con forma de U invertida de la dimensión 5, asimetría: las imágenes con puntuaciones intermedias en complejidad fueron consideraras como más bellas que las puntuadas como extremadamente asimétricas o extremadamente simétricas.

Este agrupamiento de las dimensiones de acuerdo a su relación con las puntuaciones en belleza sigue el mismo patrón que sus saturaciones en cada uno de los tres factores comentados arriba. Las dimensiones de complejidad relacionadas con el factor *elementos* guardan una relación lineal con la belleza. La relación entre las dimensiones de complejidad relacionadas con el factor *organización* y las puntuaciones de belleza parece tener forma de U. Por el contrario, la relación entre la *asimetría* y la preferencia estética parece tener forma de U invertida.

¿Es posible que la diversidad de relaciones entre complejidad y belleza que se han hallado en estudios previos se deba a su énfasis sobre distintos factores de complejidad? Nuestra revisión de la literatura sugiere que éste puede ser el caso. De los estudios que examinamos en la introducción a este trabajo seleccionamos aquellos que usaron algún tipo de medida específica de complejidad, y dejamos de lado los que usaron una escala general de complejidad. Entre estos primeros estudios seis diseñaron o utilizaron estímulos que variaban en el factor elementos (Aitken, 1974; Day, 1967; Heath *et al.*, 2000; Nicki, 1972; Nicki & Moss, 1975; Stamps, 2002), cinco diseñaron o usaron estímulos que variaban en *organización* (Krupinski y Locher, 1988; Neperud y Marschalek, 1988; Nicki *et al.*, 1981; Nicki y Moss, 1975; Osborne y Farley, 1970), uno usó estímulos que variaban sólo en *asimetría* (Krupinski y Locher, 1988), tres usaron estímulos que variaban en *asimetría* y *elementos* (Eisenman, 1967; Imamoglu, 2000; Munsinger & Kessen, 1964), y uno usó estímulos que variaban en los tres factores (Francès, 1976). Si nuestra hipótesis es correcta, deberíamos esperar que aquellos estudios que manipularon la complejidad variando el número o heterogeneidad de los elementos hubieran encontrado una relación lineal creciente entre complejidad y preferencia. Esperaríamos hallar también que los estudios que manipularon la complejidad mediante rasgos relacionados con la organización hubieran obtenido una relación lineal decreciente o en forma de U entre complejidad y preferencia. Finalmente esperaríamos hallar que estudios previos que operativizaron la complejidad a lo largo de un continuo simetría-asimetría reportaran la esperada relación entre complejidad y preferencia en forma de U invertida.

De cara a someter a prueba esta predicción retrospectiva descartamos el estudio de Francès (1976) debido su uso combinado de las medidas relacionadas con los tres factores. También reunimos en una única categoría los estudios que concibieron la complejidad como asimetría o como la combinación de asimetría y número de elementos. Para cada uno de estos quince estudios resumimos su principal conclusión como un apoyo a una relación ente preferencia y complejidad monótona creciente, en forma de U invertida, o decreciente (o en forma de U). La tabla 9.18 muestra el cruce entre los tres factores principales manipulados por estos estudios y su conclusión principal, junto con la correspondiente prueba ji-cuadrado.

		Main factor			
		Elements	Organization	Symmetry	Total
Result	Increasing	5	1		6
	Inverted U	1		3	4
	Decreasing		4	1	5
Total		6	5	4	15

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15,329[a]	4	,004
Likelihood Ratio	17,646	4	,001
Linear-by-Linear Association	4,528	1	,033
N of Valid Cases	15		

a. 9 cells (100,0%) have expected count less than 5. The minimum expected count is 1,07.

Tabla 9.18. Relación entre el principal factor manipulado por estudios anteriores y la forma de la función belleza-complejidad resultante

Los resultados de la prueba ji-cuadrado son altamente significativos, lo que sugiere que la elección del factor de complejidad ente elementos, organización y simetría está muy relacionado con la forma de la distribución resultante de belleza y complejidad. Así, de acuerdo con nuestras expectativas, la mayoría de los estudios que han manipulado el número o la variedad de los elementos hallaron una relación monótona creciente entre complejidad y preferencia, la mayoría de los que manipularon aspectos organizacionales obtuvieron una relación decreciente o en forma de U, y la mayoría de los que manipularon la simetría hallaron una distribución en forma de U invertida. Además, calculamos algunas medias de asociación direccionales para valorar la fuerza de la asociación, presentadas en la tabla 9.19:

			Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Nominal by Nominal	Lambda	Symmetric	,667	,180	2,657	,008
		Result Dependent	,667	,181	2,535	,011
		Main factor Dependent	,667	,181	2,535	,011
	Goodman and Kruskal tau	Result Dependent	,517	,185		,006[c]
		Main factor Dependent	,517	,185		,006[c]
	Uncertainty Coefficient	Symmetric	,542	,130	4,131	,001[d]
		Result Dependent	,542	,130	4,131	,001[d]
		Main factor Dependent	,542	,130	4,131	,001[d]

a. Not assuming the null hypothesis.
b. Using the asymptotic standard error assuming the null hypothesis.
c. Based on chi-square approximation
d. Likelihood ratio chi-square probability.

Tabla 9.19. Medidas de asociación direccionales entre la forma de complejidad manipulada y el resultado principal

Estos resultados muestran que hay una fuerte relación entre la manera en la que estudios anteriores han especificado y operativizado el concepto de complejidad y la forma de la distribución de las puntuaciones de belleza en función de la complejidad. Más aún, las medidas de asociación nos permiten predecir el tipo de distribución resultante partiendo del conocimiento del factor manipulado por el experimentador con un alto grado de precisión.

Conclusiones

Este trabajo se llevó a cabo con el objetivo de determinar los motivos de la divergencia en los resultados de estudios que han puesto a prueba la hipotetizada relación en forma de U invertida entre preferencia y complejidad de estímulos visuales. Inicialmente conjeturamos que las diferencias en la proporción de participantes varones y mujeres, en la composición de los materiales, y en la definición y operativización de la complejidad visual entre estos estudios podían explicar por qué la predicción de Berlyne ha recibido un apoyo tan desigual.

Sin embargo, nuestros resultados apuntan a que la diferencia en la proporción de participantes varones y mujeres ha tenido un efecto muy pequeño sobre los resultados de los estudios revisados en la introducción. Además, nuestros resultados también prestan un apoyo muy limitado a la posibilidad de que el uso de distintos tipos de estímulos visuales, como artísticos frente a decorativos, o abstractos frente a representacionales, haya llevado a los mencionados resultados divergentes. También hemos sugerido que el papel de las diferencias individuales en personalidad, estilo cognitivo y la experiencia artística informal puede ser más relevante que lo que supusimos inicialmente.

Los resultados ofrecidos por nuestro estudio sugieren que la causa más probable de la divergencia en los resultados es la adopción de distintas definiciones de complejidad y formas de operativizar este concepto sobre las que los distintos investigadores han fundamentado sus trabajos. Hemos mostrado que la complejidad se entiende mejor como un concepto multidimensional. Las personas tienden a basar sus juicios sobre la complejidad visual en distintos aspectos, en función del sexo y del tipo de estímulo. Nuestros hallazgos apuntan que hay tres tipos principales de aspectos: (i) aquellos relacionados con la cantidad y variedad de elementos, (ii) aquellos relacionados con el reconocimiento de objetos y de organización de la escena, y (iii) la asimetría. Estos tres aspectos de la complejidad visual parecen estar relacionados de formas distintas a las puntuaciones de belleza, aunque esto requiere todavía confirmación experimental. Finalmente, hemos mostrado que los estudios anteriores que han explorado la relación entre complejidad y preferencia han hecho uso de materiales que variaban en distintos aspectos particulares de complejidad, y que estas diferencias son, posiblemente, el mayor determinante de la falta de coincidencia en los resultados de los estudios que han explorado la relación entre la complejidad y preferencia por estímulos visuales.

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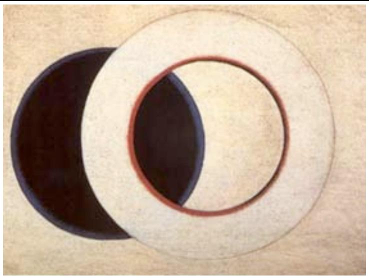
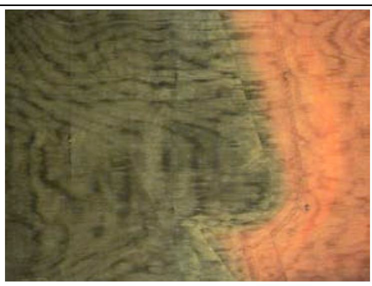
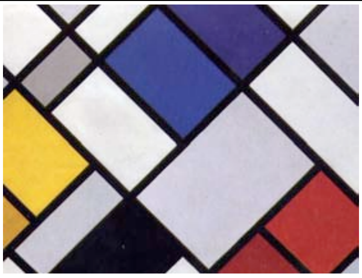
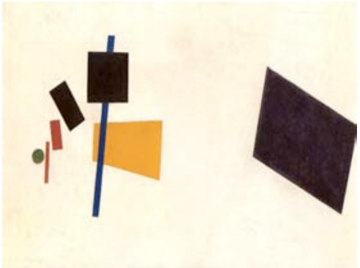
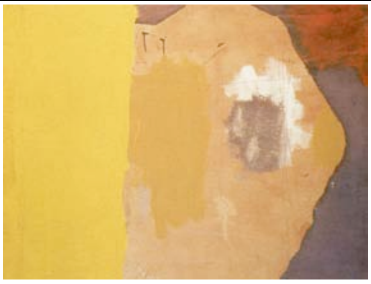
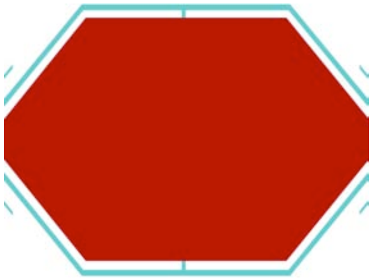
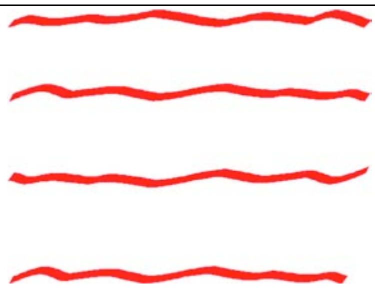
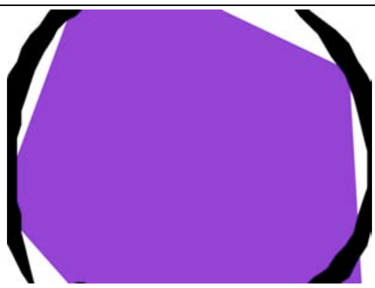
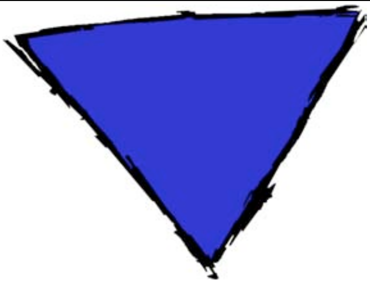
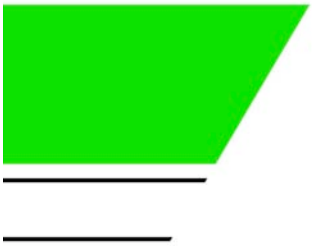
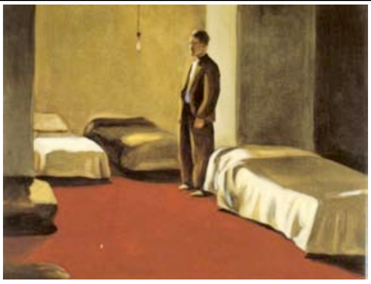
Annex A

In this Annex we present reproductions of the 120 images selected in the first phase to be used in subsequent phases. The "Scores" column includes the complexity score of each stimulus, as well as the average scores awarded by men and women. Complexity levels are 1: low, 2: intermediate, 3: high. Abstraction levels are 1: abstract, 2: representational. Artistry levels are 1: artistic, 2: decorative.

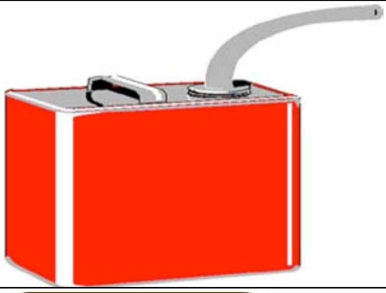
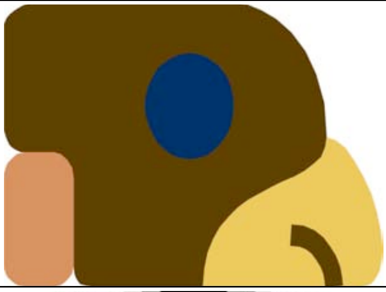
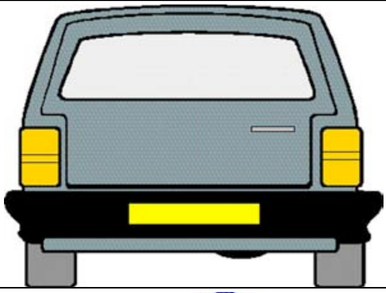
Code	Image	Scores	Complexity level	Abstraction	Artistry
1111		Complexity: 2.61 Beauty (men): 3.89 Beauty (women): 3.30	1	1	1
1112		Complexity: 2.58 Beauty (men): 2.43 Beauty (women): 2.50	1	1	1
1113		Complexity: 2.42 Beauty (men): 2.50 Beauty (women): 2.29	1	1	1
1114		Complexity: 2.39 Beauty (men): 1.91 Beauty (women): 2.20	1	1	1

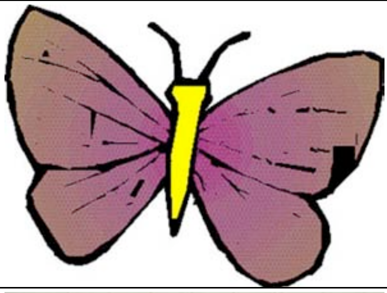
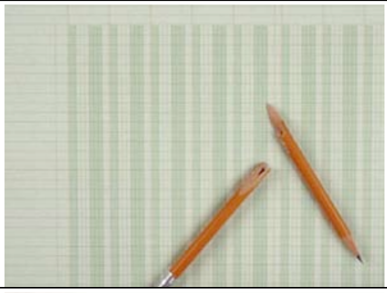
1115		Complexity: 2.36 Beauty (men): 2.59 Beauty (women): 2.98	1	1	1
1116		Complexity: 2.33 Beauty (men): 3.18 Beauty (women): 2.84	1	1	1
1117		Complexity: 2.30 Beauty (men): 2.67 Beauty (women): 2.63	1	1	1
1118		Complexity: 2.21 Beauty (men): 1.86 Beauty (women): 2.18	1	1	1
1119		Complexity: 2.79 Beauty (men): 3.04 Beauty (women): 3.46	1	1	1
1110		Complexity: 2.79 Beauty (men): 2.29 Beauty (women): 2.84	1	1	1

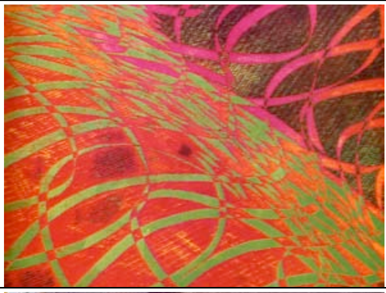
1121		Complexity: 1.24 Beauty (men): 1.95 Beauty (women): 1.86	1	1	2
1122		Complexity: 1.24 Beauty (men): 2.21 Beauty (women): 2.20	1	1	2
1123		Complexity: 1.21 Beauty (men): 2.04 Beauty (women): 2.29	1	1	2
1124		Complexity: 1.21 Beauty (men): 1.76 Beauty (women): 1.84	1	1	2
1125		Complexity: 1.18 Beauty (men): 1.67 Beauty (women): 1.70	1	1	2
1126		Complexity: 1.18 Beauty (men): 1.76 Beauty (women): 1.88	1	1	2

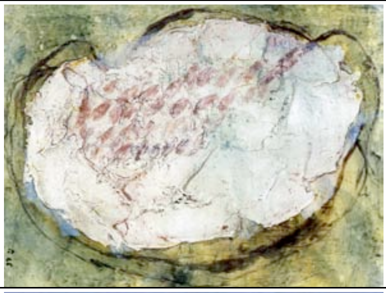
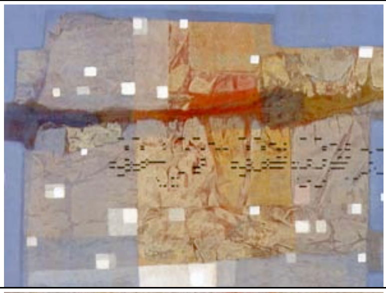
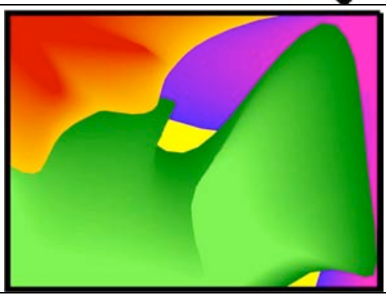
1127		Complexity: 1.18 Beauty (men): 1.71 Beauty (women): 1.93	1	1	2
1128		Complexity: 1.18 Beauty (men): 1.83 Beauty (women): 1.82	1	1	2
1129		Complexity: 1.15 Beauty (men): 1.62 Beauty (women): 1.77	1	1	2
1120		Complexity: 1.15 Beauty (men): 1.42 Beauty (women): 1.41	1	1	2
1211		Complexity: 2.94 Beauty (men): 3.82 Beauty (women): 3.86	1	2	1
1212		Complexity: 2.76 Beauty (men): 3.32 Beauty (women): 3.23	1	2	1

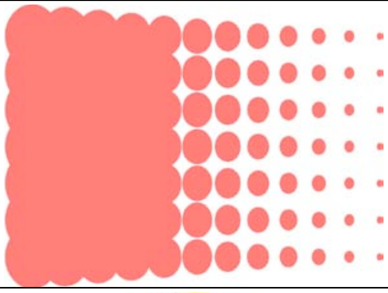
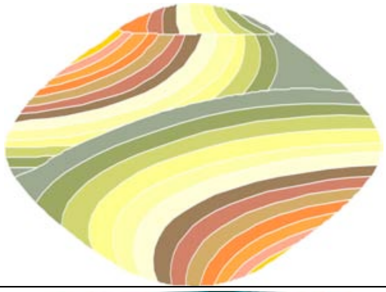
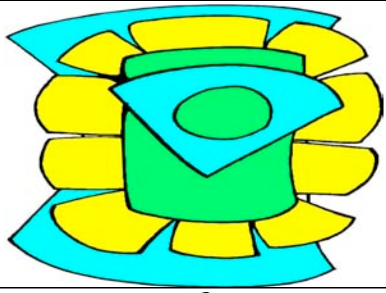
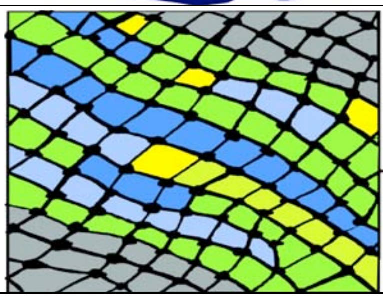
1213		Complexity: 2.70 Beauty (men): 3.54 Beauty (women): 3.13	1	2	1
1214		Complexity: 2.70 Beauty (men): 3.26 Beauty (women): 3.46	1	2	1
1215		Complexity: 2.67 Beauty (men): 3.70 Beauty (women): 3.36	1	2	1
1216		Complexity: 2.67 Beauty (men): 3.86 Beauty (women): 3.61	1	2	1
1217		Complexity: 2.67 Beauty (men): 2.41 Beauty (women): 2.43	1	2	1
1218		Complexity: 2.61 Beauty (men): 3.05 Beauty (women): 3.16	1	2	1

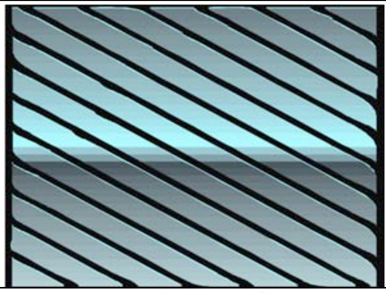
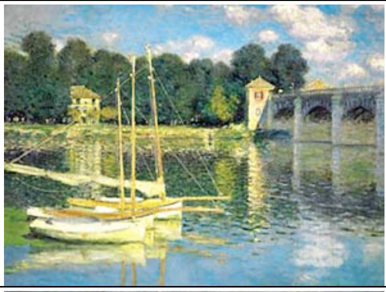
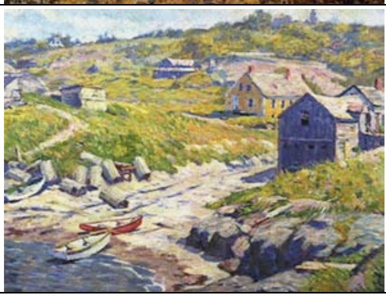
1219		Complexity: 2.52 Beauty (men): 3.59 Beauty (women): 3.63	1	2	1
1210		Complexity: 2.52 Beauty (men): 3.95 Beauty (women): 3.80	1	2	1
1221		Complexity: 1.48 Beauty (men): 2.28 Beauty (women): 1.96	1	2	2
1222		Complexity: 1.45 Beauty (men): 1.53 Beauty (women): 1.54	1	2	2
1223		Complexity: 1.42 Beauty (men): 1.51 Beauty (women): 1.36	1	2	2
1224		Complexity: 1.36 Beauty (men): 1.71 Beauty (women): 1.50	1	2	2

1225		Complexity: 1.30 Beauty (men): 2.34 Beauty (women): 2.48	1	2	2
1226		Complexity: 1.48 Beauty (men): 2.39 Beauty (women): 2.45	1	2	2
1227		Complexity: 1.45 Beauty (men): 2.47 Beauty (women): 2.70	1	2	2
1228		Complexity: 1.45 Beauty (men): 2.33 Beauty (women): 2.14	1	2	2
1229		Complexity: 1.42 Beauty (men): 2.92 Beauty (women): 3.09	1	2	2
1220		Complexity: 1.24 Beauty (men): 1.89 Beauty (women): 1.59	1	2	2

2111		Complexity: 3.36 Beauty (men): 2.28 Beauty (women): 2.80	2	1	1
2112		Complexity: 3.36 Beauty (men): 3.12 Beauty (women): 3.46	2	1	1
2113		Complexity: 3.48 Beauty (men): 2.68 Beauty (women): 2.63	2	1	1
2114		Complexity: 3.48 Beauty (men): 2.41 Beauty (women): 2.59	2	1	1
2115		Complexity: 3.48 Beauty (men): 2.39 Beauty (women): 2.70	2	1	1
2116		Complexity: 3.48 Beauty (men): 2.54 Beauty (women): 2.39	2	1	1

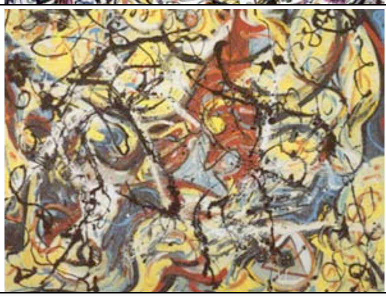
2117		Complexity: 3.52 Beauty (men): 2.17 Beauty (women): 2.32	2	1	1
2118		Complexity: 3.52 Beauty (men): 3.36 Beauty (women): 3.43	2	1	1
2119		Complexity: 3.52 Beauty (men): 3.39 Beauty (women): 3.52	2	1	1
2110		Complexity: 3.52 Beauty (men): 2.72 Beauty (women): 2.29	2	1	1
2121		Complexity: 2.15 Beauty (men): 1.67 Beauty (women): 1.55	2	1	2
2122		Complexity: 2.15 Beauty (men): 2.78 Beauty (women): 3.38	2	1	2

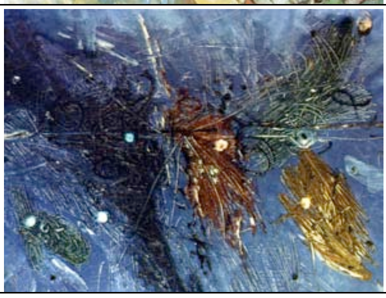
2123		Complexity: 2.09 Beauty (men): 1.76 Beauty (women): 1.95	2	1	2
2124		Complexity: 2.09 Beauty (men): 1.59 Beauty (women): 2.48	2	1	2
2125		Complexity: 2.09 Beauty (men): 1.54 Beauty (women): 1.73	2	1	2
2126		Complexity: 2.09 Beauty (men): 1.91 Beauty (women): 2.05	2	1	2
2127		Complexity: 2.06 Beauty (men): 1.53 Beauty (women): 1.52	2	1	2
2128		Complexity: 2.06 Beauty (men): 2.17 Beauty (women): 2.50	2	1	2

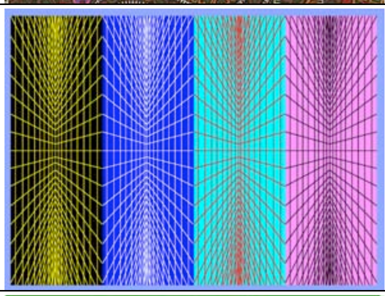
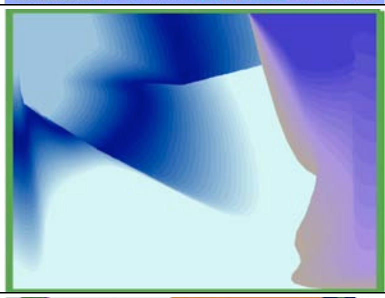
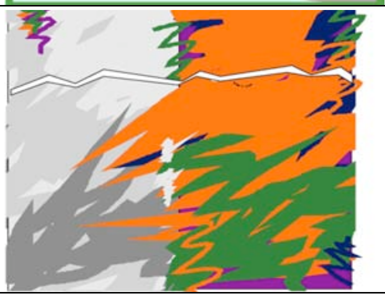
2129		Complexity: 2.06 Beauty (men): 1.91 Beauty (women): 2.14	2	1	2
2120		Complexity: 2.03 Beauty (men): 2.28 Beauty (women): 2.25	2	1	2
2211		Complexity: 3.52 Beauty (men): 4.12 Beauty (women): 3.71	2	2	1
2212		Complexity: 3.52 Beauty (men): 4.49 Beauty (women): 4.34	2	2	1
2213		Complexity: 3.52 Beauty (men): 3.54 Beauty (women): 3.83	2	2	1
2214		Complexity: 3.52 Beauty (men): 4.00 Beauty (women): 3.59	2	2	1

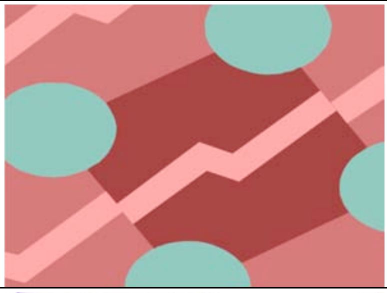
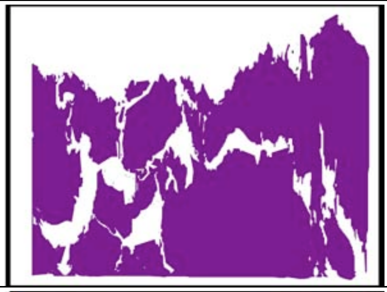
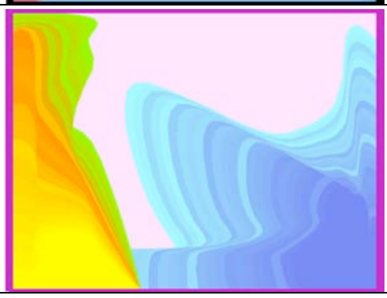
2215		Complexity: 3.52 Beauty (men): 3.09 Beauty (women): 2.93	2	2	1
2216		Complexity: 3.48 Beauty (men): 2.67 Beauty (women): 2.52	2	2	1
2217		Complexity: 3.48 Beauty (men): 3.13 Beauty (women): 3.39	2	2	1
2218		Complexity: 3.48 Beauty (men): 3.53 Beauty (women): 2.95	2	2	1
2219		Complexity: 3.42 Beauty (men): 3.09 Beauty (women): 3.13	2	2	1
2210		Complexity: 3.48 Beauty (men): 4.13 Beauty (women): 3.68	2	2	1

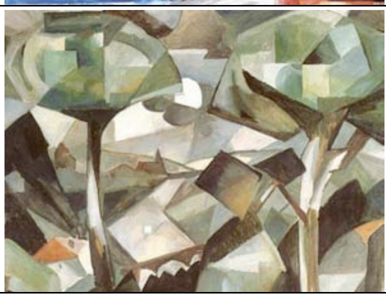
2221		Complexity: 2.91 Beauty (men): 2.72 Beauty (women): 2.34	2	2	2
2222		Complexity: 2.52 Beauty (men): 2.28 Beauty (women): 2.14	2	2	2
2223		Complexity: 2.45 Beauty (men): 2.79 Beauty (women): 2.91	2	2	2
2224		Complexity: 2.42 Beauty (men): 3.26 Beauty (women): 3.46	2	2	2
2225		Complexity: 2.36 Beauty (men): 3.05 Beauty (women): 3.20	2	2	2
2226		Complexity: 2.55 Beauty (men): 3.75 Beauty (women): 3.46	2	2	2

2227		Complexity: 2.52 Beauty (men): 3.93 Beauty (women): 3.64	2	2	2
2228		Complexity: 2.52 Beauty (men): 1.72 Beauty (women): 1.50	2	2	2
2229		Complexity: 2.48 Beauty (men): 2.62 Beauty (women): 2.50	2	2	2
2220		Complexity: 2.48 Beauty (men): 2.07 Beauty (women): 1.66	2	2	2
3111		Complexity: 4.82 Beauty (men): 2.67 Beauty (women): 3.27	3	1	1
3112		Complexity: 4.79 Beauty (men): 2.78 Beauty (women): 3.00	3	1	1

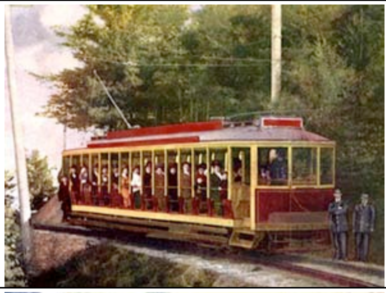
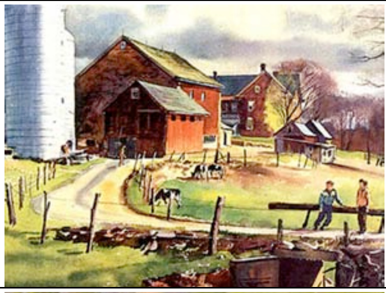
3113		Complexity: 4.76 Beauty (men): 2.79 Beauty (women): 2.57	3	1	1
3114		Complexity: 4.42 Beauty (men): 2.97 Beauty (women): 2.29	3	1	1
3115		Complexity: 4.73 Beauty (men): 3.20 Beauty (women): 2.59	3	1	1
3116		Complexity: 4.70 Beauty (men): 2.93 Beauty (women): 2.27	3	1	1
3117		Complexity: 4.70 Beauty (men): 3.58 Beauty (women): 3.59	3	1	1
3118		Complexity: 4.67 Beauty (men): 3.84 Beauty (women): 3.79	3	1	1

3119		Complexity: 4.39 Beauty (men): 2.74 Beauty (women): 2.45	3	1	1
3110		Complexity: 4.64 Beauty (men): 2.58 Beauty (women): 3.26	3	1	1
3121		Complexity: 3.79 Beauty (men): 2.83 Beauty (women): 2.61	3	1	2
3122		Complexity: 3.70 Beauty (men): 1.82 Beauty (women): 2.16	3	1	2
3123		Complexity: 3.15 Beauty (men): 2.47 Beauty (women): 3.09	3	1	2
3124		Complexity: 3.00 Beauty (men): 1.51 Beauty (women): 1.55	3	1	2

3125		Complexity: 2.88 Beauty (men): 1.70 Beauty (women): 2.39	3	1	2
3126		Complexity: 2.73 Beauty (men): 1.75 Beauty (women): 1.86	3	1	2
3127		Complexity: 2.73 Beauty (men): 1.88 Beauty (women): 2.14	3	1	2
3128		Complexity: 2.70 Beauty (men): 1.86 Beauty (women): 2.05	3	1	2
3129		Complexity: 2.58 Beauty (men): 1.89 Beauty (women): 2.13	3	1	2
3120		Complexity: 2.55 Beauty (men): 1.86 Beauty (women): 2.88	3	1	2

3211		Complexity: 4.67 Beauty (men): 2.91 Beauty (women): 3.11	3	2	1
3212		Complexity: 4.58 Beauty (men): 3.45 Beauty (women): 3.36	3	2	1
3213		Complexity: 4.45 Beauty (men): 4.14 Beauty (women): 3.93	3	2	1
3214		Complexity: 4.42 Beauty (men): 2.87 Beauty (women): 2.93	3	2	1
3215		Complexity: 4.33 Beauty (men): 3.71 Beauty (women): 3.61	3	2	1
3216		Complexity: 4.30 Beauty (men): 2.92 Beauty (women): 3.02	3	2	1

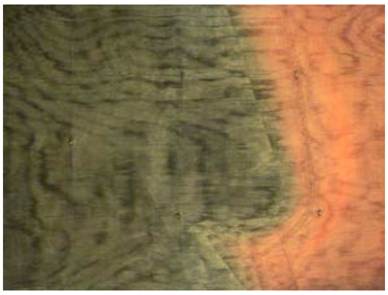
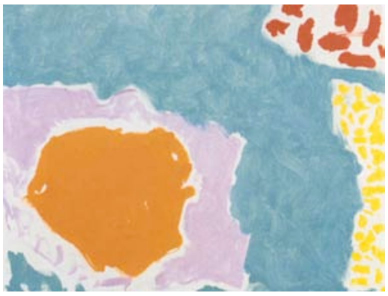
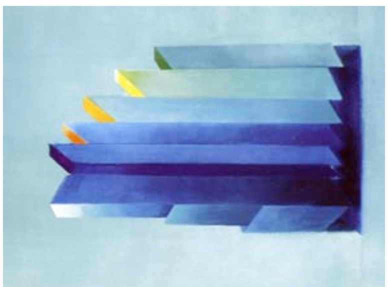
3217		Complexity: 4.27 Beauty (men): 3.50 Beauty (women): 2.64	3	2	1
3218		Complexity: 4.24 Beauty (men): 3.74 Beauty (women): 3.68	3	2	1
3219		Complexity: 4.21 Beauty (men): 4.49 Beauty (women): 4.32	3	2	1
3210		Complexity: 4.18 Beauty (men): 4.47 Beauty (women): 4.09	3	2	1
3221		Complexity: 3.85 Beauty (men): 3.49 Beauty (women): 3.23	3	2	2
3222		Complexity: 3.82 Beauty (men): 2.53 Beauty (women): 2.29	3	2	2

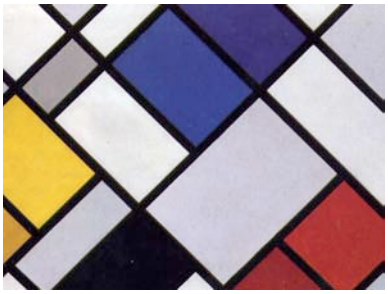
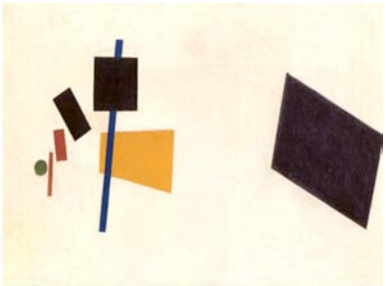
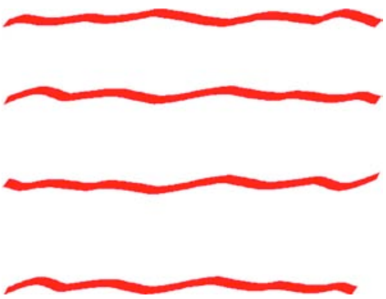
3223		Complexity: 3.76 Beauty (men): 3.58 Beauty (women): 3.04	3	2	2
3224		Complexity: 3.52 Beauty (men): 3.14 Beauty (women): 2.91	3	2	2
3225		Complexity: 3.36 Beauty (men): 3.67 Beauty (women): 3.66	3	2	2
3226		Complexity: 3.94 Beauty (men): 3.97 Beauty (women): 3.68	3	2	2
3227		Complexity: 3.91 Beauty (men): 3.39 Beauty (women): 3.63	3	2	2
3228		Complexity: 3.91 Beauty (men): 4.29 Beauty (women): 4.02	3	2	2

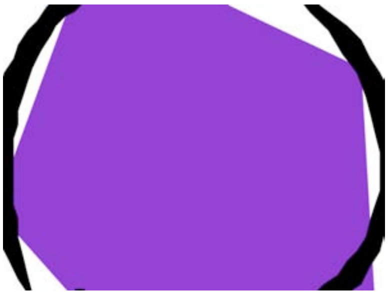
3229		Complexity: 3.76 Beauty (men): 4.30 Beauty (women): 4.25	3	2	2
3220		Complexity: 3.67 Beauty (men): 4.25 Beauty (women): 3.95	3	2	2

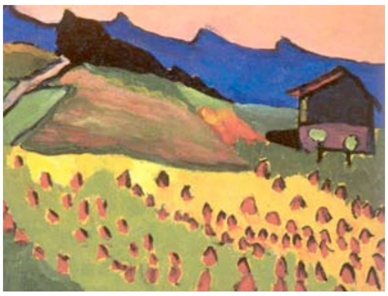
Annex B

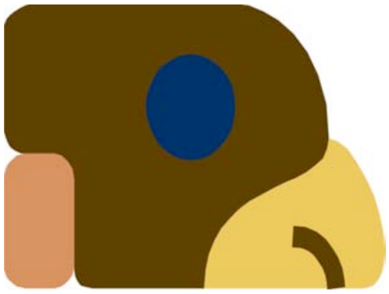
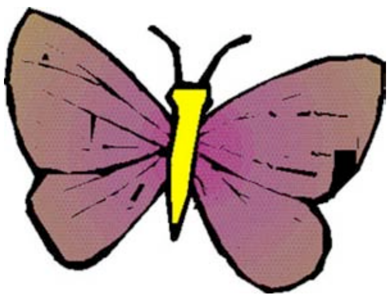
In this Annex we include reproductions of the 60 stimuli used in the third phase of this work, related with the clarification of the concept of complexity. We also include the average scores awarded by men and women to each stimulus on each of the 7 complexity dimensions.

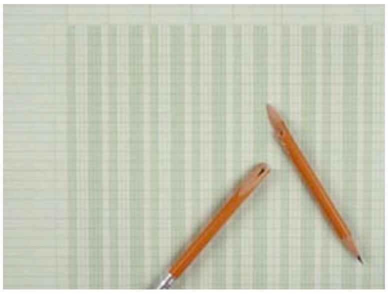
Code	Image	Complexity dimensions	M	W
1113		Unintelligibility of the elements	6.53	6.14
		Disorganization	6.63	6.25
		Amount of elements	3.71	2.82
		Element heterogeneity	2.95	3.07
		Asymmetry	6.71	6.20
		Colour variety	2.82	2.38
		Three-dimensionality	1.97	2.51
1114		Unintelligibility of the elements	5.76	5.57
		Disorganization	6.76	6.15
		Amount of elements	3.34	3.32
		Element heterogeneity	3.63	4.18
		Asymmetry	7.00	7.07
		Colour variety	3.82	4.27
		Three-dimensionality	1.61	2.15
1115		Unintelligibility of the elements	3.13	3.52
		Disorganization	4.66	4.58
		Amount of elements	3.92	4.13
		Element heterogeneity	3.29	2.91
		Asymmetry	4.34	4.68
		Colour variety	3.76	3.96
		Three-dimensionality	6.13	6.26

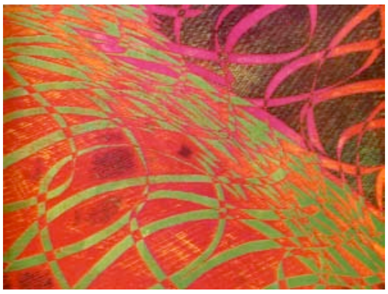
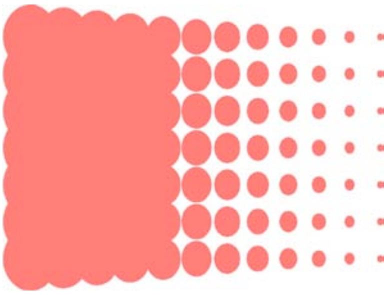
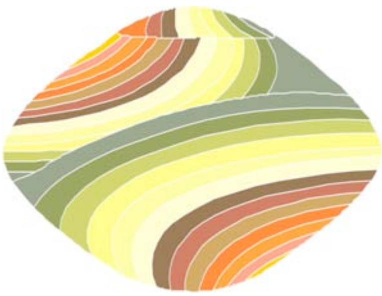
1116		Unintelligibility of the elements Disorganization Amount of elements Element heterogeneity Asymmetry Colour variety Three-dimensionality	3.66 3.47 3.76 2.92 4.76 4.37 1.82	3.25 3.95 3.52 2.66 4.02 5.00 2.23
1117		Unintelligibility of the elements Disorganization Amount of elements Element heterogeneity Asymmetry Colour variety Three-dimensionality	4.39 5.82 2.95 2.39 3.13 2.89 3.00	4.07 5.80 2.98 3.07 3.29 3.72 3.94
1122		Unintelligibility of the elements Disorganization Amount of elements Element heterogeneity Asymmetry Colour variety Three-dimensionality	3.87 3.76 1.61 1.26 2.79 1.42 1.18	2.82 3.30 1.52 1.11 3.18 1.16 1.40
1123		Unintelligibility of the elements Disorganization Amount of elements Element heterogeneity Asymmetry Colour variety Three-dimensionality	4.92 5.76 1.21 1.53 6.05 1.28 1.24	3.95 4.67 1.20 1.30 6.39 1.14 1.34

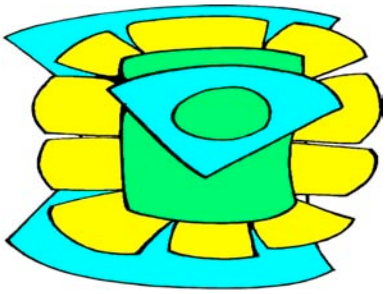
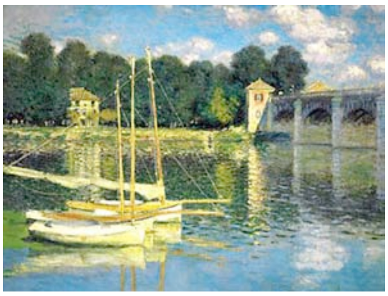
1124		Unintelligibility of the elements	4.50	4.21
		Disorganization	5.63	4.93
		Amount of elements	1.13	1.30
		Element heterogeneity	1.42	1.43
		Asymmetry	8.37	7.86
		Colour variety	1.38	1.20
		Three-dimensionality	1.22	1.26
1125		Unintelligibility of the elements	4.82	3.98
		Disorganization	5.26	4.56
		Amount of elements	1.45	1.50
		Element heterogeneity	1.42	1.21
		Asymmetry	8.53	8.43
		Colour variety	1.26	1.10
		Three-dimensionality	1.11	1.25
1126		Unintelligibility of the elements	5.11	4.34
		Disorganization	5.74	4.93
		Amount of elements	1.50	1.61
		Element heterogeneity	1.68	2.14
		Asymmetry	2.61	2.80
		Colour variety	1.63	1.30
		Three-dimensionality	1.24	1.41
1213		Unintelligibility of the elements	2.26	1.71
		Disorganization	1.58	1.95
		Amount of elements	3.39	3.18
		Element heterogeneity	3.79	3.20
		Asymmetry	3.66	3.96
		Colour variety	4.63	3.86
		Three-dimensionality	6.24	5.82

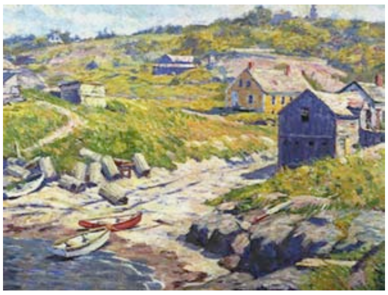
1214		Unintelligibility of the elements Disorganization Amount of elements Element heterogeneity Asymmetry Colour variety Three-dimensionality	2.29 1.82 4.18 4.34 4.37 4.79 6.81	1.86 2.00 3.91 3.66 3.96 4.58 6.61
1215		Unintelligibility of the elements Disorganization Amount of elements Element heterogeneity Asymmetry Colour variety Three-dimensionality	2.68 1.95 6.11 6.95 7.13 7.37 7.35	1.86 2.20 6.18 7.21 7.36 7.28 6.64
1216		Unintelligibility of the elements Disorganization Amount of elements Element heterogeneity Asymmetry Colour variety Three-dimensionality	2.47 2.08 4.82 4.45 5.61 5.92 6.89	1.96 2.54 4.45 4.63 5.36 5.19 6.45
1217		Unintelligibility of the elements Disorganization Amount of elements Element heterogeneity Asymmetry Colour variety Three-dimensionality	3.42 3.32 4.97 5.03 6.26 6.59 4.86	2.43 2.85 4.63 5.09 6.14 6.46 4.39

1222		Unintelligibility of the elements	4.42	4.46
		Disorganization	4.95	5.14
		Amount of elements	2.24	2.68
		Element heterogeneity	2.24	2.66
		Asymmetry	4.42	4.66
		Colour variety	2.68	2.92
		Three-dimensionality	1.61	2.00
1223		Unintelligibility of the elements	1.16	1.34
		Disorganization	1.45	1.58
		Amount of elements	1.74	1.63
		Element heterogeneity	2.18	2.30
		Asymmetry	5.82	5.68
		Colour variety	2.23	2.53
		Three-dimensionality	2.11	2.20
1224		Unintelligibility of the elements	1.21	1.21
		Disorganization	2.21	1.86
		Amount of elements	2.00	2.27
		Element heterogeneity	2.32	3.07
		Asymmetry	6.79	6.68
		Colour variety	2.45	2.32
		Three-dimensionality	1.50	1.85
1225		Unintelligibility of the elements	1.66	1.39
		Disorganization	1.45	1.67
		Amount of elements	1.50	1.27
		Element heterogeneity	1.95	1.46
		Asymmetry	5.13	6.02
		Colour variety	2.16	2.10
		Three-dimensionality	1.49	1.89

1226		Unintelligibility of the elements	1.61	1.43
		Disorganization	2.26	2.09
		Amount of elements	2.21	1.84
		Element heterogeneity	2.39	2.00
		Asymmetry	5.82	5.80
		Colour variety	2.33	2.00
		Three-dimensionality	5.00	4.55
2112		Unintelligibility of the elements	6.68	7.13
		Disorganization	7.50	6.59
		Amount of elements	4.05	4.29
		Element heterogeneity	3.95	4.71
		Asymmetry	6.82	6.43
		Colour variety	4.97	5.23
		Three-dimensionality	2.45	2.67
2113		Unintelligibility of the elements	6.79	6.96
		Disorganization	7.37	6.96
		Amount of elements	6.16	5.54
		Element heterogeneity	4.61	5.23
		Asymmetry	3.76	4.30
		Colour variety	3.69	3.96
		Three-dimensionality	2.28	2.59
2114		Unintelligibility of the elements	6.58	6.96
		Disorganization	7.13	7.14
		Amount of elements	5.58	5.63
		Element heterogeneity	4.61	5.41
		Asymmetry	4.05	4.45
		Colour variety	4.66	5.16
		Three-dimensionality	3.05	3.49

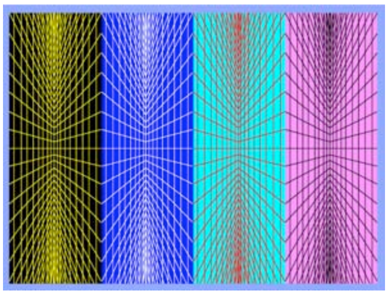
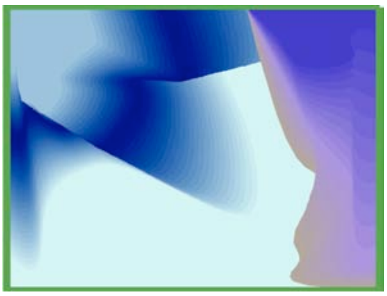
2115		Unintelligibility of the elements	6.34	6.07
		Disorganization	7.24	6.38
		Amount of elements	5.61	5.34
		Element heterogeneity	4.58	4.41
		Asymmetry	5.55	5.77
		Colour variety	5.11	4.96
		Three-dimensionality	6.18	6.38
2116		Unintelligibility of the elements	7.03	7.11
		Disorganization	7.32	6.96
		Amount of elements	5.53	5.09
		Element heterogeneity	5.00	4.57
		Asymmetry	3.58	3.98
		Colour variety	3.97	3.54
		Three-dimensionality	3.03	3.38
2123		Unintelligibility of the elements	3.68	3.66
		Disorganization	3.58	4.09
		Amount of elements	3.58	3.50
		Element heterogeneity	1.63	1.93
		Asymmetry	4.26	3.86
		Colour variety	1.29	1.20
		Three-dimensionality	1.71	2.71
2124		Unintelligibility of the elements	5.32	4.54
		Disorganization	6.53	5.16
		Amount of elements	4.32	4.05
		Element heterogeneity	2.95	3.23
		Asymmetry	5.08	5.48
		Colour variety	4.66	6.14
		Three-dimensionality	2.14	2.68

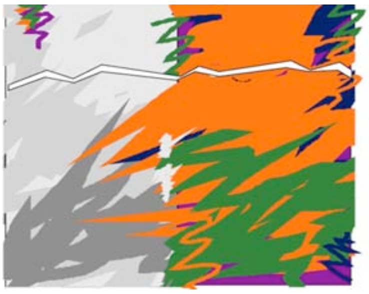
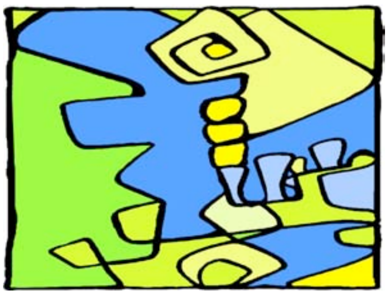
2125		Unintelligibility of the elements	4.71	5.54
		Disorganization	6.00	6.18
		Amount of elements	3.61	4.88
		Element heterogeneity	3.26	3.82
		Asymmetry	6.29	5.41
		Colour variety	3.26	3.39
		Three-dimensionality	2.45	2.85
2126		Unintelligibility of the elements	5.58	5.68
		Disorganization	6.76	6.18
		Amount of elements	3.42	3.34
		Element heterogeneity	2.66	3.09
		Asymmetry	6.03	6.27
		Colour variety	1.74	1.65
		Three-dimensionality	2.55	4.23
2127		Unintelligibility of the elements	5.03	4.73
		Disorganization	6.03	6.04
		Amount of elements	3.89	4.14
		Element heterogeneity	3.45	3.11
		Asymmetry	3.87	4.34
		Colour variety	2.92	4.24
		Three-dimensionality	1.62	2.02
2212		Unintelligibility of the elements	2.76	2.50
		Disorganization	1.82	2.34
		Amount of elements	6.58	6.43
		Element heterogeneity	5.97	6.14
		Asymmetry	5.55	6.18
		Colour variety	7.00	7.00
		Three-dimensionality	7.32	7.26

2213		Unintelligibility of the elements	2.82	2.32
		Disorganization	2.26	2.45
		Amount of elements	5.97	5.79
		Element heterogeneity	5.68	6.46
		Asymmetry	5.55	5.84
		Colour variety	6.72	6.42
		Three-dimensionality	7.24	7.08
2214		Unintelligibility of the elements	2.68	2.38
		Disorganization	2.71	2.45
		Amount of elements	7.03	7.02
		Element heterogeneity	6.47	6.45
		Asymmetry	7.11	7.00
		Colour variety	6.47	7.04
		Three-dimensionality	6.78	6.40
2215		Unintelligibility of the elements	4.08	3.66
		Disorganization	4.63	4.02
		Amount of elements	5.58	5.18
		Element heterogeneity	4.45	4.05
		Asymmetry	5.63	4.98
		Colour variety	4.29	4.06
		Three-dimensionality	6.47	6.10
2216		Unintelligibility of the elements	4.66	4.89
		Disorganization	4.63	4.87
		Amount of elements	6.82	6.38
		Element heterogeneity	6.29	6.43
		Asymmetry	5.95	5.89
		Colour variety	5.69	6.19
		Three-dimensionality	5.41	4.85

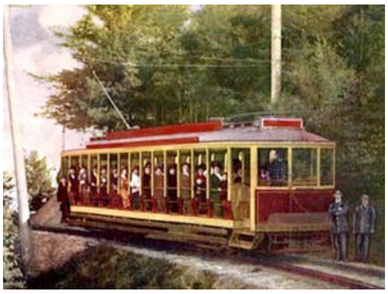
2223		Unintelligibility of the elements	2.63	2.46
		Disorganization	3.34	3.18
		Amount of elements	3.79	4.70
		Element heterogeneity	3.39	5.11
		Asymmetry	3.37	3.77
		Colour variety	4.87	5.61
		Three-dimensionality	1.92	2.58
2224		Unintelligibility of the elements	1.97	1.73
		Disorganization	2.00	1.87
		Amount of elements	3.95	4.14
		Element heterogeneity	4.63	5.04
		Asymmetry	4.53	4.57
		Colour variety	3.59	3.85
		Three-dimensionality	6.32	5.60
2225		Unintelligibility of the elements	1.79	1.64
		Disorganization	1.53	1.80
		Amount of elements	3.26	2.73
		Element heterogeneity	2.26	2.13
		Asymmetry	7.58	6.98
		Colour variety	3.56	3.42
		Three-dimensionality	3.61	3.66
2226		Unintelligibility of the elements	2.13	1.61
		Disorganization	1.58	1.84
		Amount of elements	5.32	5.11
		Element heterogeneity	5.42	5.27
		Asymmetry	4.00	4.38
		Colour variety	5.37	5.33
		Three-dimensionality	7.92	7.23

2227		Unintelligibility of the elements	1.71	1.57
		Disorganization	1.29	1.93
		Amount of elements	5.13	4.71
		Element heterogeneity	4.89	5.68
		Asymmetry	6.13	5.23
		Colour variety	5.66	5.50
		Three-dimensionality	7.84	7.57
3112		Unintelligibility of the elements	8.05	7.88
		Disorganization	7.53	7.13
		Amount of elements	7.84	7.71
		Element heterogeneity	7.00	7.13
		Asymmetry	4.92	4.52
		Colour variety	7.15	7.37
		Three-dimensionality	2.92	3.17
3113		Unintelligibility of the elements	8.18	6.89
		Disorganization	7.79	6.41
		Amount of elements	7.24	7.41
		Element heterogeneity	6.05	5.13
		Asymmetry	3.55	2.82
		Colour variety	4.79	4.69
		Three-dimensionality	3.11	3.28
3114		Unintelligibility of the elements	7.16	7.86
		Disorganization	7.26	7.69
		Amount of elements	7.76	7.45
		Element heterogeneity	6.76	6.64
		Asymmetry	5.95	6.48
		Colour variety	5.45	5.04
		Three-dimensionality	4.32	4.63

3115		Unintelligibility of the elements	7.53	7.30
		Disorganization	7.13	6.73
		Amount of elements	7.00	6.14
		Element heterogeneity	6.39	6.21
		Asymmetry	3.95	4.07
		Colour variety	5.89	5.31
		Three-dimensionality	5.84	6.17
3116		Unintelligibility of the elements	7.13	7.64
		Disorganization	7.47	7.53
		Amount of elements	8.18	7.88
		Element heterogeneity	7.08	7.13
		Asymmetry	4.16	4.23
		Colour variety	5.55	4.94
		Three-dimensionality	5.14	4.80
3122		Unintelligibility of the elements	4.29	4.54
		Disorganization	4.03	4.38
		Amount of elements	4.63	6.14
		Element heterogeneity	2.42	3.13
		Asymmetry	3.11	3.09
		Colour variety	5.33	5.30
		Three-dimensionality	6.71	7.11
3123		Unintelligibility of the elements	6.11	6.41
		Disorganization	6.97	5.80
		Amount of elements	3.00	3.30
		Element heterogeneity	2.61	2.64
		Asymmetry	6.21	5.82
		Colour variety	2.42	2.68
		Three-dimensionality	4.21	5.15

3124		Unintelligibility of the elements	6.92	6.30
		Disorganization	7.82	6.98
		Amount of elements	5.26	5.54
		Element heterogeneity	4.32	4.30
		Asymmetry	4.89	4.59
		Colour variety	4.97	5.31
		Three-dimensionality	2.61	2.71
3125		Unintelligibility of the elements	5.87	6.29
		Disorganization	7.16	6.96
		Amount of elements	4.82	6.04
		Element heterogeneity	4.47	5.18
		Asymmetry	7.39	6.95
		Colour variety	4.05	4.38
		Three-dimensionality	2.24	3.26
3126		Unintelligibility of the elements	4.61	4.13
		Disorganization	6.03	5.70
		Amount of elements	3.03	3.09
		Element heterogeneity	2.71	3.13
		Asymmetry	4.58	4.43
		Colour variety	2.79	3.02
		Three-dimensionality	1.58	2.44
3212		Unintelligibility of the elements	5.42	6.02
		Disorganization	6.66	6.35
		Amount of elements	7.89	7.91
		Element heterogeneity	7.18	6.89
		Asymmetry	4.55	3.98
		Colour variety	7.76	7.90
		Three-dimensionality	6.37	6.30

3213		Unintelligibility of the elements	3.13	3.38
		Disorganization	2.47	2.73
		Amount of elements	8.13	8.13
		Element heterogeneity	7.95	8.09
		Asymmetry	4.13	4.50
		Colour variety	7.58	7.70
		Three-dimensionality	7.32	7.65
3214		Unintelligibility of the elements	6.21	6.30
		Disorganization	6.32	6.20
		Amount of elements	7.26	7.23
		Element heterogeneity	6.71	6.18
		Asymmetry	4.76	4.54
		Colour variety	5.49	5.25
		Three-dimensionality	5.86	5.64
3215		Unintelligibility of the elements	5.08	4.95
		Disorganization	6.58	6.00
		Amount of elements	7.37	7.55
		Element heterogeneity	7.34	7.70
		Asymmetry	6.39	6.46
		Colour variety	7.18	7.20
		Three-dimensionality	4.28	4.45
3216		Unintelligibility of the elements	6.55	7.13
		Disorganization	6.37	6.47
		Amount of elements	6.34	6.70
		Element heterogeneity	5.66	5.93
		Asymmetry	3.13	4.20
		Colour variety	4.58	4.92
		Three-dimensionality	5.24	5.65

3223		Unintelligibility of the elements	2.42	2.25
		Disorganization	2.13	2.50
		Amount of elements	6.26	6.73
		Element heterogeneity	5.66	5.88
		Asymmetry	5.34	5.05
		Colour variety	6.71	6.68
		Three-dimensionality	6.89	7.13
3224		Unintelligibility of the elements	2.53	2.29
		Disorganization	2.50	2.47
		Amount of elements	6.76	6.84
		Element heterogeneity	7.16	7.52
		Asymmetry	6.58	6.59
		Colour variety	7.15	7.35
		Three-dimensionality	7.46	7.02
3225		Unintelligibility of the elements	2.39	2.09
		Disorganization	1.71	2.15
		Amount of elements	6.24	6.63
		Element heterogeneity	6.47	6.71
		Asymmetry	5.26	4.96
		Colour variety	6.92	7.10
		Three-dimensionality	7.18	7.13
3226		Unintelligibility of the elements	2.82	2.32
		Disorganization	2.24	2.44
		Amount of elements	6.66	5.93
		Element heterogeneity	4.97	4.86
		Asymmetry	6.16	6.71
		Colour variety	4.26	3.94
		Three-dimensionality	7.42	7.09

3227		Unintelligibility of the elements	2.34	2.02
		Disorganization	2.16	2.48
		Amount of elements	7.24	7.71
		Element heterogeneity	6.50	6.07
		Asymmetry	4.53	3.93
		Colour variety	6.32	5.88
		Three-dimensionality	7.70	7.11

Annex C

In this Annex we present the results of our analysis of double interactions between our three independent variables (Complexity, Abstraction, Artistry) on men and women's beauty scores.

Abstraction x Artistry

Artistry in Abstraction ($\alpha^* = \frac{.05}{2} = .025$)

<u>Abstract stimuli</u>: Are there differences between beauty scores awarded to artistic and decorative abstract stimuli?

Ranks

	Artistry	N	Mean Rank	Sum of Ranks
Beauty men	Artistic stimuli	30	42,28	1268,50
	Decorative stimuli	28	15,80	442,50
	Total	58		
Beauty women	Artistic stimuli	30	41,80	1254,00
	Decorative stimuli	30	19,20	576,00
	Total	60		

Test Statistics[a]

	Beauty men	Beauty women
Mann-Whitney U	36,500	111,000
Wilcoxon W	442,500	576,000
Z	-5,969	-5,013
Asymp. Sig. (2-tailed)	,000	,000

a. Grouping Variable: Artistry

Artistic abstract stimuli were rated more beautiful than decorative abstract stimuli by both men and women (p<.025).

Representational stimuli: Are there differences between beauty scores awarded to artistic and decorative representational stimuli?

Ranks

	Artistry	N	Mean Rank	Sum of Ranks
Beauty men	Artistic stimuli	30	37,58	1127,50
	Decorative stimuli	30	23,42	702,50
	Total	60		
Beauty women	Artistic stimuli	30	37,43	1123,00
	Decorative stimuli	30	23,57	707,00
	Total	60		

Test Statistics[a]

	Beauty men	Beauty women
Mann-Whitney U	237,500	242,000
Wilcoxon W	702,500	707,000
Z	-3,142	-3,076
Asymp. Sig. (2-tailed)	,002	,002

a. Grouping Variable: Artistry

Artistic representational stimuli were rated more beautiful than decorative representational stimuli by both men and women (p<.025).

Abstraction in Artistry ($\alpha^* = \frac{.05}{2} = .025$)

<u>Artistic stimuli</u>: Are there differences between beauty scores awarded to abstract and representational artistic stimuli?

Ranks

	Abstraction	N	Mean Rank	Sum of Ranks
Beauty men	Abstract stimuli	30	20,18	605,50
	Representational stimuli	30	40,82	1224,50
	Total	60		
Beauty women	Abstract stimuli	30	21,23	637,00
	Representational stimuli	30	39,77	1193,00
	Total	60		

Test Statistics[a]

	Beauty men	Beauty women
Mann-Whitney U	140,500	172,000
Wilcoxon W	605,500	637,000
Z	-4,576	-4,111
Asymp. Sig. (2-tailed)	,000	,000

a. Grouping Variable: Abstraction

Representational artistic stimuli were rated more beautiful than abstract artistic stimuli by both men and women (p<.025).

Decorative stimuli: Are there differences between beauty scores awarded to abstract and representational decorative stimuli?

Ranks

	Abstraction	N	Mean Rank	Sum of Ranks
Beauty men	Abstract stimuli	28	18,46	517,00
	Representational stimuli	30	39,80	1194,00
	Total	58		
Beauty women	Abstract stimuli	30	23,87	716,00
	Representational stimuli	30	37,13	1114,00
	Total	60		

Test Statistics[a]

	Beauty men	Beauty women
Mann-Whitney U	111,000	251,000
Wilcoxon W	517,000	716,000
Z	-4,809	-2,943
Asymp. Sig. (2-tailed)	,000	,003

a. Grouping Variable: Abstraction

Representational decorative stimuli were rated more beautiful than abstract decorative stimuli by both men and women (p<.025).

Abstraction x Complexity

Complexity in Abstraction ($\alpha^* = \frac{.05}{2} = .025$)

<u>Abstract stimuli</u>: Are there differences among the beauty scores awarded to low, intermediate, and high complexity abstract stimuli?

Ranks

	Complexity	N	Mean Rank
Beauty men	Low	20	26,50
	Medium	20	29,45
	High	18	32,89
	Total	58	
Beauty women	Low	20	25,60
	Medium	20	31,63
	High	20	34,28
	Total	60	

Test Statistics[a,b]

	Beauty men	Beauty women
Chi-Square	1,357	2,593
df	2	2
Asymp. Sig.	,507	,273

a. Kruskal Wallis Test

b. Grouping Variable: Complexity

There were no statistical differences among the beauty scores awarded to low, intermediate, and high complexity abstract stimuli

Representational stimuli: Are there differences among the beauty scores awarded to low, intermediate, and high complexity representational stimuli?

Ranks

	Complexity	N	Mean Rank
Beauty men	Low	20	22,02
	Medium	20	29,83
	High	20	39,65
	Total	60	
Beauty women	Low	20	23,17
	Medium	20	29,48
	High	20	38,85
	Total	60	

Test Statistics[a,b]

	Beauty men	Beauty women
Chi-Square	10,232	8,163
df	2	2
Asymp. Sig.	,006	,017

a. Kruskal Wallis Test

b. Grouping Variable: Complexity

There were statistical differences among the beauty scores awarded to low, intermediate, and high complexity abstract stimuli, for both men and women (p<.025). We carried out pairwise contrasts using the Mann-Whitney test to determine the complexity levels between which beauty scores differed ($\alpha^* = \frac{.05}{6} = .0083$).

Ranks

	Complexity	N	Mean Rank	Sum of Ranks
Beauty men	Low	20	17,70	354,00
	Medium	20	23,30	466,00
	Total	40		
Beauty women	Low	20	18,27	365,50
	Medium	20	22,73	454,50
	Total	40		

Ranks

	Complexity	N	Mean Rank	Sum of Ranks
Beauty men	Medium	20	17,02	340,50
	High	20	23,98	479,50
	Total	40		
Beauty women	Medium	20	17,25	345,00
	High	20	23,75	475,00
	Total	40		

Test Statistics[b]

	Beauty men	Beauty women
Mann-Whitney U	144,000	155,500
Wilcoxon W	354,000	365,500
Z	-1,515	-1,204
Asymp. Sig. (2-tailed)	,130	,229
Exact Sig. [2*(1-tailed Sig.)]	,134[a]	,231[a]

a. Not corrected for ties.

b. Grouping Variable: Complexity

Test Statistics[b]

	Beauty men	Beauty women
Mann-Whitney U	130,500	135,000
Wilcoxon W	340,500	345,000
Z	-1,880	-1,759
Asymp. Sig. (2-tailed)	,060	,079
Exact Sig. [2*(1-tailed Sig.)]	,060[a]	,081[a]

a. Not corrected for ties.

b. Grouping Variable: Complexity

Ranks

	Complexity	N	Mean Rank	Sum of Ranks
Beauty men	Low	20	14,82	296,50
	High	20	26,17	523,50
	Total	40		
Beauty women	Low	20	15,40	308,00
	High	20	25,60	512,00
	Total	40		

Test Statistics[b]

	Beauty men	Beauty women
Mann-Whitney U	86,500	98,000
Wilcoxon W	296,500	308,000
Z	-3,070	-2,760
Asymp. Sig. (2-tailed)	,002	,006
Exact Sig. [2*(1-tailed Sig.)]	,002[a]	,005[a]

a. Not corrected for ties.

b. Grouping Variable: Complexity

Both men and women rated the beauty of high complexity representational stimuli higher than low complexity representational stimuli (p<.0083).

Abstraction in Complexity ($\alpha^* = \frac{.05}{6} = .0083$)

Low complexity stimuli: Are there differences between beauty scores awarded to abstract and representational low complexity stimuli?

Ranks

	Abstraction	N	Mean Rank	Sum of Ranks
Beauty men	Abstract stimuli	20	16,52	330,50
	Representational stimuli	20	24,48	489,50
	Total	40		
Beauty women	Abstract stimuli	20	17,33	346,50
	Representational stimuli	20	23,67	473,50
	Total	40		

Test Statistics[b]

	Beauty men	Beauty women
Mann-Whitney U	120,500	136,500
Wilcoxon W	330,500	346,500
Z	-2,151	-1,718
Asymp. Sig. (2-tailed)	,032	,086
Exact Sig. [2*(1-tailed Sig.)]	,030[a]	,086[a]

a. Not corrected for ties.

b. Grouping Variable: Abstraction

For both men and women, differences between beauty scores awarded to abstract and representational low complexity stimuli were not significant.

Intermediate complexity stimuli: Are there differences between beauty scores awarded to abstract and representational intermediate complexity stimuli?

Ranks

	Abstraction	N	Mean Rank	Sum of Ranks
Beauty men	Abstract stimuli	20	14,07	281,50
	Representational stimuli	20	26,92	538,50
	Total	40		
Beauty women	Abstract stimuli	20	15,80	316,00
	Representational stimuli	20	25,20	504,00
	Total	40		

Test Statistics[b]

	Beauty men	Beauty women
Mann-Whitney U	71,500	106,000
Wilcoxon W	281,500	316,000
Z	-3,477	-2,543
Asymp. Sig. (2-tailed)	,001	,011
Exact Sig. [2*(1-tailed Sig.)]	,000[a]	,010[a]

a. Not corrected for ties.

b. Grouping Variable: Abstraction

Both men and women rated the beauty of representational intermediate complexity stimuli higher than abstract intermediate complexity stimuli (p<.0083).

High complexity stimuli: Are there differences between beauty scores awarded to abstract and representational high complexity stimuli?

Ranks

	Abstraction	N	Mean Rank	Sum of Ranks
Beauty men	Abstract stimuli	18	11,75	211,50
	Representational stimuli	20	26,48	529,50
	Total	38		
Beauty women	Abstract stimuli	20	13,27	265,50
	Representational stimuli	20	27,73	554,50
	Total	40		

Test Statistics[b]

	Beauty men	Beauty women
Mann-Whitney U	40,500	55,500
Wilcoxon W	211,500	265,500
Z	-4,079	-3,909
Asymp. Sig. (2-tailed)	,000	,000
Exact Sig. [2*(1-tailed Sig.)]	,000[a]	,000[a]

a. Not corrected for ties.

b. Grouping Variable: Abstraction

Both men and women rated the beauty of representational high complexity stimuli higher than abstract high complexity stimuli (p<.0083).

Artistry x Complexity

Complexity in Artistry ($\alpha^* = \frac{.05}{2} = .025$)

<u>Artistic stimuli</u>: Are there differences among the beauty scores awarded to low, intermediate, and high complexity artistic stimuli?

Ranks

	Complexity	N	Mean Rank
Beauty men	Low	20	28,00
	Medium	20	29,33
	High	20	34,17
	Total	60	
Beauty women	Low	20	28,73
	Medium	20	30,45
	High	20	32,33
	Total	60	

Test Statistics[a,b]

	Beauty men	Beauty women
Chi-Square	1,386	,425
df	2	2
Asymp. Sig.	,500	,808

a. Kruskal Wallis Test

b. Grouping Variable: Complexity

For both men and women differences among the beauty scores awarded to low, intermediate, and high complexity artistic stimuli were non-significant.

Decorative stimuli: Are there differences among the beauty scores awarded to low, intermediate, and high complexity decorative stimuli?

Ranks

	Complexity	N	Mean Rank
Beauty men	Low	20	22,35
	Medium	20	30,55
	High	18	36,28
	Total	58	
Beauty women	Low	20	20,05
	Medium	20	30,98
	High	20	40,47
	Total	60	

Test Statistics[a,b]

	Beauty men	Beauty women
Chi-Square	6,565	13,708
df	2	2
Asymp. Sig.	,038	,001

a. Kruskal Wallis Test

b. Grouping Variable: Complexity

Whereas differences among the beauty scores awarded by men to low, intermediate, and high complexity decorative stimuli were non-significant, they reached statistical significance levels in the case of women (p<.025). Pairwise contrasts between complexity levels were carried out $(\alpha^* = \frac{.05}{6} = .0083)$ by means of Mann-Whitney tests.

Ranks

	Complexity	N	Mean Rank	Sum of Ranks
Beauty women	Low	20	16,70	334,00
	Medium	20	24,30	486,00
	Total	40		

Ranks

	Complexity	N	Mean Rank	Sum of Ranks
Beauty women	Medium	20	17,17	343,50
	High	20	23,83	476,50
	Total	40		

Test Statistics[b]

	Beauty women
Mann-Whitney U	124,000
Wilcoxon W	334,000
Z	-2,057
Asymp. Sig. (2-tailed)	,040
Exact Sig. [2*(1-tailed Sig.)]	,040[a]

a. Not corrected for ties.

b. Grouping Variable: Complexity

Test Statistics[b]

	Beauty women
Mann-Whitney U	133,500
Wilcoxon W	343,500
Z	-1,800
Asymp. Sig. (2-tailed)	,072
Exact Sig. [2*(1-tailed Sig.)]	,072[a]

a. Not corrected for ties.

b. Grouping Variable: Complexity

Ranks

	Complexity	N	Mean Rank	Sum of Ranks
Beauty women	Low	20	13,85	277,00
	High	20	27,15	543,00
	Total	40		

Test Statistics[b]

	Beauty women
Mann-Whitney U	67,000
Wilcoxon W	277,000
Z	-3,598
Asymp. Sig. (2-tailed)	,000
Exact Sig. [2*(1-tailed Sig.)]	,000[a]

a. Not corrected for ties.

b. Grouping Variable: Complexity

Hence, women awarded higher beauty scores to high complexity decorative stimuli than to low complexity decorative stimuli (p<.0083).

Artistry in Complexity ($\alpha^* = \frac{.05}{6} = .0083$)

<u>Low complexity stimuli</u>: Are there differences between beauty scores awarded to artistic and decorative low complexity stimuli?

Ranks

	Artistry	N	Mean Rank	Sum of Ranks
Beauty men	Artistic stimuli	20	28,95	579,00
	Decorative stimuli	20	12,05	241,00
	Total	40		
Beauty women	Artistic stimuli	20	29,15	583,00
	Decorative stimuli	20	11,85	237,00
	Total	40		

Test Statistics[b]

	Beauty men	Beauty women
Mann-Whitney U	31,000	27,000
Wilcoxon W	241,000	237,000
Z	-4,572	-4,681
Asymp. Sig. (2-tailed)	,000	,000
Exact Sig. [2*(1-tailed Sig.)]	,000[a]	,000[a]

a. Not corrected for ties.

b. Grouping Variable: Artistry

Both men and women rated the beauty of artistic low complexity stimuli higher than the beauty of decorative low complexity stimuli (*p*<.0083).

Intermediate complexity stimuli: Are there differences between beauty scores awarded to artistic and decorative intermediate complexity stimuli?

Ranks

	Artistry	N	Mean Rank	Sum of Ranks
Beauty men	Artistic stimuli	20	26,30	526,00
	Decorative stimuli	20	14,70	294,00
	Total	40		
Beauty women	Artistic stimuli	20	26,30	526,00
	Decorative stimuli	20	14,70	294,00
	Total	40		

Test Statistics[b]

	Beauty men	Beauty women
Mann-Whitney U	84,000	84,000
Wilcoxon W	294,000	294,000
Z	-3,139	-3,139
Asymp. Sig. (2-tailed)	,002	,002
Exact Sig. [2*(1-tailed Sig.)]	,001[a]	,001[a]

a. Not corrected for ties.

b. Grouping Variable: Artistry

Both men and women rated the beauty of artistic intermediate complexity stimuli higher than the beauty of decorative intermediate complexity stimuli ($p<.0083$).

High complexity stimuli: Are there differences between beauty scores awarded to artistic and decorative high complexity stimuli?

Ranks

	Artistry	N	Mean Rank	Sum of Ranks
Beauty men	Artistic stimuli	20	21,92	438,50
	Decorative stimuli	18	16,81	302,50
	Total	38		
Beauty women	Artistic stimuli	20	23,00	460,00
	Decorative stimuli	20	18,00	360,00
	Total	40		

Test Statistics[b]

	Beauty men	Beauty women
Mann-Whitney U	131,500	150,000
Wilcoxon W	302,500	360,000
Z	-1,418	-1,353
Asymp. Sig. (2-tailed)	,156	,176
Exact Sig. [2*(1-tailed Sig.)]	,158[a]	,183[a]

a. Not corrected for ties.

b. Grouping Variable: Artistry

For both men and women, differences between beauty scores awarded to artistic and decorative high complexity stimuli were not significant.

Annex D

In this Annex we present the results of our analysis of triple interactions between our three independent variables (Complexity, Abstraction, Artistry) on men and women's beauty scores, except for the analysis of the effects of Complexity in Abstraction x Artistry, which was included in the main text of this work.

Artistry in abstraction x complexity $(\alpha^* = \frac{.05}{30} = .0016)$

Abstract stimuli

Low complexity abstract stimuli: Are there any differences between beauty scores awarded to artistic and decorative low complexity abstract stimuli?

Ranks

	Artistry	N	Mean Rank	Sum of Ranks
Beauty men	Artistic stimuli	10	14,90	149,00
	Decorative stimuli	10	6,10	61,00
	Total	20		
Beauty women	Artistic stimuli	10	15,10	151,00
	Decorative stimuli	10	5,90	59,00
	Total	20		

Test Statistics[b]

	Beauty men	Beauty women
Mann-Whitney U	6,000	4,000
Wilcoxon W	61,000	59,000
Z	-3,327	-3,481
Asymp. Sig. (2-tailed)	,001	,000
Exact Sig. [2*(1-tailed Sig.)]	,000[a]	,000[a]

a. Not corrected for ties.

b. Grouping Variable: Artistry

Both men and women awarded higher beauty scores to artistic low complexity abstract stimuli than to decorative low complexity abstract stimuli (*p*<.0016).

Intermediate complexity abstract stimuli: Are there any differences between beauty scores awarded to artistic and decorative intermediate complexity abstract stimuli?

Ranks

	Artistry	N	Mean Rank	Sum of Ranks
Beauty men	Artistic stimuli	10	14,60	146,00
	Decorative stimuli	10	6,40	64,00
	Total	20		
Beauty women	Artistic stimuli	10	14,20	142,00
	Decorative stimuli	10	6,80	68,00
	Total	20		

Test Statistics[b]

	Beauty men	Beauty women
Mann-Whitney U	9,000	13,000
Wilcoxon W	64,000	68,000
Z	-3,103	-2,797
Asymp. Sig. (2-tailed)	,002	,005
Exact Sig. [2*(1-tailed Sig.)]	,001[a]	,004[a]

a. Not corrected for ties.

b. Grouping Variable: Artistry

Men awarded higher beauty scores to artistic intermediate complexity abstract stimuli than to decorative intermediate complexity abstract stimuli (p<.0016). However, differences did not reach statistical significance levels in the case of women.

High complexity abstract stimuli: Are there any differences between beauty scores awarded to artistic and decorative high complexity abstract stimuli?

Ranks

	Artistry	N	Mean Rank	Sum of Ranks
Beauty men	Artistic stimuli	10	13,50	135,00
	Decorative stimuli	8	4,50	36,00
	Total	18		
Beauty women	Artistic stimuli	10	13,70	137,00
	Decorative stimuli	10	7,30	73,00
	Total	20		

Test Statistics[b]

	Beauty men	Beauty women
Mann-Whitney U	,000	18,000
Wilcoxon W	36,000	73,000
Z	-3,556	-2,419
Asymp. Sig. (2-tailed)	,000	,016
Exact Sig. [2*(1-tailed Sig.)]	,000[a]	,015[a]

a. Not corrected for ties.

b. Grouping Variable: Artistry

Both men and women awarded higher beauty scores to artistic high complexity abstract stimuli than to decorative high complexity abstract stimuli (p<.0016).

Representational stimuli

Low complexity representational stimuli: Are there any differences between beauty scores awarded to artistic and decorative low complexity representational stimuli?

Ranks

	Artistry	N	Mean Rank	Sum of Ranks
Beauty men	Artistic stimuli	10	15,30	153,00
	Decorative stimuli	10	5,70	57,00
	Total	20		
Beauty women	Artistic stimuli	10	15,10	151,00
	Decorative stimuli	10	5,90	59,00
	Total	20		

Test Statistics[b]

	Beauty men	Beauty women
Mann-Whitney U	2,000	4,000
Wilcoxon W	57,000	59,000
Z	-3,628	-3,477
Asymp. Sig. (2-tailed)	,000	,001
Exact Sig. [2*(1-tailed Sig.)]	,000[a]	,000[a]

a. Not corrected for ties.

b. Grouping Variable: Artistry

Both men and women awarded higher beauty scores to artistic low complexity representational stimuli than to decorative low complexity representational stimuli (p<.0016).

Intermediate complexity representational stimuli: Are there any differences between beauty scores awarded to artistic and decorative intermediate complexity representational stimuli?

Ranks

	Artistry	N	Mean Rank	Sum of Ranks
Beauty men	Artistic stimuli	10	13,60	136,00
	Decorative stimuli	10	7,40	74,00
	Total	20		
Beauty women	Artistic stimuli	10	13,40	134,00
	Decorative stimuli	10	7,60	76,00
	Total	20		

Test Statistics[b]

	Beauty men	Beauty women
Mann-Whitney U	19,000	21,000
Wilcoxon W	74,000	76,000
Z	-2,344	-2,193
Asymp. Sig. (2-tailed)	,019	,028
Exact Sig. [2*(1-tailed Sig.)]	,019[a]	,029[a]

a. Not corrected for ties.

b. Grouping Variable: Artistry

For both men and women, differences between beauty scores awarded to artistic and decorative intermediate complexity representational stimuli did not reach statistical significance.

High complexity representational stimuli: Are there any differences between beauty scores awarded to artistic and decorative high complexity representational stimuli?

Ranks

	Artistry	N	Mean Rank	Sum of Ranks
Beauty men	Artistic stimuli	10	10,40	104,00
	Decorative stimuli	10	10,60	106,00
	Total	20		
Beauty women	Artistic stimuli	10	10,35	103,50
	Decorative stimuli	10	10,65	106,50
	Total	20		

Test Statistics[b]

	Beauty men	Beauty women
Mann-Whitney U	49,000	48,500
Wilcoxon W	104,000	103,500
Z	-,076	-,113
Asymp. Sig. (2-tailed)	,940	,910
Exact Sig. [2*(1-tailed Sig.)]	,971[a]	,912[a]

a. Not corrected for ties.

b. Grouping Variable: Artistry

For both men and women, differences between beauty scores awarded to artistic and decorative high complexity representational stimuli did not reach statistical significance.

Abstraction in artistry x complexity $(\alpha^* = \frac{.05}{30} = .0016)$

Artistic stimuli

Low complexity artistic stimuli: Are there any differences between beauty scores awarded to abstract and representational low complexity artistic stimuli?

Ranks

	Abstraction	N	Mean Rank	Sum of Ranks
Beauty men	Abstract stimuli	10	7,10	71,00
	Representational stimuli	10	13,90	139,00
	Total	20		
Beauty women	Abstract stimuli	10	6,95	69,50
	Representational stimuli	10	14,05	140,50
	Total	20		

Test Statistics[b]

	Beauty men	Beauty women
Mann-Whitney U	16,000	14,500
Wilcoxon W	71,000	69,500
Z	-2,570	-2,686
Asymp. Sig. (2-tailed)	,010	,007
Exact Sig. [2*(1-tailed Sig.)]	,009[a]	,005[a]

a. Not corrected for ties.

b. Grouping Variable: Abstraction

For both men and women, differences between beauty scores awarded to abstract and representational low complexity artistic stimuli did not reach statistical significance.

Intermediate complexity artistic stimuli: Are there any differences between beauty scores awarded to abstract and representational intermediate complexity artistic stimuli?

Ranks

	Abstraction	N	Mean Rank	Sum of Ranks
Beauty men	Abstract stimuli	10	6,80	68,00
	Representational stimuli	10	14,20	142,00
	Total	20		
Beauty women	Abstract stimuli	10	7,40	74,00
	Representational stimuli	10	13,60	136,00
	Total	20		

Test Statistics[b]

	Beauty men	Beauty women
Mann-Whitney U	13,000	19,000
Wilcoxon W	68,000	74,000
Z	-2,798	-2,343
Asymp. Sig. (2-tailed)	,005	,019
Exact Sig. [2*(1-tailed Sig.)]	,004[a]	,019[a]

a. Not corrected for ties.

b. Grouping Variable: Abstraction

For both men and women, differences between beauty scores awarded to abstract and representational intermediate complexity artistic stimuli did not reach statistical significance.

High complexity artistic stimuli: Are there any differences between beauty scores awarded to abstract and representational high complexity artistic stimuli?

Ranks

	Abstraction	N	Mean Rank	Sum of Ranks
Beauty men	Abstract stimuli	10	7,60	76,00
	Representational stimuli	10	13,40	134,00
	Total	20		
Beauty women	Abstract stimuli	10	7,70	77,00
	Representational stimuli	10	13,30	133,00
	Total	20		

Test Statistics[b]

	Beauty men	Beauty women
Mann-Whitney U	21,000	22,000
Wilcoxon W	76,000	77,000
Z	-2,192	-2,117
Asymp. Sig. (2-tailed)	,028	,034
Exact Sig. [2*(1-tailed Sig.)]	,029[a]	,035[a]

a. Not corrected for ties.

b. Grouping Variable: Abstraction

For both men and women, differences between beauty scores awarded to abstract and representational high complexity artistic stimuli did not reach statistical significance.

Decorative stimuli

<u>Low complexity decorative stimuli</u>: Are there any differences between beauty scores awarded to abstract and representational low complexity decorative stimuli?

Ranks

	Abstraction	N	Mean Rank	Sum of Ranks
Beauty men	Abstract stimuli	10	8,25	82,50
	Representational stimuli	10	12,75	127,50
	Total	20		
Beauty women	Abstract stimuli	10	9,60	96,00
	Representational stimuli	10	11,40	114,00
	Total	20		

Test Statistics[b]

	Beauty men	Beauty women
Mann-Whitney U	27,500	41,000
Wilcoxon W	82,500	96,000
Z	-1,702	-,680
Asymp. Sig. (2-tailed)	,089	,496
Exact Sig. [2*(1-tailed Sig.)]	,089[a]	,529[a]

a. Not corrected for ties.

b. Grouping Variable: Abstraction

For both men and women, differences between beauty scores awarded to abstract and representational low complexity decorative stimuli did not reach statistical significance.

Intermediate complexity decorative stimuli: Are there any differences between beauty scores awarded to abstract and representational intermediate complexity decorative stimuli?

Ranks

	Abstraction	N	Mean Rank	Sum of Ranks
Beauty men	Abstract stimuli	10	6,75	67,50
	Representational stimuli	10	14,25	142,50
	Total	20		
Beauty women	Abstract stimuli	10	8,40	84,00
	Representational stimuli	10	12,60	126,00
	Total	20		

Test Statistics[b]

	Beauty men	Beauty women
Mann-Whitney U	12,500	29,000
Wilcoxon W	67,500	84,000
Z	-2,837	-1,589
Asymp. Sig. (2-tailed)	,005	,112
Exact Sig. [2*(1-tailed Sig.)]	,003[a]	,123[a]

a. Not corrected for ties.

b. Grouping Variable: Abstraction

For both men and women, differences between beauty scores awarded to abstract and representational intermediate complexity decorative stimuli did not reach statistical significance.

High complexity decorative stimuli: Are there any differences between beauty scores awarded to abstract and representational high complexity decorative stimuli?

Ranks

	Abstraction	N	Mean Rank	Sum of Ranks
Beauty men	Abstract stimuli	8	4,50	36,00
	Representational stimuli	10	13,50	135,00
	Total	18		
Beauty women	Abstract stimuli	10	6,10	61,00
	Representational stimuli	10	14,90	149,00
	Total	20		

Test Statistics[b]

	Beauty men	Beauty women
Mann-Whitney U	,000	6,000
Wilcoxon W	36,000	61,000
Z	-3,556	-3,326
Asymp. Sig. (2-tailed)	,000	,001
Exact Sig. [2*(1-tailed Sig.)]	,000[a]	,000[a]

a. Not corrected for ties.

b. Grouping Variable: Abstraction

Both men and women awarded higher beauty ratings to representational high complexity decorative stimuli than to abstract high complexity decorative stimuli (p<.0016)