Lateral compositional effects on aesthetic preference.

Thesis submitted in accordance with the requirements of the University of Liverpool for the degree of Doctor in Philosophy

by

Carole Bode

Supervisor:
Dr Marco Bertamini

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Acknowledgements

While at a conference at Leuven during the first few weeks of my PhD, Professor Tom Troscianko asked me about my research and myself. I gave him a brief account of my work, and also my family life and other job. He was quiet for a moment, then said “Awesome. You’re probably a little bit crazy, aren’t you?” I explain this tale for two reasons, firstly because juggling a PhD with 3 young children, and a job, is probably not for the faint of heart. Secondly, it was my supervisor, Marco Bertamini, who arranged for Tom to meet up with and look after me. Thank you, Marco for affording me the opportunity to work on great projects, and your patience when things went a bit awry or when I didn’t “keep things simple”. Thanks to my fellow graduate school survivors and colleagues, especially Pawel and Carol who were always there to make me laugh and put things in perspective. Thanks must also go to my sister Nene, and all the Lester family, whose love, support and encouragement when things got tough was always there.

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Abstract

Composition, the conscious arrangement of elements within a visual image, is an important principle in art and is thought to be an integral component in eliciting affective aesthetic responses in judgments and appreciation of art. In this thesis I present four studies that give significant new insights on how human aesthetic preference for visual art is affected by compositional lateral asymmetries, and intrinsic factors such as symmetry, complexity and movement. Chapter 1 introduces the theoretical foundations of aesthetic preference and composition as context for the research, followed by an overview of the chapters, methodology and main findings. The research is divided into two main areas. Chapters 2-3 explore preferences in non-experts for symmetries and lateral asymmetries in static images (novel abstract patterns and photographic self-portraits). Chapters 4-5 analyse asymmetrical biases in cinema films. Chapter 2 revisits previous research on British and Egyptian symmetry preferences using novel abstract patterns, and measurements of complexity. Findings supported a degree of universality for symmetry preference, but some differences in preferences for complexity. Chapter 3 examines whether previously reported preferences for a right-facing bias in painted self-portraits generalise to self-portraits by untrained subjects. Findings confirmed a similar bias, thus supporting a biological basis for side biases. Chapter 4 assesses whether mirror reversal of films affects viewer preference. Viewers did not detect the reversal of the film, but a composition specific exposure effect was observed in those who watched the original version. In Chapter 5, an analysis of posing position and orientation in film actors confirmed an inward-facing bias, a preference for left-to-right directionality in movement, but no left cheek bias. A trend implicated the influence of reading direction in the Egyptian data. Overall these findings confirmed some known preferences in direction and side biases in static and moving images, and provide new evidence in support of a biological basis for side biases independent of expertise. Importantly, they highlight some cultural differences in preferences for compositional symmetries that may be linked to reading direction, and a difference in preference for complexity. Defining what factors relating to composition determine preference is key to understanding human aesthetic preference and decisions in the appreciation and production of visual art. This thesis provides a significant contribution towards that goal.
Chapter 1. Introduction

The world is a thing of utter inordinate complexity and richness and strangeness that is absolutely awesome. I mean the idea that such complexity can arise not only out of such simplicity, but probably absolutely out of nothing, is the most fabulous extraordinary idea. 

11. Philosophical and theoretical frameworks of aesthetic preference

Artistic creativity and the ability to appreciate art and beauty are intrinsic characteristics of what defines our species. These characteristics are also closely linked to human evolution and social and cultural development. What constitutes beauty in visual art is a long-debated and controversial theme in Western art and philosophy. Aesthetics, the study of what determines beauty, has traditionally been the domain of philosophy. The German philosopher Alexander Baumgarten (1750) first used the word “aesthetics” (derived from the Greek term aisthetikos (αἰσθητικός) meaning sensory perception) to describe the process of understanding what determines that something is beautiful or ugly, and how we make these judgments.

To the philosophers of ancient Greece, beauty represented the victory of harmony and order over chaos. Beauty as an inherent characteristic of art was one that was firmly established in the ancient world, but this idea was not unchallenged. The philosopher Plato’s account of beauty in The Symposium argues that the objective of beauty is perfect unity, and Pythagoras was one of the first to explicitly note the ratio between beauty and proportion (Eco, 2004). However, Plato was sceptical of the intrinsic value of art and dismissed it as merely a poor imitation of life (Shimamura, 2012). From Plato’s perspective, beauty was a discrete state unconnected to the physical object in which it was embodied. However, he conceded that the beauty of an artwork could be found by calculating the average between two extremes. This suggested a quantifiable measure of aesthetic judgment was possible (Eco, 2002).

As humans, our lives frequently involve choices. From the moment we wake up we make choices about what food we will eat, what newspaper we read, what colour shirt we wear, and so on. The preferences we express for everyday objects help to define us as individuals. Preference for such items is theoretically interesting to economists in relation to an item’s hedonic or utilitarian value (our willingness to pay more for a beautiful object than for one less beautiful). However, according to Immanuel Kant (1790) an intrinsic feature of aesthetic judgment is that it is less likely to be concerned with an objective value such as monetary worth, and more likely to be concerned with a subjective pleasant or unpleasant sensation.
Kant (in *The Critique of Judgment*, 1790/2007) made the explicit connection between preference for an object and the observer’s personal experience, rather than merely preference for the aesthetic attributes of the object. Kant claimed that aesthetic judgments were distinguished by four fundamental properties: subjectivity, disinterest, universality, and purpose. He also argued that aesthetic judgments are subjective. This argument is based on the idea that the individual aesthetic experience of liking or disliking an object is a result of the relationship between the viewer and the object (rather than an objective aesthetic evaluation of the object alone).

According to Kant, aesthetic judgments also require disinterest. Therefore, we should be satisfied with an object simply because we judge it to be beautiful rather than judging it beautiful because it gratifies some need. Furthermore, Kant insisted that aesthetic judgments are both universal and necessary and synonymous with common sense. Thus there is no objective property that makes an object beautiful. He argued that aesthetic judgments involve far more complex processes than individual preferences, and therefore aesthetic judgments may not always be universal. Thus, even if we agree that 'beauty is in the eye of the beholder', we might still expect others to agree with our judgement of an object as if its beauty were an objective property rather than personal experience (Zimmerman, 1963). From this point, the discussion of beauty began to evolve from philosophical enquiry to the scientific and quantitative approach that embodies current empirical aesthetics.

Aesthetic preference for visual art is a fascinating though complex topic. However, a question that is frequently asked is whether aesthetic responses to art can be studied meaningfully within the framework of empirical psychology. There are fundamental disagreements regarding the definitions and parameters relating to aesthetic experience of visual art, and whether it can be considered an emotional or affective state (Jacobsen, 2004; Leder et al., 2004; Shimamura, 2014). The debate also involves the issue of whether aesthetics should be limited to the study of art, or whether the same aesthetic principles can, and should be applied to mundane, manufactured objects as well as natural objects (such as flowers, animals, or landscapes; Marković, 2012). Furthermore, aesthetic preference is of interest to diverse fields of (e.g. evolutionary, historical, cultural, educational, cognitive, neurobiological, personality) research. Given this broad approach, it also follows that aesthetic judgments of artworks are shaped by as many different factors (e.g.
symmetry, complexity, familiarity or novelty, the artistic medium and genre, socio-cultural and individual preferences) that influenced the creation of the artwork in the first place (Leder & Nadal, 2014).

This is reflected in the challenging in building a robust framework for the study of visual aesthetics, the least problem of which is the standardisation of terms (Child, 1962). In a review of aesthetic measures, McWhinnie (1968) made the distinction between aesthetic preference and aesthetic judgment. He defined aesthetic preference within a set of bipolar dimensions, that is, the extent to which people like or dislike an artwork, and aesthetic judgment as the extent to which the person judges the aesthetic value of the artwork. However, it may be that aesthetic experience is best examined and defined from a broader perspective involving different and appropriate levels of analysis (Jacobsen, 2002).

1.1.1. Foundations of early modern empirical aesthetics: From Fechner to Gestalt

It is only relatively recently that empirical methods have been used to investigate and explain how objects and scenes can influence responses in viewers. Modern empirical aesthetics and psychophysics is agreed to owe much to the work of Gustav Theodor Fechner (1801-1887). Prior to Fechner, examination of the psychological phenomena of art and aesthetics had relied on personal experience and observations of others responses to an artwork. Fechner conducted some of the earliest psychophysical studies involving visual perception and aesthetics. These studies, collected in *Vorschule der Ästhetik* (Preschool of Aesthetics, 1876) provide an overview of Fechner’s work on aesthetics.

Fechner’s (1871) study of the paintings of the *Madonna des Bürgomeister Meyer zum Hasen* (1526-8, attributed to Hans Holbein the Younger, Fig.1) is considered to be one of the earliest examples of empirical investigation of aesthetic preference. Art experts had questioned the authenticity of the paintings. It was Fechner’s general belief that authentication of the original painting depended on which of the two were judged as more beautiful. In order to make a direct comparison of preferences for the two paintings, Fechner asked visitors to an exhibition that included both paintings to decide which they most preferred using a simple two-alternative forced-choice (2AFC) paradigm. In particular, Fechner asked them to judge which Madonna’s face was most beautiful as he considered that it
would not be feasible to address other aspects of the paintings (e.g., colour, style, arrangement and proportions of the figures). Whilst Fechner reported a clear preference for the Darmstadt Madonna, there were only 113 respondents, and of these, only forty-three whom Fechner considered to have followed his instructions correctly. He also based his conclusions on overheard comments from the exhibition visitors. Additionally, it is also possible that an attempt to authenticate the Darmstadt version prior to the exhibition may have influenced preference (see Marshall et al., 1995).

The results of Fechner’s studies are probably of less interest than his attempt to collect and analyse data using a psychophysical approach, reliance on empirical research and replicable behavioural measures (Marshall et al., 1995). Criticisms of Fechner’s methodology have focused on its reductionist approach, and disregard for individual differences (see Cupchik, 1986; Eysenck, 1997). Nonetheless, Fechner's idea of “aesthetics from above and below”, his attempts to understand the aesthetic experience, and his critical interpretations of the characteristics of various visual stimuli provided the foundations for further psychophysical research.

Figure 1. The two versions of Madonna des Bürgomeister zum Hasen (1526-8), attributed to Hans Holbein the Younger. Left: Darmstadt Madonna (Swäbisch Hall, Baden-Württemburg); Right: Dresden Madonna (c.1630, Bartholomäus Sarburgh).
Gestalt psychology has been considerably influential in the psychology of art and aesthetics and stems from the philosophical and theoretical writings of, among others, Johann Wolfgang von Goethe (1749-1832), Immanuel Kant, and Ernst Mach (1838-1916). The notion of Gestalt (meaning an integrated form or shape) was introduced by Christian von Ehrenfels and was based on observations of how people can recognize two melodies as identical even when the notes do not have the same frequency (1890/1988).

In comparison to Fechner’s psychophysical approach, Gestalt psychology aimed to provide a less reductionist methodology for the investigation of perceptual phenomena. Gestalt psychology took a more holistic approach, emphasising the importance of context and order in the investigation of visual stimuli (Cupchik, 1986; Arnheim, 1971). Max Wertheimer’s discovery of the “phi phenomenon” (the illusion of apparent motion during the rapid and sequential presentation of still images) led him to consider the tendency to perceive groups of features as unified wholes (Cupchik, 2007). That is, “the whole is something other than the sum of its parts” (Metzger, 1936/2006; Wagemans et al., 2012a; Wagemans et al., 2012b).

Wertheimer and his colleagues, Kurt Koffka and Wolfgang Köhler, formalised this as the “laws of Prägnanz” (meaning “pithiness”). A key principle of Prägnanz states that a visual scene is an organised group of global features that should be viewed as a whole entity, independent of its simpler, fundamental components. This suggested a human predisposition to perceive form or structure in the simplest way possible, through the use of groupings based on spatial, feature and motion similarities or symmetry and closure (Koffka, 1935).

These concepts have subsequently been applied to theories of art and aesthetics (Arnheim, 1943, 1954/1974/1996, 1933/1958/1983; Wagemans et al., 2012a; Wagemans et al., 2012b). Importantly, Gestalt psychology acknowledged that the visual world can be perceptually ambiguous and chaotic, and considered the principles of order and complexity to be important determinants of aesthetic appreciation. That is, in relation to the understanding of a visual scene, humans interpret the overall organisation rather than the individual components that comprise the scene.

Limitations and criticisms of Gestalt psychology relate to issues regarding the lack of a robust methodology involving imprecise formulations of multiple laws of perceptual organisation, vague theoretical assumptions, and simplistic,
confounded stimuli. The post-war period (from 1945) saw a decline in the interest in Gestalt psychology. Nonetheless, it has continued to influence empirical aesthetics, and a recent renewal of interest in Gestalt has seen a move to address conceptual and theoretical criticisms (see Wagemans et al., 2012a; Wagemans et al., 2012b).

The next section considers an author whose work in the Gestalt tradition has been a considerable inspiration not only on the research contained in this thesis (which owes several debts to Arnheim’s ‘visual thinking’ on the subjects of film, symmetry, and composition) but also on the psychology of visual art as a field of research.

1.1.2. Arnheim:

One of the most important writers in the field of visual art and aesthetics was Rudolf Arnheim (1904-2007). Arnheim’s holistic approach to perception provided a more cognitive and theoretically driven approach in the application of Gestalt psychology to art and aesthetics (Cupchik, 2007; Verstegen, 2007). As a student of Max Wertheim and Wolfgang Köhler, Arnheim’s work on expression (The Gestalt Theory of Expression, 1949), film (Film as Art, 1933/1958/1983), perceptual organisation and visual art were strongly informed by Gestalt principles. Arnheim’s (1954/1974/1996) highly influential theory of visual composition (derived from the work of Denman Ross, 1907) emphasised the role of organisation and dynamics of perceptual features act in creating interesting works of art (particularly in terms of expressiveness; McManus, Stöver, & Kim, 2011). In Art and Perception: The Psychology of the Visual Eye, Arnheim (1954/1974/1996) provides an overview of the core Gestalt principles of perceptual organisation (i.e. balance, harmony and the placement of objects influences the aesthetic experience). A feature of Arnheim’s theory is that visual experience of an image is subject to dynamic psychological effects or ‘forces’. He argued that by conforming to principles of composition when creating an artwork, artists are able to elicit aesthetic responses such as a sense of calm or tension in observers (1954/1974/1996).

Furthermore, for an artwork to be considered aesthetically pleasing, these tensions or ‘perceptual forces’ as he described them, need to be balanced. Debate surrounds what exactly Arnheim meant by the term “perceptual force”. Cupchik (2007) suggested that these are likely to be metaphors and should not be taken too
seriously and are far less concrete than Arnheim’s work on composition and the dynamics of balance. McManus et al. (2011) contend that Arnheim considered perceptual forces to be perceptually and artistically real (see Arnheim, 1954/1974/1997, pp.16-19).

Arnheim illustrated the idea of balance by describing the way in which the positioning of a circle at the centre or to the side of a rectangle can reduce or increase this tension (see Fig.2). Arnheim’s analyses of pictorial composition have been criticised for being largely intuitive observations, and lacking in empirical evidence (Tyler, 2007). Nonetheless, Arnheim’s work continues to exert its influence on experimental aesthetics, despite mixed support from subsequent work relating to balance and composition in images (Cupchik, 2007; Gershoni & Hochstein, 2011; McManus et al, 1985; McManus et al., 2011; Palmer & Guidi, 2011).

Figure 2. Arnheim’s structural skeleton of a square (a). The dotted lines represent stability, strongest at the axes of symmetry and at the centres of the circles. Elements placed along the axes of symmetry and at the centres will be visually balanced. Arnheim created the diagram by moving a black disk around a square and assessing its’ stability. For example, (b) represents instability, and (c) stability in relation to the contour and centre of the square.
In the following section, I discuss two influential writers who contributed to the development of quantifiable aesthetic measures. Both were influenced by Gestalt psychology, directly in the case of the psychologist Hans Eysenck (1916-1997), and indirectly, in the case of the mathematician George David Birkhoff (1884-1944). Here, I focus on their attempts to define a measure of complexity, which has long been considered an important principle in aesthetic preference for artworks. A section dedicated to complexity is also included further on in this introduction, which reviews the theoretical and empirical approaches from a more recent perspective. However, their importance in relation to some of the research contained in this thesis (see Chapter 1) warrants that Birkhoff and Eysenck are given a section of their own.

1.1.3. Birkhoff and Eysenck: the development of an Aesthetic Measure

The concept of visual complexity evolved from Gestaltist review theory (Koffka, 1922; Köhler, 1920; Hochberg, 1957). However, whilst other writers had discussed these characteristics in order to develop a definition of beauty, it was George David Birkhoff (1932) who first proposed that visual complexity could be measured via a mathematical formula. Birkhoff argued that the aesthetic value of an object could be achieved by calculating the relationship between its order and its complexity. Birkhoff (1932) proposed a formula of aesthetic pleasure where the amount of attraction and attention to an object \( M \) depends on the ratio of order \( O \) or the amount of symmetry or harmony, and complexity \( C \) or the amount of visual detail in the object perceived by the observer, described as follows:

\[
M = \frac{O}{C}
\]

Objects with characteristics relating to order \( O \) contribute positively to the aesthetic measure \( M \), while characteristics relating to complexity \( C \) contribute negatively.

According to Birkhoff (1932), the aesthetic experience involves three consecutive phases: i) An initial effort of attention, necessary for the act of perception, which increases relative to the complexity \( C \) of an object; ii) The association of ideas and aesthetic feeling arising from these ideas account for full perception of an object; and iii) The feeling of value or aesthetic measure \( M \) of the object of attention resulting from the estimate of the amount of order \( O \) intrinsic to the object in comparison to its complexity \( C \). Birkhoff also stipulated order and
complexity for different categories and objects, such as polygonal figures, vase contours, as well as rhythmic structures of poetry and music. Birkhoff (1932) also created 90 examples of polygons (each with ‘M’ values, see Fig.3) that could be used as stimuli. He 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) as elements of order for polygonal figures. Birkhoff (1932) defined complexity as the number of independent straight lines that contain all the sides of the polygon. Birkhoff did not test the predictions of his formula against the ratings made by different groups of participants, others have and results have been mixed (Cf. Myszkowski, Storme, & Zenasni, 2016; McWhinnie, 1966, 1968).

Disagreements regarding Birkhoff’s formula for aesthetic measure focused on the idea that the aesthetic measure (M) was a product of order over complexity (Burt, 1933; Eysenck, 1942) rather than as a ratio of order and complexity (Birkhoff, 1932). Along with its failure to address the issue of individual differences when making aesthetic judgments, there was also the issue of semantic associations of certain polygons (McWhinnie, 1968).

Figure 3. Examples of Birkhoff’s (1932) polygons.
These issues prompted Hans Eysenck’s (1940, 1941a, 1941b) development of an alternative formula. Eysenck (1942) also refuted Birkhoff’s claims that an observer’s eye movements do not follow the outline of a polygon. In a series of studies using 70 of Birkhoff’s polygons, Eysenck (1941a) chose to avoid using those with obvious semantic associations such as the crucifix, swastika and Star of David. By avoiding such polygons, Eysenck demonstrated that his formula provided more robust correlations for order and complexity in preference for polygons. He predicted that the formula could be used to assess aesthetic preference in stimuli other than polygons. Eysenck (1941a) divided the polygons into two sets and asked two groups of seven subjects drawn from different disciplines to rank polygons in order of preference. Two different factors emerged from the analysis of the rankings: a general factor (‘T’ or ‘taste’ factor) with positive loadings, and a bipolar factor (‘K’ factor or ‘complexity factor’, see Eysenck, 1941b) with approximately equal numbers of positive and negative loadings. Eysenck (1941a) noted the geometric features (i.e. vertical, horizontal and rotational symmetries, angles close to 90° or 180°, and the number of non-parallel sides of complex polygons) of polygons that strongly correlated with the ‘T’ factor. From a regression equation of these characteristics Eysenck (1941b) devised the following formula that could predict preference for simple polygons:

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

The (independent) variables in Eysenck’s formula correspond to the following characteristics for the prediction of aesthetic preference for simple polygons: \( x_1 \) refers to vertical or horizontal symmetry, \( x_2 \) to rotational symmetry, \( x_3 \) to equilibrium, \( x_4 \) to repetition, \( x_3 \) is compact figure, \( x_6 \) to polygons with more than 6 non-parallel sides, \( x_7 \) to both vertical and horizontal symmetry, \( x_8 \) to pointed top and/or base, \( x_9 \) to between three and six non-parallel sides, \( x_{10} \) to two non-parallel sides, \( x_{11} \) to re-entrant angles, and \( x_{12} \) to angles approximately 90° or 180° (Eysenck, 1941b). By correlating the average orders of the two sets of polygons with the expected values of the formula, he tested the accuracy of the formula and demonstrated that the formula accounted for over 80% of the factors influencing preference judgments for polygons. A further experiment with different participants and some additional polygons confirmed the accuracy of the formula. Unlike in
Birkhoff’s formula (M=O/C), the terms associated with complexity in Eysenck's (1941b) formula showed positive correlations with preferences for polygons.

Eysenck (1942) suggested that the formula M = O*C to be a better predictor of preferences for polygons. He also noted that the final formula would probably need to be much more complex in order to accommodate not only different classes of objects, but the relationships between the fundamental elements of those objects in the context of the whole. Subsequent studies addressed the issue of order and complexity using Birkhoff’s polygons (Eysenck, 1968) and extended this to other geometric forms (Eysenck, 1971), which gave further credence to his formula (i.e. M = O*C, Eysenck, 1942).

Post-war social and political upheaval, along with the death of key members saw a decline in the popularity and influence of Gestalt psychology, though recently there has been a resurgence of interest in the Gestalt approach to empirical aesthetics (see Wagemans et al., 2010a, 2010b). In this section, I discuss some of the more influential theories of aesthetic preference of the mid to late 20th century.

1.1.4. Modern frameworks for aesthetic preference: psychobiological and cognitive approaches

In contrast to the Gestalt perspective, the “psychobiological approach” proposed by Daniel Berlyne (1970, 1971, 1974) embraced and owes much to the empirical aesthetics “from below” approach of Fechner (Cupchik, 2014). Berlyne’s work undoubtedly contributed to the renewal of scientific interest in the study of art and aesthetics. His most important text is generally considered to be Conflict, Arousal and Curiosity (1960) in which he integrated the behaviourist approach with his work on arousal, exploratory behaviour and curiosity (Konečni, 1979). His interest in the effects of collative motivation on aesthetic phenomena culminated in Aesthetics and Psychobiology (1971), and Studies in the New Experimental Aesthetics (1974), a collection of empirical studies that applied motivational theories to aesthetics. Berlyne integrated different concepts including stimulus-response reinforcement processes based on the relationship between the pleasure or “hedonic” value of a stimulus and arousal mechanisms in the brain (Konečni, 1979). Although Berlyne intended a broader scope in terms of application for this concept, it was also accepted as a reasonable explanation of aesthetic behaviour (Cupchik, 1986). For
example, an early study on aesthetics by Berlyne involved examining human ‘interest' in the physical environment. Berlyne’s (1949) aim was to determine the relationship between interest and the psychological actions involved in attention to the stimulus and the motivational aspects of sensation. Of particular interest to Berlyne was the motivation to seek out novelty, for which he distinguished three categories: “variation due to satiation”, involves the need for interesting activity when confronted with boredom; “curiosity”, generates the impulse to seek out new sensations, experiences and knowledge; and “aesthetic interest”, which concerns patterns “that are interesting regardless of their representational content” (Berlyne, 1949, p. 193).

Berlyne considered that complexity (alongside novelty) was one of the most important features of visual stimuli. Berlyne (1971) observed that people tend to prefer moderately complex stimuli rather than very simple or highly complex ones. He proposed that the relationship between preference for complexity and arousal potential could be predicted and described by the Wundt curve (Wundt, 1874). That is, in relation to judgments of beauty, artworks with intermediate arousal potential (i.e. moderately complex stimuli) tend to be preferred. Therefore, as arousal potential increases towards the intermediate level, preference increases. Further increases in arousal potential lead to diminished pleasure (and therefore, in preference) and increasing displeasure (Martindale, Moore, & Borkum, 1990). He contended the arousal potential of a stimulus depended on complex psychological and biological responses to “collative”, “psychophysical” and “ecological” properties (Matoschka, 1980; Cupchik, 1992). Collative variables such as novelty, complexity, surprisingness, conflict, uncertainty and unfamiliarity relate to the viewer’s impression of the stimulus. Psychophysical variables relate to sensory characteristics of the stimulus (i.e. brightness, intensity, pitch) and ecological variables are associated with the meaning and associations to environmental objects.

According to Berlyne (1950), an aesthetic response to an artwork is linked to two categories of exploratory behaviour on the part of the viewer. He defined “diversive exploratory behaviour” as behaviour arising from seeking stimulation from sources with collative attributes. “Specific exploratory behaviour” occurs when viewer interest is aroused by incompleteness or ambiguity in the perception of visual information. Each of these produce affective responses in the brain’s reward and aversion systems, the combined effects of which result in an inverted U-function of
the relevant variable: aesthetic pleasure increases and then decreases when arousal exceeds the desired level.

Criticisms of Berlyne’s theoretical and methodological framework have distinguished several limitations. These relate to the validity of Berlyne’s concept of arousal, the significance of the role of complexity in aesthetic preference, and his focus on psychobiological rather than cognitive approach. Attempts to replicate the curvilinear relationships between hedonic value and collative variables (particularly relating to emotional interactions during aesthetic experience, and in the creation and perception of art) have been met with mixed results (Cupchik & Gebotys, 1988; Dickie, 1962; Konečni, 1996; Leder et al., 2004) has received particular attention.

Silvia (2005) used appraisal models of emotion to test Berlyne’s hypotheses regarding interest. He argued that a limitation of Berlyne’s theory was that it offered only a narrow range of affective responses to art. Appraisal theories view interest as an emotion, rather than as a judgment or as the property of a stimulus. It proposes that people continually make cognitive evaluations of the world around them, and circumstances or events that are relevant to the person are appraised further. Emotions elicited by these evaluations are linked to events, suggesting a more cognitive approach to emotions (see Aitken, 1974; Lazarus, 1991; Scherer, 2001, 2003; Silvia, 2005). Furthermore, Berlyne’s inverted-U model has received criticism for its unreliability in predicting the peak of preference (Krupinski & Locher, 1988; Martindale et al., 1990). Despite rigorous testing using a wide variety of laboratory-based stimuli as well as real artworks (i.e. novel abstract patterns, paintings, poetry and music) Berlyne’s theory has received mixed support (Nadal, 2007; Nadal et al., 2010; Jacobsen, 2006). Additionally, where results are consistent with Berlyne’s hypothesis, limitations included insufficient sample sizes and too few ambiguous figures (Forsythe et al., 2008).

In comparison to Berlyne’s psychobiological approach, Colin Martindale’s alternative hypothesis (Martindale & Moore, 1988; Martindale, Moore, & West, 1988) provides a strongly cognitive perspective. Martindale (1988) contended that preference is determined by the degree to which a stimulus is “prototypical” (typical of the category to which it belongs). Martindale and colleagues argued that preference is positively related to prototypicality because typical stimuli elicit stronger activation of the salient cognitive categories (Martindale, Moore, & Anderson, 2005; Martindale, Moore, & Borkum, 1990). Martindale’s criticisms of
the role of arousal in aesthetic preference led him to test Berlyne’s predictions relating to the influence of collative variables such as novelty and complexity.

For example, Martindale, Moore, & West (1988) carried out a series of experiments comparing novelty and prototypicality (a fundamental tenet of Martindale’s theory) as functions of aesthetic preference. Martindale et al. (1988) asked participants to rate their preference for words in a 171 items inventory. By controlling for typicality and usage frequency (on a +10 to -10 scale), they found that in removing usage frequency effects, typicality explained 43% of the variance in preference ratings. Conversely, removing typicality effects resulted in usage frequency accounting for only 8.1% of the variance. Moreover, they found no evidence of a curvilinear relationship between novelty and aesthetic preference. A later series of experiments (Martindale, Moore & Borkum, 1990) compared collative, ecological and psychophysical variables with meaningfulness by asking 33 male participants to rate their preference for random polygons on a +10 to -10 scale. The polygons varied in size (14 levels) and complexity (based on the number of turns 5, 8, 10, 13 and 20). They found that size did not affect preference, and polygons with 10 turns were preferred most. While this at first seemed to support Berlyne’s predictions, when the experiment was repeated using polygons with a greater size range and complexity Martindale et al. (1990) found a linear relationship between preference and complexity. The anomalies in their findings led Martindale et al. (1990) to question not only the ecological validity of Berlyne’s inverted-U model, but also whether it could be generalized to other determinants of aesthetic pleasure.

Martindale (1989, 1991) later proposed a neural network theory in which preference is explained in terms of the activation of interconnecting cortical modules (nodes) specialised for processing perceptual, semantic and episodic and other information. Martindale (1988, 1991) hypothesized that inhibitory processes regulate the information between cortical modules ensuring that relevant information reaches the appropriate module (e.g. when processing perceptual information, activation of the episodic memory module is inhibited). Thus, an aesthetic response elicited by a stimulus is relative to the level of activation of the module.

However, criticism has been leveled at Martindale’s (Martindale et al., 1988) methodology, in terms of whether the tasks involved were indeed aesthetic preference tasks, nor was it clear what properties of the stimuli the participants were
judging (Boselie, 1991). Martindale’s proposal that prototypicality and meaningfulness are crucial to aesthetic preference, might also be biased by confounds in stimuli which varied in typicality rather than complexity (North & Hargreaves, 2000; Boselie, 1991), which could explain the variances in typicality, and complexity. Additionally, McManus & Weatherby, (1997) argued that rather than the driving force underlying aesthetic judgment, prototypicality should be the framework on which aesthetic judgments can be constructed. More recently, Silvia (2014) argued that a critical factor with the concept of prototypicality is that the notion of typicality is difficult to clarify. Nonetheless, attempts to reconcile these perspectives have resulted in the examination and discussion of the importance of categorisation of typical and novel objects in relation to aesthetic preference (Hekkert, Snelders, & van Wieringen, 2003; North & Hargreaves, 2000).

1.1.5. Frameworks of empirical aesthetics: developing an integrated approach

There is currently a concerted effort in the field of cognitive psychology to build a cohesive framework for the study of art and aesthetics. The resurgence of scientific interest in visual aesthetics has led to the re-evaluation of methodologies and paradigms used to measure aesthetic preference. In the following section, I will briefly consider some of the more recent attempts to develop an integrated model for aesthetic preference. Some attempts to develop an integrated model of aesthetic experience have been made. Kreitler and Kreitler’s (1972, 1982) psychology of the arts theory synthesised elements from other theories that included a concept of psychological arousal as a core principle (e.g. psychoanalysis, behaviourism and neo-behaviourism, Gestalt, and information theory). The concepts of “homeostasis” (the tendency of an organism to regulate and maintain a state of internal equilibrium), and “cognitive orientation” (the cognitive processes to which a stimulus is subject to, and from which the viewer can extract meaning from and apply it to other objects) formed the basis of aesthetic experience from the perspective of the viewer, rather than the creation of art or creativity of the artist (Harris, Arnistine, O’Leary, Kreitler & Kreitler, 1974).

Arnheim (1966) was critical of the reductive approach to the complex processes that occur in the perception, organisation and understanding of artworks. He argued that the “the compulsive need for quantitative exactness” (p.19) fails to
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recognise the importance of qualitative approaches in describing the fundamental properties of an artwork, by focusing on the qualities that are measurable only in numbers. Arnheim’s views on atomistic empirical perspectives of the aesthetic experience, particularly those of Fechner and Berlyne, are echoed by Joseph Margolis (1980). Margolis (1980) argued that it is problematic to attempt to study and analyse art without consideration of the influences that have informed it, such as culture, history, and language, an interdisciplinary and integrative view also shared by Cupchik (1986; Cupchik & Heinrichs, 1981). Cupchik (1986) argues that it does not take into account the active role of the artist and the viewer in the creation and aesthetic judgment of an artwork, and thus emphasises a component driven model of attention in which both artist and viewer are the passive actors (Cupchik, 1986). He asserts that the quantification of visual information and processes fails to account for the aesthetic ideas, objectives and semantic meaning involved when an artist constructs an artwork. Cupchik (1986) also states that the act of appraising a piece of art is not merely passive processing of components. He suggests people seek to organise these components into aesthetic and personal meaning, which involves other cognitive processes. In relation to this, efforts have been made to improve ecological validity in research carried out in the experimental setting in order to resemble and replicate the varied and complex aspects involved in aesthetic experience (Carbon, 2017; Leder, 2013; Locher, 2006).

Importantly, recent theories of aesthetic experience argue the importance of contextual influences (an issue highlighted by Arnheim, 1966) and that aesthetic experiences may necessitate the prior categorisation of an object as an artwork. For example, the inclusion of an object in an art gallery or museum provides a contextual cue in the categorisation of whether an object is worthy of undergoing aesthetic processing (Cupchik, Vartanian, Crawley, & Mikulis, 2009; Jacobsen, 2006; Jacobsen, 2010; Leder & Nadal, 2014). Leder, Belke, Oeberst, and Augustin, (2004) proposed a comprehensive five-stage model of cognitive processing of the aesthetic experience and judgment of an artwork. According to the model the five stages occur concurrently as well as sequentially, and involve: i) *Perceptual analysis*—low level processing of features such as complexity, symmetry, and grouping are strongly associated with aesthetic preference (Arnheim, 1974; Ramachandran & Hirstein, 1999; Reber, Schwarz, & Winkielman, 2004); ii) *Implicit memory integration*—prior experience (priming and prototypicality, Martindale & Moore, 1999) and implicit
knowledge (i.e. mere exposure, Zajonc, 1968) can influence aesthetic processing; iii) 
Explicit classification- when processing style and content of artworks, non-experts 
will likely focus on the content whilst experts may use explicit knowledge of the 
genre, painting style, symbolism, cultural and social contexts to classify the painting 
(Augustin, Leder, Hultzler, & Carbon, 2008; Augustin, Defrancheschi, Fuchs, 
Carbon, & Hultzler, 2011; Beudt & Jacobsen, 2015; Cupchik, 1992). This also 
relates to the following two stages: iv) Cognitive mastery (art-specific versus self-
related interpretations); and lastly, v) Evaluation (the measure of successful 
mastery). The crucial element of the five-stage model centres on a feedback-loop 
between cognitive mastery and evaluation. That is, the outcomes of cognitive 
mastery are continuously evaluated relative to how much meaning is garnered from 
the artwork, and indeed whether the object is considered to be an artwork. The 
outcomes of the evaluation process are two parallel outputs: aesthetic judgment (e.g. 
the interpretation and judgment of an artwork’s beauty) and an aesthetic emotion or 
affective state (e.g. a feeling of pleasure/displeasure).

The model specifies that successful processing of these stages be 
accompanied by positive affective states (pleasure or satisfaction), and non-
successful processing results in negative emotions. The model acknowledges the 
importance of top-down processing, involving prior categorisation of the object as 
art, as well as context and knowledge, as especially important for the aesthetic 
experience (Cupchik, 1992; Martindale, 1984). For example, when they are removed 
from their everyday contexts and displayed in a museum, the bed and detritus of 
Tracey Emin’s My Bed (1998), the urinal of Marcel Duchamp’s Fountain (1917) are 
considered influential and groundbreaking.

It is as yet unclear how these components interact, although there is some 
empirical evidence to support the model. Belke, Leder, & Augustin (2006) tested the 
assumption that style processing of art is dependent on the affective state, as well as 
the level of expertise (cognitive mastery) of the viewer. They investigated how the 
appreciation of modern and contemporary abstract paintings is affected when 
stylistic information (i.e. composition, technique, media, stylistic features, etc.) is 
applied to new paintings by the same artists. They found that stylistic information 
mediated aesthetic appreciation of artworks in non-experts and people who were in a 
positive mood, but people with knowledge of art were less affected. Belke et al. 
suggest that the treatment of the paintings or conflicting information for those with
prior knowledge of art may have influenced this outcome (see also Augustin & Leder, 2006).

Cupchik, Vartanian, Crawley, & Mikulis (2009) explored how aesthetic perception is assisted by cognitive control, perceptual facilitation and the experience of emotion. Their fMRI study instructed people to adopt either an objective or subjective approach in viewing artworks. They found that aesthetic perception activated an area to which emotional experience is attributed (insula of the bilateral sulcus), and a subjective approach activated the left lateral prefrontal cortex, supporting its role in internally oriented and self-referential goals. Additionally, paintings eliciting visuospatial exploration activated an area involved in image construction (left superior parietal lobule).

Cupchik et al., (2009) suggest that this provides evidence to support the notion of interaction between top-down (orientation of attention) and bottom-up (perceptual input) processing. Leder and Nadal (2014) modified (see Fig. 4) the model constructed by Leder et al. (2004). The modifications stress the importance of affective evaluation, context and emotional processing (Cupchik et al., 2009; Brieber, Nadal, Leder, & Rosenberg, 2014), the interactions between specific aspects of cognitive mastery and affective states (Gerger, Leder, & Kremer, 2014), and that time courses overlap as opposed to being processed sequentially (Augustin, Leder, Holtzler & Carbon, 2008).

Importantly, Leder and Nadal (2014) argue that the aesthetic experience comprises social and individual differences, a subjective approach (aesthetic orientation, Cupchik et al., 2009) along with other ecological factors. Lastly, they address the problem of assuming that art and aesthetics are interchangeable. The model is distinguished by its goal to assess the psychological processes (relating to symbolism, historical and ecological contexts, and composition, etc.) involved in the experience of art (especially modern art).

Leder and Nadal (2014) argue that art, unlike aesthetics is not solely concerned with beauty as a function of aesthetic response (see also Bergeron & Lopes, 2012; Silvia, 2009; Van de Cruys & Wagemans, 2011). Aesthetics, on the other hand, involves the aesthetic experience of a broader set of phenomena and stimuli.
Leder and Nadal (2014) argue for the need to integrate other areas of psychology such as neurobiological and evolutionary perspectives, which are dependent on future developments in those fields rather than relying solely on the localization of brain areas involved in aesthetic experience. These are views echoed by Jacobsen (2006, 2010) whose model also argues for a broader approach.

Jacobsen’s (2006) classification system for aesthetic experience focuses on individual differences and personality in aesthetic experiences. Jacobsen’s framework allows for different levels of analysis. It takes an interdisciplinary approach that involves seven different (but not mutually exclusive) perspectives, which are as follows: i) The Mind (e.g. psychological aspects of cognition, emotions and attitudes); ii) The Body (i.e. biological and neurocognitive aspects of aesthetic processing); iii) Ipsichronia (i.e. cultural and social processes); iv) Diachronia (i.e. biological/cultural evolution and temporal stability); v) Content (i.e. features of the stimuli: art, music, literature, food etc.); vi) The Situation (schemata for the context in which aesthetic experiences take place); and vii) The Person (i.e. group and individual differences, expert and non-expert). Jacobson (2010) has since extended the taxonomy of his framework to include neuroaesthetics. While specific features of the framework still need to be developed and tested, it presents an approach that acknowledges the complex interactions of factors related to aesthetic experience. With its integrative approach, this framework might contribute to a less reductive, model of aesthetic experience.
The emergence of “neuroaesthetics” (a term accredited to Semir Zeki, 1999) as a field of study has advanced our understanding of the neural basis of art and aesthetic experience. An interdisciplinary subdivision of cognitive neuroscience, neuroaesthetics aims to understand the neural substrates of human aesthetic experience (Chatterjee, 2011; Chatterjee & Vartanian, 2014; Leder, 2013; Pearce et al., 2016; Zeki, 1999). Technological innovations (e.g. brain imaging, transcranial magnetic stimulation (TMS), eye-tracking, imaging and computer software, etc.) have allowed the analysis of behavioural, physiological and eye-movement data to be studied concurrently and triangulated (Leder & Nadal, 2014). Studies employing these methods have confirmed or led to the reassessment of studies that have informed the investigation of aesthetic preference. However, while neuroaesthetics is essential in the exploration of the aesthetic experience in relation to affective responses, a more integrated approach may be needed in understanding the broader concepts of aesthetics such as beauty.

One implication of the integrated approach relates to the necessity for a multilevel approach in methodologies. For example, Pearce et al. (2016) argue for an interdisciplinary approach that incorporates socio-cultural perspectives together with neuroscience, biology and psychology. They suggest that neuroaesthetics methodologies (e.g., fMRI, MEG, TMS) should enhance or complement, rather than replace experimental and non-experimental methods.

In the following section, the discussion finally turns to the central theme of the research for this thesis: composition and aesthetic preferences for asymmetries in visual art. This section includes a review of the theoretical and empirical literature encompassing the main concepts of the studies that form this thesis.
1.2. Theoretical frameworks of Composition and aesthetic preference

One of the most important aspects influencing aesthetic preference for an image is spatial composition (Arnheim, 1954, 1983). The British artist David Hockney describes the process of “mark-making” that characterises the development of a drawing from the blank page to building the relationships between the marks to create a whole:

The moment you put down two or three marks on a piece of paper, you get relationships. They’ll start to look like something. If you draw two little lines they might look like two figures or two trees. One was made first, one second. We read all kinds of things into marks. You can suggest landscape, people and faces with extremely little. It all depends on the human ability to see a mark as a depiction (2016, p.34).

In other words, there is a relationship between what the artist perceives and renders in an image and, in turn how it is perceived, interpreted and judged by the viewer. This involves perceiving and understanding the complexity of relationships between the spatial structures and dynamic juxtapositions between the figures and ground, shape, light, shade and colour; specifically, the composition of the image. Early attempts to examine the psychological factors involved in spatial composition were mainly confined to personal, and intuitive reactions (e.g. Wölfflin, 1941; Arnheim, 1974/1997; Gombrich, 1960/2002).

More recently, some researchers have attempted to formalise these processes. For example, the Spatial Agency hypothesis was originally developed to investigate whether frequently experienced actions (cognitive events) expressed in language and writing are also embodied spatially (“thematic roles”, Schubert & Maass, 2011). One explanation for this is that mental representations (i.e. of concepts such as space) use expressed language to map onto rudimentary spatial schemas in preverbal encoding processes that are thought to be universal in humans (Mandler, 2010; Chatterjee, 2001). Chatterjee argues that certain spatial representations are strongly associated to the perception of agency, such that left positions are more strongly associated with agency rather than right positions. The Spatial Agency hypothesis was developed
from Maher, Chatterjee, Gonzales-Rothi, and Heilman’s (1995) observations of an aphasic patient (WH) with impaired ability in producing and comprehending reversible sentences such as “the boy chases the dog”. WH had difficulty assigning thematic roles describing actions carried out by the subject (i.e. the boy-the “agent” of the action) to the object (i.e. the dog- the “recipient” of the action). Interestingly, when describing pictures, WH developed a spatial strategy by which he was able to produce sentences where the agent was on the left of the picture and the recipient was on the right of the picture. Interestingly, further studies involving drawing tasks showed that the agent of action tends to be positioned on the left of the drawing (Chatterjee et al., 1995). Furthermore, the agent was more easily recognised when the action had a left to right directionality. The same schema for spatial representations also appears to be extant in the normal population (Chatterjee, Southwood, & Basilico 1999; Maass & Russo, 2003).

Empirical evidence suggests the Spatial Agency Bias may provide an explanation for some compositional effects such as left and right-facing profile biases in portraits and self-portraits (see Chatterjee, 2002; Schirillo, 2000, 2007), for gender and status in portraits (Humphrey & McManus, 1973; Suitner & Maass, 2007). The notion of spatial agency finds some support in the “cultural hypothesis”. The cultural hypothesis applies a psycholinguistic perspective and proposes that the rightward directionality in perception is related to reading and writing direction. This is particularly relevant for studies of spatial composition as it may explain preferences for left-to-right directionality in Western cultures, as well for studies involving cultures with a right-to-left reading direction (e.g., Pérez-González, 2007; Maass & Russo; for an extended and interesting discussion, see Suitner & McManus, 2011). Arnheim (1974) states that:

Visual experience is dynamic. This theme will recur throughout the present book. What a person or animal perceives is not only an arrangement of objects, of colors and shapes, of movements and sizes. It is, perhaps first of all, interplay of directed tensions. These tensions are not something the observer adds, for reasons of his own, to static images. Rather, these tensions are as inherent in any percept as size, shape, location, or color. Because they have magnitude and direction, these tensions can be described as psychological forces. (p. 11).
While the idea of a culturally, and experientially embedded dynamism in art is not new (Arnheim advocates for the visual experience to be regarded as a dynamic, directional and contextual event), the potential for the further exploration of the Spatial Agency Bias in investigating spatial composition outside the domain of Western culture is an exciting prospect.

Another theory provides an ecological explanation for spatial composition that fits well with Chatterjee’s (1999) Spatial Agency theory. Ecological Valence theory (EVT) encompasses colour and spatial composition preferences. As this thesis is concerned with theoretical aspects of spatial composition, I include only a brief description of EVT and colour preference (a full discussion of EVT and colour preference, amongst other applications for EVT, can be read in Palmer, Schloss, & Sammartino, 2013 and Palmer & Schloss, 2010). Palmer and Schloss’s (2010) hypothesis asserts that colour preferences are caused by people’s average affective responses to colour-associated objects in the environment. For example, people prefer colours they positively associate with objects they find attractive (e.g., a positive association for blue colours with clear skies and clean water) and dislike colours associated with objects they dislike (e.g., negative associations for brown colours with faeces and rotting food).

In a systematic analysis of asymmetries in spatial composition, Palmer et al. (2013) proposed that human aesthetic preferences are influenced by implicit ecological knowledge of the environment. That is to say, human aesthetic preferences for spatial compositions are consistent with their environment and their everyday experiences. In relation to the field of spatial composition, EVT describes a set of compositional biases in preference for object locations within a rectangular frame (e.g., a centre bias and inward bias, Palmer, Gardner, & Wickens, 2008; anterior bias, Bertamini, Bennett, & Bode, 2011; a perspective bias, Sammartino & Palmer, 2012; canonical size, Konkle & Oliva, 2011; canonical perspective, Palmer, Rosch, & Chase, 1981). Palmer and colleagues (2013) suggest that most of these biases are determined by people’s implicit knowledge of the important features of objects of interest and the nature of the objects’ relationship to the person. In other words aesthetic preference is based on a ‘good fit’ between the spatial composition of an image and its (implicit) meaning. For example, Palmer et al. (2013) contend that if an image is given a different title, thus changing the meaning of the image, a
preferred spatial composition may be disregarded in favour of one that does not comply with the default biases, as long as it is consistent with the title provided.

Diverse explanations have been offered for compositional preferences relating to asymmetrical biases in artworks, and the following sections explore the factors that may determine these preferences, beginning with an overview, and then moving on to an examination of the relationships between key principles of composition such as symmetry and other variables, such as complexity, culture, biology, novelty and familiarity. However, first it is important to discuss a major principle in composition: symmetry.

1.3. Perception of Symmetry

Symmetry is a basic principle of aesthetics (Ramachandran & Hirstein, 1999) and the relationship between visual symmetry and beauty is of particular interest (Bertamini, Makin & Rampone, 2013; McManus, 2005; Washburn & Crowe, 1988). In 1952, the mathematician Hermann Weyl (1885-1955) gave a series of public lectures that would subsequently become the basis of his book *Symmetry* (1952). Conversant in art and philosophy, as well as an authority in mathematics and science, Weyl stated:

If I am not mistaken the word symmetry is used in our everyday language with two meanings. In the one sense symmetric means something like well-proportioned, well-balanced, and symmetry denotes that sort of concordance of several parts by which they integrate not a whole. Beauty is bound up with symmetry…The image of the balance provides a natural link to the second sense in which the word symmetry is used in modern times: bilateral symmetry, the symmetry of the left and right, which is so conspicuous in the structure of the higher animals, especially the human body (1952, p.3).

Symmetry appears to be a robust preference in both humans and animals. This preference has been explained in terms of biological signals of mate quality, and a need to recognize objects (Enquist & Arak, 1994; Møller, 1992), preference for body and facial symmetry (Bertamini, Byrne, & Bennett, 2013; Zaidel &
The field of neuroaesthetics has confirmed the human visual system sensitivity to symmetry, though some are more salient than others. For example, vertical symmetry is detected faster compared to horizontal symmetry (Julesz, 1971; Palmer & Hemenway, 1978). Reflectional symmetry is more easily detected than others, and a vertical axis of reflection is more salient than a horizontal axis (Corballis & Roldan, 1975; Mach, 1959; Bertamini & Makin, 2014; Makin, Rampone, & Bertamini, 2015; Sasaki, Vanduffel, Knutsen, Tyler, & Tootell, 2005). This evidence about a tuning of the visual system to symmetry suggests a very fundamental role of symmetry within the visual system.

However, symmetry in our physical environment may not be instantly obvious, indeed it is far from symmetrical. Many objects and organisms in the physical world, including the human body have left-right (bilateral) symmetry. That is, they are organised around a principle (vertical) axis of symmetry. Although the left and right sides of the object or scene may resemble each other, the similarity between them is inexact; that is to say, it is asymmetric. For example, a mirror image or reflection of a human body looks like the real person, but there are subtle differences: the heart is on the wrong side, hair partings and clothes fastenings move to the opposite side, a right-handed person becomes left-handed, left-footed and so on. Mach (1886/1959) observed that mirror (reflectional) symmetry is more easily detected than others, and a vertical axis of reflection is more salient than a horizontal axis. This suggested to Mach that the salience of left-right symmetry resulted from the structural symmetry of the visual system. However, Julesz (1971) argued that bilateral symmetry in particular, may be detectable as a result of processes in the primary visual cortex. In support of this, Corballis and Roldan (1974) confirmed that judgments of bilateral symmetry are made faster than judgments of bilateral repeated stereograms. In a later study participants were presented similar stereograms in which the axes of symmetry were not vertical. Participant reaction times increased as the axes of symmetry shifted from the vertical line. Corballis and Roldan (1975) proposed the idea that people employed “mental rotation” in order to correct the shifting axes back to vertical. Thus, perceptual judgments take place via comparisons between the two hemispheres.

The idea that the left and right hemispheres of the brain have different functions has its origin in experiments on ‘split-brain’ patients, which allowed...
researchers to assess the mechanisms of each hemisphere independently (Corballis, 2018). These asymmetries may determine attention to, and preference for the left or right sides of an image (Jewell & McCourt, 2000; Nicholls, Bradshaw, & Mattingley, 1999; Charles, Sahraie, & McGeorge, 2007).

There is a great deal of evidence to suggest that compositional asymmetries in paintings and other artworks may occur as a result of hemispheric asymmetries in the brain. In the next section the relationships between preference for compositional asymmetries and human visual laterality is further discussed.

1.3.1. Laterality, handedness and reading direction

Visual art frequently requires the viewer to comprehend complex compositions, which we can overcome through scanning the picture as a whole and focussing our attention on specific features of the image. One aspect of spatial composition that is of particular interest to aestheticians is the way in which artists typically organise objects along a horizontal dimension and is generally referred to as lateral organisation (Freimuth & Wapner, 1979).

Mirrors are a part of human history, and have been around in one form or another since pre-historic times and have been a source of fascination for writers, artists and scientists (Pendergrast, 2003). Artists such as Leonardo da Vinci (1452-1519) were aware of the transformational effects of mirror reversal: “I say that when you paint you should have a flat mirror and often look at your work as reflected in it, when you will see it reversed, and it will appear to you like some other painter's work, so you will be better able to judge of its faults than in any other way” (2015, p.208-209).

Ernst Mach (1886, 1959) carried out some of the earliest psychophysical studies involving mirror symmetry, who argued that in the case of mirror symmetry judgments of geometrical similarity are easier when two shapes are placed on a vertical axis rather than a horizontal axis. Heinrich Wölfflin’s (1941) study of mirror reflection prompted him to claim that Raphael's cartoons changed in meaning, as the drawings were mirror-reversed in order to produce tapestries. He suggested that the right side of an image should be emphasised, and the arrangement of the important figures in the cartoons to the left “seemed more divisive because they are more pronounced” (p.90). However, Gross and Bornstein (1974) argue that experimental
studies involving the detection of reversed paintings have failed to confirm the claim that reversal transforms an image. They suggest that using markedly asymmetrical images (e.g., Wölfflin), rather than both symmetrical and asymmetrical compositions, would account for the obvious difference when the image is reversed. Wölfflin also argued that pictures are ‘read’ from left to right, so that the diagonal runs from bottom left to top right is seen as descending and the other as descending. Wölfflin (1941) also tentatively linked the idea of objective movement in a painting to Western writing direction (i.e. left to right), though he issued the caveat that movement is of course not always in a left to right direction.

Support for the importance of left-right scanning as a determinant for aesthetic responses arising from viewing a painting or a mirror-reversed version came from Oppé (1944). Oppé suggested that viewing positions from the left or right of the picture might have a significant effect on aesthetic preference particularly when the painting is mirror-reversed. This subsequently developed by the art historian Mercedes Gaffron (1950, 1956) who proposed that one possibility is that people have a specific way of scanning a picture, and as a consequence, they prefer images in which movement proceeds from left to right. Gaffron referred to this scanning path as the “glance curve” that moves from the left foreground to the right background (i.e. along the first diagonal). She argued when standing in front of a painting, the viewer subjectively identifies and experiences it as if facing its left side. Gaffron (1956) extrapolated this information and proposed that reading direction correlates with right hemispheric dominance, thus controlling the left visual field (LVF). Corballis (1983) later dismissed Gaffron’s idea, as evidence now suggests that the right hemisphere is strongly associated with specialised perceptual processing. Reading direction may also be a factor and left-to-right readers have been found to show the opposite bias (Nachson, Argaman, & Luria, 1999; but see Nicholls & Roberts, 2002).

In relation to right hemispheric dominance and handedness, Levy (1976) interpreted a preference for important objects to be placed on the right of a picture (the Right Bias) in dextrals as a need to create balance. This preference can reverse for sinistrals (the Left bias), which is consistent with known cerebral asymmetries and pseudo- neglect (McLaughlin, 1986; Nicholls & Roberts, 2002). Beaumont (1985) proposed that this preference is determined by the processing efficiency of the hemisphere to which the percept is matched. Beaumont suggested that dextral
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viewers tend to fixate on areas of principal interest on the right of an image. Fixation in areas on the right of an image results in a detailed analysis (via the fovea). Thus, the rest of the picture falls within the LVF, activating the right hemisphere, and eliciting a positive aesthetic response to images with the area of principal interest on the right. Similarly, Mead and McLaughlin (1992) also found that dextrals and inverted sinistrals preferred paintings with cued motion from left-to-right were preferred to those with right-to-left.

Another aspect in the perception of symmetry that needs to be considered are socio-cultural factors. Perception is a process involving the extraction of knowledge about events and objects in the environment (Palmer, 1999), and what we see around us can influence our preference for objects. Cultural factors may also influence what people prefer in terms of symmetry. Washburn (1999) for instance, wrote that the salience of symmetry has been used in art as a metaphor for describing important cultural principles and relationships. Masuda, Gonzalez, Kwan and Nisbett (2008) examined cultural variations in visual art among East Asians and Americans. Their analysis of traditional East Asian and Western art found that Western art tends to be object-focused (i.e., attention is focused on discrete objects seen from a single viewpoint) whereas East Asian art is principally context-inclusive (attention is focused on the relationships between multiple objects from multiple viewpoints). Evolutionary explanations for cultural differences in mate preference (Pisanski and Feinberg (2013) suggest that facial symmetry may be less important in countries where there is greater parental input in offspring, and more important in regions where disease resistance of offspring is most valued.

As Eysenck and Castle (1970) noted, artists are trained to appreciate order and symmetry in the visual world. In different cultures, acquired skills, such as reading and writing, may affect spatial cognition and perception of visual stimuli and thus, aesthetic judgments (Chokron & De Agostini, 2000; Nachson, 1981; Nachson, Argamon & Luria, 1999). Pérez González (2012) compared samples of 19th century studio portraits from Spanish and Iranian photographers (left to right and right to left readers respectively). The set of Spanish photographs displayed a preference for left to right direction, but the Iranian photographs showed the converse pattern. This suggests a relationship between writing direction and compositional organisation in visual art. Maass & Russo (2003) investigated whether the spatial agency bias is a function of hemispheric specialization or of directionality of written language (left to
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right in Italian, right to left in Arabic) in two experiments involving a sentence-picture matching tasks for position and directionality of action. They compared Italian and Arab participants. Both studies found a reversal of directional bias in Arabic speaking participants. Italians tended to position the subject to the left of the object, and Arabs tended to position the subject to the right of the object, suggesting that both hemispheric specialisation and scanning habit affect visual imaging. However, other research has found results that support the attentional bias account of leftward biases, regardless of reading or scanning habits. Nicholls and Roberts (2002) investigated the left side bias using well-known explanations of it as bases for their experiments (e.g., left-to-right scanning biases, pre-motor activation of the right hemisphere, and a left hemispatial attentional bias). English and Hebrew readers carried out a greyscale task (a forced two-choice discrimination of the relative brightness of two simultaneously presented horizontal bars, frequently used as a measure of attentional bias following unilateral hemispheric damage) and a line bisection task. Despite different reading/scanning habits and controls for scanning, both groups exhibited a leftward perceptual bias. A second experiment presented peripheral spatial cues prior to the greyscale task. Nicholls and Roberts (2002) found that English readers showed a reduced leftward bias for right-sided cues compared to left-sided and neutral cues, which suggested that right-side cues might override a pre-existing leftward attentional bias.

From the evidence reviewed, preference for symmetric patterns appears to be stronger than that for asymmetry (e.g., Eisenman, 1967; Jacobsen & Höfel, 2001, 2002; Reber et al., 2004). However, there appears to be large individual differences in preference for symmetry; artists, for instance have shown a preference for asymmetry (Corballis & Beale, 1976), and simplicity in images (Soueif & Eysenck, 1973). Therefore, a crucial question relating to this thesis is whether it is possible to identify the factors that can explain some of these individual differences and divergence of findings across empirical studies. A widely researched concept is that preference for symmetry depends on the visual complexity of an image (e.g., the number of independent elements it contains). Empirical studies of symmetry and aesthetic judgment (e.g., Jacobsen & Höfel, 2001, 2003, 2004; Jacobsen, 2004) have found that in addition to symmetry, another important property that strongly influences aesthetic judgment for beauty is complexity. In the next section, I briefly address some of the issues relating to symmetry and complexity that are particularly
relevant to the research in Chapter 2.

1.3.2. Symmetry and Complexity

Symmetry, composition and beauty are closely associated, but they comprise several different concepts. For beauty, possibly the most important one is that it is a function of the balance of two distinct sets of factors: order, unity, harmony and complexity, multiplicity, or diversity (Berlyne, 1971; Boselie & Leeuwenberg, 1985; Forsythe, Nadal, Sheehy, Cela-Conde, & Sawey, 2011). In empirical investigations of visual art, symmetry is considered the best predictor, closely followed by complexity of aesthetic judgements of beauty and preference (Jacobsen, 2010; Nadal, Munar, Marty, & Cela-Conde, 2010).

Complexity is commonly defined as the amount of visual detail an image contains (Snodgrass & Vanderwart, 1980), although definitions of complexity may differ from study to study (Gauvrit, Soler-Toscano, & Guida, 2017; Palumbo, Ogden, Makin & Bertamini, 2014). Furthermore, differences in opinion regarding metrics and diversity of stimuli used to examine complexity in relation to aesthetic preference have made any progress towards a unified approach a challenging prospect. This has led to varied and sometimes contradictory results, especially when studies have used pictures, paintings, portraits or other real-world objects in attempts to increase ecological validity (e.g., Krupinski & Locher, 1988; Nicki, Lee, & Moss, 1981; Schyns & Oliva, 1994). For example, to test Berlyne’s prediction regarding preference for intermediate complexity in stimuli, Nadal et al. (2010) compiled a stimulus set comprising 120 artistic (e.g., reproductions of paintings of different genre) and non-artistic images (e.g. urban scenes, landscapes, artifacts) by asking people to rate their artistry, abstraction and complexity. One group (N=94) rated the images for their beauty on five dimensions (very ugly- very beautiful). The same group then rated a subset of images using a 9-point scale based on seven dimensions relating to aspects of complexity. Nadal et al. (2010) describe the dimensions were as follows: i) Unintelligibility of the elements (difficulty identifying elements in the image), ii) Disorganization (difficulty organising the elements into coherent scenes), iii) Amount of elements, iv) Variety of elements, v) Asymmetry, vi) Variety of colors, and vii) 3-dimensional appearance. Nadal and colleagues found no significant influence of complexity on the ratings of beauty. They identified three relevant
dimensions of complexity: i) amount and variation of elements (which was the best overall predictor of visual complexity), ii) organisation of elements (the way the elements are grouped to form objects and scenes), and iii) asymmetry. Notably, the amount of elements was sufficient to predict visual complexity for both abstract and representational stimuli.

However, prediction of the complexity level of artistic images depended on additional dimensions, and only asymmetry showed a curvilinear relationship with ratings of beauty. Nadal et al. (2010) suggest that these mixed results may reflect the problem of using mono-dimensional measures of complexity in relation to aesthetic evaluation of diverse stimuli when a multi-dimensional approach should be taken. Additionally, they suggest that divergence in results may reflect the fact that complexity is conceptualised and measured differently across studies (see also Oliva, Mack, Shrestha, & Peeper, 2004).

Previously, aesthetic measures for complexity have tended to use mathematical calculations of the features of stimuli (i.e. line, regularity, irregularity, homogeneity, heterogeneity, etc.) that then contribute to a calculation of visual complexity (e.g., Birkhoff, 1932; Eysenck, 1941, 1968; Eysenck & Castle, 1970; Jacobsen & Höfel, 2003). In relation to the heterogeneity of stimuli, Gauvrit et al. (2017) argued that analysis of abstract binary patterns (e.g., black and white patterns, Bertamini, Makin, & Pecchinenda, 2013; Chipman, 1977; Ichikawa, 1985; fractals, Spehar, Clifford, Newell, & Taylor, 2003) is less vulnerable to misinterpretation. Importantly, they can be modeled to allow comparison to established measures of complexity.

A recent and important advance in the mathematical formalisation of visual complexity is algorithmic information theory (AIT; Solomonoff, 1986) or Kolmogorov complexity theory (Li & Vitnyi, 1997). In relation to this, visual complexity is defined as the length of the shortest programme that can produce the visual image. This measure can be estimated by the image file size after applying compression algorithms such as Graphics Interchange Format (GIF) or Joint Photographic Expert Group (JPEG) to an image (Donderi, 2006; Donderi & McFadden, 2005). In the case of GIF ratio, the idea is that the application of a compression algorithm will achieve greater reduction in size for a pattern that is lower in algorithmic complexity. In other words, the simpler the pattern, the bigger the GIF ratio. GIF compression provides an estimate of the best-compressed version
of the grid. However, the algorithm on which the GIF compressor is based cannot
detect regularity, and GIF metrics may be more accurately defined as a redundancy
measure (of any sub-patterns) than as a reliable estimate of the algorithmic
complexity (Gauvrit et al., 2017), and are best combined with other measures (i.e.
Block Decomposition Method (BDM). BDM is based on the coding theorem method,
and is considered a reliable estimate of algorithmic complexity for two-dimensional
patterns. (Zenil, Soler-Toscano, Delahaye, & Gauvrit, 2015).

Recent studies have examined complexity and aesthetic preference using
automated and quantitative measures of complexity. For example, Forsythe, Sheehy,
and Sawey (2003) measured icon complexity. In this case, icons are small, graphic
representations that can communicate information that can be recognised and
understood quickly and easily (e.g., road signs). Three elements are thought to be
important in determining a: concreteness, distinctiveness, and complexity. They
calculated six icon properties (icon foreground, the number of objects in an icon, the
number of holes, calculations of edge length and homogeneity) using image-
processing functions and correlated them with previously reported (human based)
complexity ratings for icons (Garcia, Badre, & Stasko 1994: McDougall, Curry, &
de Bruijn, 1999). Forsythe et al., (2003) found that structural variability and edge
length correlated strongly with human judgments of complexity. With respect to the
reliability of these measures, Forsythe et al. (2008) also found image compression of
the contours in nonsense shapes also correlated with subjective human judgments for
the same shapes whilst avoiding familiarity biases.

In a later study, Forsythe, Nadal, Sheehy, Cela-Conde, and Sawey (2011)
analysed objective measures of visual complexity applied to a variety of artworks
and natural scenes. They found that simple GIF image compression was the most
successful predictor of visual complexity ratings (better than JPEG compression or
perimeter detection). Forsythe et al. (2011) also used a fractal dimension ($D$)
measure calculated by a box counting algorithm to predict perceived beauty of the
images. Their conclusions suggested that fractal dimension together with visual
complexity (GIF) could explain more variance of perceived beauty than complexity
alone. People also preferred polygons with partial symmetry and, greater complexity
in contour length and in the number of concavities (Friedenberg & Bertamini, 2015).

Friedenberg and Liby (2016) found that a correlation between GIF ratio and
edge length suggested a preference for intermediate density over the number of
elements in binary chequerboard patterns. Gauvrit et al., (2017) reanalysed the data from the study carried out by Friedenberg and Liby (2016). Gauvrit and colleagues used measures of entropy and algorithmic complexity (GIF ratio and BDM), Edge length (the complexity of the edge created by the cells, relating to the ‘crookedness’ of the pattern) and the number of parts (a measure of how scattered the black cells are) as additional measures of complexity. In this context, entropy refers to the density, but not the organisation of black and white cells in a pattern, and relates to Shannon first order entropy (Shannon & Weaver, 1949). In information theory Shannon entropy is a measure of the amount of information that is missing from a message before it is received.

Gauvrit et al. (2017) found that people showed an overall preference for high entropy, but low algorithmic complexity, when controlling for entropy. They also found that aesthetic judgments positively correlated with total Edge length, supporting the findings by Forsythe et al. (2008). In other words, people prefer some, but not all, types of complexity depending on the balance of the number of elements, ‘crookedness’ and density. Gauvrit et al. (2017) concluded that the divergence in results across studies of perceived beauty and complexity, suggest that a precise definition of complexity along with a taxonomy of measures is needed.

1.3.3. Novelty, mere exposure and familiarisation

Research has suggested that novel stimuli elicit strong affective responses (i.e. curiosity, fear, liking) in both humans and animals (Bornstein, 1989; Panksepp, 2005; Russell, 1973). Repeated exposure to the stimulus may overcome or enhance the initial response resulting in the animal developing a preference or an aversion for the stimulus (Sluckin, Hargreaves, & Colman, 1983). Berlyne (1971) construed that novelty has several psycholinguistic characteristics, rather than merely being a facet of something that is new. He argued that affective responses to these features could be measured following one of two approaches. The first approach involved a mathematical formula that largely disregarded language; the second involved using scaling methods to measure subjective linguistic responses to the stimuli. Using the latter approach, Berlyne’s experiments revealed three aspects of novelty: i) absolute novelty, when a stimulus has never been encountered before (according to Berlyne, this was a rare event as most of the time novelty is a relative experience); ii) short
term novelty, when the stimulus differs from stimuli previously presented, but is
seen again after a short interval (e.g., minutes or hours); and iii) long term novelty is
when a stimulus is reencountered after a longer period of time (e.g., months or
years). According to Berlyne (1971) the arousal effects of these characteristics
depend on context, meaning, degree of intensity, and frequency to which they are
present during an experience of novelty; that is, aesthetic experience of viewing an
artwork after a long interval may be more pleasing than seeing it constantly (Sluckin
et al., 1983). For example, artists may work on paintings in rotation (sometimes there
may be years in between the artist working on them) in order to allow them to
reassess aspects such as overall composition.

There is strong evidence to suggest that exposure to, and familiarity with
visual stimuli may subsequently increase our preference for them (“mere exposure”;
Bornstein, 1989; Zajonc, 1968). This idea can be found in Fechner (1876, p. 240-
243) and James (1890, p. 672), and subsequent research focused on the investigation
of long held beliefs such as “absence makes the heart grow fonder” and “familiarity
breeds contempt” (Zajonc, 1968, p.1). However, Zajonc (1968) conducted the first
robust empirical examination and proposed that the effects of exposure on preference
tend to elicit positive responses (depending on context), though responses may differ
between novel and more familiar stimuli. Zajonc (1968) focused on assessing
correlational evidence for the mere exposure hypothesis by measuring the usage
frequencies of pairs of antonyms (e.g., beauty/ugliness, and happiness/unhappiness).
This approach was based on evidence from earlier research (Thorndike-Lorge, 1944)
that suggested that words with positive affective meaning (such as “happiness” and
“beauty”) are used more frequently than those with negative connotations (e.g.,
“unhappiness” and “ugliness”). Zajonc’s work was primarily conducted in relation to
language. In relation to perception and aesthetics other factors relating to preference
and affective responses, like fluency have also been explored. For example, Reber et
Prior to seeing these images, the participants were primed by showing them even
more badly degraded drawings. They found that when the primer drawing depicted
the same object as in the target drawing, recognition times decreased, along with
preference. Reber et al., (1998) concluded that this suggested that fluency of
perception influenced preference (see also Reber et al., 2004 and Winkielman et al.,
2006).
More recently, a study by Biederman and Vessel (2006) argued that repeated exposure to a stimulus increases pleasure which peaks when a meaningful understanding (via prior ecological knowledge) of the stimulus is achieved. Thereafter, habituation leads to a decline in arousal for that stimulus, and suggesting a preference for stimuli that allows for interpretation. Thus, familiarity with an object can increase or decrease pleasure depending on the degree of exposure or overexposure. For example, Tinio and Leder (2009) performed a group and individual level analysis of the influence of different degrees of familiarization on aesthetic judgments of symmetry and complexity. They confirmed the influence of symmetry and complexity on aesthetic appreciation found in earlier research (e.g. Augustin & Leder, 2006; Jacobsen & Höfel, 2002; Silvia, 2006). Interestingly, a second experiment revealed contrast effects for complexity after repeated exposure (“massive familiarisation”) of participants to the same group of stimuli. Participants who were familiarised with simple stimuli judged complex stimuli as more beautiful, and those familiarised with complex stimuli judged simple stimuli as more beautiful. An analogy from a viewer perspective could be, for instance, a person seeing reproductions of Monet’s “Water lilies” on a biscuit tin, calendars and coasters and so on, and then seeing the original paintings. One would expect the latter to be judged as more beautiful. There were no similar effects for symmetry or for moderate familiarization of the stimuli. Tinio and Leder (2009) interpreted the contrast effects of familiarisation as a “craving for novelty” (p.249).

These findings are consistent with previous research suggesting that familiarisation results in a stronger preference for novelty (Biederman & Vessel, 2006). Tinio and Leder (2009) also noted that the stimuli used in earlier research (e.g.. Zajonc, 1968) focused on structural generalisation of grammatical rules, rather than specific visual structures (e.g., complexity and symmetry) which are agreed to influence aesthetic preference. An analysis of individual participant judgment patterns similar to the analysis used in previous research (Jacobsen, 2004; Jacobsen & Höfel, 2002, 2003) were consistent for symmetry as the best predictor of preference, followed respectively by complexity and a factor described as 'regular' composition. Tinio and Leder (2009) cautiously defined regular composition as “typically symmetrical and highly complex” (p.245). This suggests that familiarisation with stimuli may temper the influence of complexity on aesthetic preference. Additionally, Forsythe, Mulhern, and Sawey (2008) suggested that
complexity metrics based on human judgments, such as meaningfulness, familiarity and learning effects can influence visual complexity ratings, with the result that novel stimuli are rated as more complex than they actually are. These findings suggest that individual differences as well as familiarisation with stimuli may moderate the influence of complexity on aesthetic responses.

1.3.4. Left-right Symmetry in art

In art, as in the world around us, symmetry is important but rarely perfect, and asymmetry is thought to be an important factor in stimulating our interest in looking at artworks (Zaidel, 2010). It is generally agreed in the literature that most people prefer symmetrical stimuli, but not all symmetry types have equal salience to the viewer (Bertamini, Makin, & Pecchinenda, 2013; Bertamini et al., 2013; Enquist & Arak, 1994). Symmetry (especially vertical and horizontal symmetry) in a visual image can be detected faster than if it is absent, though people tend to detect vertical symmetry faster in comparison to horizontal symmetry, (Julesz, 1971; Locher & Nodine, 1989; Palmer & Hemenway, 1978). One explanation for the perceptual salience of vertical symmetry is that most objects in the world contain symmetry along the vertical axis (e.g., human anatomy, buildings, trees, etc., Corballis & Beale, 1976; Sammartino & Palmer, 2012). Not only are symmetrical patterns perceived faster than asymmetrical patterns, but most people find them more interesting and aesthetically pleasing as well (Eisenman, 1967; Day, 1968). For both humans and animals, bilateral symmetry (when an object is symmetrical about a vertical axis) is a particularly noticeable perceptual feature, and an object appears balanced implying “good gestalt” (Arnheim, 1974).

In relation to perceptions of orientation of visual art, people preferred vertical and horizontal lines in pseudo-artistic paintings in comparison to oblique lines, suggesting specialisation for these symmetries in human neural structures (Latto, Brain & Kelly, 2000). Latto and Russell-Duff (2002) carried out an analysis of 88 paintings which determined artists seem to favour the use of horizontal and vertical line, rather than oblique line, when painting in landscape or portrait orientations. They found a significant interaction for more vertical lines in portrait orientations and horizontal lines in landscape orientations. Latto and Russell-Duff suggest a triumvirate of interrelated explanations: firstly, this supports Latto et al.’s (2000)
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explanations for a visual sensitivity to vertical and horizontal lines; secondly, a possible that a framing effect for lines which are parallel to the frame; and finally an ecological explanation relating to a preference for art work in vertical and horizontal orientations, resulting from the prevalence of vertical and horizontal symmetries in the environment. Furthermore, the salience of symmetry generally increases with the number of axes of symmetry (Treder, 2010), and a strong preference for reflection and rotation has been observed (Makin, Pecchinenda & Bertamini, 2012).

Symmetry is certainly an important feature, particularly in abstract patterns, but this is not always the case with paintings, as interpretation of their compositional structure often involves more complex measures of balance (Locher, Gray, & Nodine, 1996; Gershoni & Hochstein, 2011). There are many examples of paintings that illustrate this, for instance the painting of The Cholmondely Ladies (c.17th century, top image, Fig. 6) has intrigued art historians, not only with regard to the mystery of the identity of the two sitters, but also because of the painting’s imperfect translational symmetry (the trans-positioning of an object without it being rotated or mirrored). Initially, the sitters seem identical, but on closer inspection, there are differences in features such as eye colour, fabrics and jewellery. In Augustus Egg’s The Travelling Companions (1862, centre image, Fig. 6) the composition of the two women in identical dresses, positioned on either side of the railway compartment seems, at least at first glance, to depict a well balanced bilateral symmetry. Yet small details, such as one of the sitters reading a book whilst the other sleeps, break the symmetry of the painting. The broken symmetry in the photographic portrait of the artists The Singh Twins (Dan Kenyon, 2009, bottom image, Fig. 6) is subtler. Not only are the women identical twins, the doors behind them (bilateral symmetry) and the tiled floor (rotational symmetry) beneath them are geometrically symmetrical; but the folds and drapes of the identical saris the women wear are not. Thus, while symmetry is an important feature in judgments of beauty, an excess of symmetry can result in a ‘sterile rigidity’, making an image less interesting and dynamic (and therefore less beautiful) than images that contain some elements of asymmetry (McManus, 2005, p.158).
One of the ways artists make their work visually interesting is the way in which they arrange the objects in the image. This can be affected by several factors such as whether the image is in a frame or not, and the use of balance and asymmetry. In the following sections, I discuss the theoretical and empirical evidence for these factors in relation to aesthetic judgments.

1.4. Composition and pictorial balance

Composition in the context of visual art refers to the way in which the artist arranges objects of interest in a meaningful and harmonious way relative to the other elements and also to the space in which they are contained (Arnheim, 1954, 1983). Visual artists often have to compose the elements of their artwork within the boundaries of a defined space. Most visual artists have a good understanding of composition, and art school training will invariably include general instruction and feedback on how elements (e.g. composition, proportion, use of colour, line, originality) can be arranged in an artwork. Art students will learn various geometric principles and techniques with which they can control objects in framed pictorial spaces and achieve a competent and visually satisfying artwork (Bouleau, 1980).

Pictorial balance is an important design principle by which an artist organises the elements in a painting into a cohesive and meaningful narrative that can direct the attention of the viewer to salient objects and locations (Jacobsen, 2006; Locher, Tinio, & Smith, 2013). While it is one of the most frequently discussed aspects of composition is “balance”, is also one of the most fuzzily defined. Arnheim (1974) devotes a whole chapter to it in Art and Visual Perception detailing the determining factors that describe it, without giving a conclusive definition. Similarly, artists may be able to demonstrate what “good” balance entails, by physically demonstrating it with a sketch, but will struggle to define exactly what makes the drawing “work” in terms of balance. In his famous painting manual Composition (1914), the painter and art educator Arthur Dow (1857-1922) includes balance in a subset of compositional factors of symmetry. He suggests that “The most common and obvious way of satisfying the desire for order is to place two equal lines or shapes in exact balance, as in a gable, windows each side of a door, or objects on a shelf” (p. 37). Dow does not specify precisely why placing the objects in these positions is satisfying, it is presented as self-evident.

The way in which people interpret what is interesting in a painting (given there
may be multiple objects and locations to which the viewer can attend) is of great interest to art historians and scientists alike. Although Berlyne conducted little in the way of empirical research, he reviewed the evidence and included balance as a “special case” (1971, pp.232-236). Berlyne suggests that the role of balance is to moderate the arousal-inducing influence of symmetry, and salient stimuli are thought to possess greater “psychological weight”. However, he observed that the “mechanical analogy” of balance (which suggests heavier/bigger objects should be placed nearer the centre and lighter/smaller objects placed further out in an image to maintain equilibrium) does not necessarily reflect the salience of the elements (i.e. use of colour) used to create balance (p.234). Subsequent research agrees in principle that balance is important, but takes a more empirical approach in understanding balance (e.g., Locher, 2003; Vartanian et al., 2005). McManus, Edmondson, and Rodger (1985) examined subjective balance in art. Participants were asked to move a fulcrum to the left or right under reproductions of art until they judged it to be balanced relative to the fulcrum. In the first experiment there were large differences between images, but smaller differences between participants. In a second experiment, McManus et al. used abstract images of squares laid over white stripes on a black background. They found that position was the determining factor in balance judgments but that there were also some interactions involving colour. This is in agreement with the observations made by Berlyne relating to early studies of balance (e.g. Pierce, 1894). In a second experiment, McManus and colleagues (1985) also found that a vertical position did not influence balance, though the shape of a rectangle interacted with the degree of perspective displayed in the image.

Empirical research has provided evidence for three important structural elements that contribute to and determine pictorial balance in a composition (Arnheim, 1954; Locher, 2003; Locher, Stappers, & Overbeeke, 1999, 1998): i) the distribution of objects of interest or ‘weight’ around the horizontal and vertical axes of symmetry of the pictorial space (Gershoni & Hochstein, 2011); ii) directional cues (i.e. left and right lateral organization, Palmer et al., 2008); and iii) the location of areas of interest or greatest structural weight (e.g., Freimuth & Wapner, 1979; Gaffron, 1950; McLaughlin & Kermisch, 1997; Mead & McLaughlin, 1992).
1.4.1. Composition, symmetry and balance in a frame

Composition can help direct the viewer’s attention to interesting and meaningful objects and locations in an image. This space in which these objects are contained, the frame, is often rectangular and may itself be a work of art (Gombrich, 1979). There is strong evidence to suggest that the constraints of a frame have a strong influence on the composition, (particularly the balance and proportion) of the image. In turn, this influences perceptual and aesthetic responses to the image, as well as components within the frame (Palmer et al., 2008). Rectangles are of interest in experimental aesthetics, in particular how aesthetic preference can be influenced depending on how objects are placed in them (Höge, 1995; Jacobsen & Beudt, 2017; McManus, Cook, & Hunt, 2010; McManus & Wu, 2013; McWhinnie, 1987).

For example, extensive empirical work has examined the Golden ratio (also referred to the “golden section” or “divine proportion”), a widely known geometric measurement that has a ratio of width to length of 1:1.618. The Golden ratio has fascinated mathematicians and artists since the time of Euclid and was thought to possess special aesthetic properties. Classical texts such as Luca Pacioli’s *De Divina Proportione* (1509) explored the mathematics of the Golden ratio in relation to aesthetics and included illustrations by his student, Leonardo Da Vinci. Fechner’s (1871, 1876) studies to determine the aesthetic appeal of artworks containing the Golden ratio represent some of the earliest psychophysical experiments. Fechner (1871, 1876) asked people to rate which of ten rectangles with varying length to width ratios they liked best and which they liked least. Around three-quarters of the participants preferred rectangles with ratios of 1.50, 1.62, and 1.75. The “golden rectangle” (with the ratio of 1.62) was liked the most, and none of the participants chose it as their least preferred rectangle.

However, replications of Fechner’s studies have revealed mixed results. McManus and Weatherby (1997) found relatively robust evidence that positioning of objects within a frame is approximately related to the golden section or to the rule of thirds. Höge’s (1995) replications of Fechner’s experiments showed that different methods (drawing or judging rectangles) produced different outcomes in the production and sorting of the rectangles, suggesting perceptual and cognitive processes may influence preference for the golden section. Despite extensive research, the role of the Golden ratio in determining balance in an image is still
controversial, and neither the supporting or opposing evidence provides robust explanations (Boselie, 1984, 1992). In the next section, I discuss several other well-known biases discussed in the empirical literature.

1.4.2. Left, Right, and Centre: Compositional biases

There is strong evidence for the existence of biases that favour symmetrical composition. Indeed, Rudolf Arnheim devoted an entire book (The Power of the Centre, 1982) to the subject of a centre bias in symmetrical spatial composition. Yet, asymmetry is a common feature in many works of art, and an important consideration when composing an artwork is the position and orientation of an object.

Palmer (1991) found that objects, such as a person facing towards the observer, were liked best when located in the centre of the frame (the Centre bias). Palmer et al. (2008) also found that left-facing or right-facing objects viewed side-on were liked best when facing into the frame. Palmer et al. (2008) define the Inward bias as follows: ‘‘the direction the object faces (i.e., the direction from the object’s centre to its front) is the same as the direction from the object’s centre to the frame’s centre’’ (p. 425). The left to right directional bias is consistent with a bias to see motion from left to right (Gaffron, 1950), although Palmer et al. (2008) noted that the bias was the same for animate and inanimate objects (e.g., a teapot). It is also consistent with a bias to place salient objects on the right (the Right bias), given that the anterior (head) is the most salient feature of objects (such as an animal, see also the Anterior bias, Bertamini et al., 2011).

Photographers frequently refer to the rule of thirds (ROT) in composing photographs. The ROT states that a salient object should be located, both horizontally and vertically, one-third the distance from the margin, (Clifton, 1973). Palmer et al. (2008) did not find evidence to support the existence of this bias in their study. A pictorial summary of these biases is shown in Figure 2 (from Bertamini et al., 2011), and are categorised as positional and directional biases. Some of the biases may be combined in complex scenes, while others may be incompatible with each other. For example, mirror reversal would affect some biases: the Left bias would become the Right bias in a mirror image. In contrast, mirror reversal would
not change the Inward bias because a right-facing object would still face into the centre, and the same would be true for a left-facing object.

Mamassian (2008) argues that visually salient *a priori* features, such as high contrast edges and contours are generally regarded as the most important for commanding visual attention. However, in the context of the compositional conventions used in works of art, locations such as the centre of the frame are considered to be of particular interest. An important factor in spatial composition, particularly for composition within a frame, is the concept of the ‘centre’. Rudolf Arnheim’s *The Power of the Center* (1982) and Alexander’s *The Nature of Order* (2002) provide classic accounts of the phenomenon.

Figure 6. A summary of biases based on the literature, divided into Positional and Directional biases. From top: Centre bias (symmetry); One-third bias; Right bias; Facing bias to the right; Inward bias. The Centre bias is incompatible with the One third and the Right biases, Bertamini, Bennett, & Bode, 2011.

Gestalt principles underpinned Arnheim's intuitive formulation of an implicitly perceived “structural skeleton” (1974, p.13) in which the frame of a square provides the scaffolding on which images are composed. According to Arnheim, perception of this structure occurs through an interaction between “perceptual forces” in the brain and simultaneous perception of the inward and outward contours of the frame. The diagram of the structure (*The Power of the Center*, p.13) itself was created by moving a disc around the frame, and illustrates Arnheim's perceptual
experience in experimenting with positioning and structural stability (Palmer & Guidi, 2011). These experiments led Arnheim to conclude that the centre of the frame was the most stable and balanced position within the framed space.

Empirical testing has shown some general agreement with Arnheim’s hypothesis of the stability of the axes of symmetry in a frame and the centre bias. Palmer (1991) asked people to view images of a simple disc in a frame and rate them with a “goodness of fit” measure, and found high scores for both vertical and horizontal axes, but highest scores were for the centre. Later research found that the deciding factor in assessing good fit was the location of the disc within the frame, and whilst individual differences were observed, average preferences were highly correlated with ratings of “good fit” (see also Palmer & Guidi, 201; Palmer & Griscom, 2012).

Palmer et al.’s (2008) study of aesthetic preference for the position of objects in a frame found significant interactions between the orientation and position on a horizontal midline in a 2-AFC adjustment “goodness of fit” task. Front facing objects were preferred when they were placed at or near the centre of the frame. The results were largely consistent with Arnheim’s hypothesis regarding implicit perception of the structure of a rectangular frame. Thus, according to Palmer et al. (2013), the centre bias does not depend on knowledge of the depicted object but only on the location of the objects own centre. The centre bias is a symmetrical bias, and while these results support a preference for symmetric abstract patterns over asymmetric ones, empirical research on aesthetic judgments of pictures has identified some compositional asymmetrical biases.

Levy (1976) proposed a model of attentional-bias which suggests that visuo-spatial processing activates the right hemisphere eliciting an attentional bias to the left visual field: the right side bias. Levy’s findings indicated that dextrals (right-handed people) preferred vacation slides (i.e. images of landscapes, wildlife, architecture and street scenes) with content of greater interest or ‘weight’ on the right compared to the left. Levy’s (1976) “attentional-bias model” explains those images with greater weight on the right counters a left attentional imbalance, and are considered more pleasing. Beaumont (1985) found a preference to have larger salient content on the right side of paintings. He also observed gaze cues directed from left to right. Beaumont (1985) proposed an alternative to Levy’s (1976) attentional-bias
model that states that the right-gaze bias allows a larger portion of the picture to fall in the left visual field where it is then analysed in the right cerebral hemisphere.

Mead & McLaughlin’s work (1992) extended Beaumont’s (1985) model suggesting that aesthetic preference for an image is a result of efficient visual processing, similar to the explanation for the innate human preference for symmetry (Rentschler, Jüttner, Unzicker, & Landis, 1999). Additionally, Mead and McLaughlin’s (1992) findings indicated that aesthetic preference was largely determined by the direction of the stimuli. That is, participants strongly preferred stimuli with left-to-right directionality, even when there was no object of interest or greater weight on the right side of the painting.

Another, less well known and somewhat controversial, compositional rule is the “Eye-centring principle” (ECP; Tyler, 1998, 2007). Tyler’s (1998) analyses of 265 portraits spanning 400 years revealed a dominant positioning principle in which one eye of the sitter tends to be placed on the central vertical axis. Support for the ECP remains mixed. Nicholls et al. (1999) measured horizontal positions of the left and right eyes in 137 solo portraits in which only the upper body or head were depicted. Of the portraits that were sampled, 57% presented more of the left side of the face, 36% presented more of the right side and 7% showed no bias. Half of all portraits depicted either the left eye or the right eye in the centre of the painting, confirming the central tendency proposed by Tyler (1998). Of the portraits for which one eye fell in the middle of the painting, 63% of these featured the left eye. Other research has found no evidence for the ECP. McManus and Thomas (2007) carried out a similar analysis of 600 paintings but failed to find a corresponding bias. They interpreted the ECP as one that possibly arises from the constraints of depicting an object that is large, relative to the dimensions of the canvas.

A compositional bias that is frequently employed by photographers is the ‘rule of thirds’ (ROT). The ROT states that salient objects should be placed at a location that is one-third of the distance from the both horizontal and vertical margins (Clifton, 1973). However, Palmer & Guidi (2011) found that the ROT was at odds with positions of good fit in the frame, and the four locations identified by the ROT were rated as a poor fit in the frame.

The one-third bias is derived from the rule of thirds and it believed to be a rough approximation of the Golden ratio as their numerical values (0.666 and 0.618 respectively) are similar. Photographers frequently use this rule to compose a
picture, which states that the principal object of interest should be positioned at a location that is one-third the distance (both horizontally and vertically) from the edge of the frame (Clifton, 1973). Palmer et al. (2008) did not find evidence to support the existence of the ROT in their study, and they found it conflicted with preferences of single forward facing objects when they were placed near or on the centre of the frame. They found same to be true when objects faced outward. However, Palmer and colleagues note that real world photographs often contain multiple objects and background structures that might influence preference in the placement of a focal point, whereas their images contained only single objects. Furthermore, Bruno et al. (2013) tested the ROT, the Golden ratio, and the ECP using a database of 388 photographic self-portraits (selfies). They suggested that the purpose of the ROT, the Golden ratio, and the ECP might simply be to deter the placing of the object of interest at the centre of the frame, consequently avoiding a less visually dynamic composition. Bruno et al. (2013) concluded there was little evidence to support any of the three rules of composition tested in relation to photographic self-portraits.

Palmer et al. (2008) proposed that alongside a centre bias for front facing objects, there was also what they termed an Inward bias resulting from the direct influence of the centre bias which resulted in asymmetrical distribution of left and right facing objects on the left and right sides of the frame. That is, left facing objects were preferred when placed on the right side of the frame, whilst right facing objects were preferred when placed on the left side of the frame. Palmer et al. (2008) concluded that in comparison to the centre bias, the inward bias appears not only to be object dependent, it also requires the viewer to understand and differentiate between the front and back of an object. Support consistent with the Inward bias comes from Bertamini et al., (2011) who analysed works of art depicting animals and found a bias composed of more space in front than behind the animal (Anterior bias). They also found a modulated version of this bias consisting of a stronger Anterior bias for left-facing animals, which may originate from a combination of an Anterior bias and a Right bias.

Much of the research discussed so far has focused on preferences for simple stimuli within frames. Other effects in relation to aesthetic judgment and preference for the size and perspective of real world objects in framed space are also present. Konkle and Oliva (2011) found that when shown different sized objects within a frame, people preferred small objects (e.g. Birds, keys) depicted with a smaller size
and larger objects (e.g. Elephants, caravans) depicted as larger. This effect, referred to as “canonical size” relates to the way in which the visual size of an object is proportional to the logarithm of the size the object is believed to be in the real world and is best characterised as the ratio of the object and the surrounding frame of space (Konkle & Oliva, 2011). Empirical evidence for canonical size has shown that in paintings of animals by different artists, the average size of an animal predicts the proportion of the frame it occupies (Bertamini et al., 2011); and in different sized photographs of single objects (Linsen, Leyssen, Sammartino, & Palmer, 2011).

One area of research that has generated an array of social and biological explanations for compositional asymmetries is the genre of portraiture. In the following sections I discuss the literature relating to posing biases in portraits and self-portraits. Firstly, I briefly address the importance of the face as a means of communication.

1.4.3. Asymmetrical posing biases in art: portraits and self-portraits

Drawing is almost as old as mankind, and the urge to produce drawings of the people around us is likely to have emerged around the same time. Recent archaeological finds at Angoulême, in western France, and Dolní Věstonice, in the Czech Republic have claimed evidence of self-portraits and portraits dating from around 30,000 years ago. It is interesting that even at the dawn of art, certainly long before mirrors and cameras, the face was considered interesting and important enough to be painted on cave walls and placed in burial mounds. These pre-historic portraits are recognisably human, although highly stylised and resemble more modern artworks such as those by Picasso and Modigliani (see Fig. 3).

In comparison to the Modigliani sculpture, the portrait by Picasso is notably asymmetrical, yet it still has a degree of beauty. Facial symmetry is widely accepted as a positive attribute in favourable judgments of attractiveness and physical health (Reis & Zaidel, 2001; Zaidel, Aarde, & Baig, 2005; Zaidel & Hessamian, 2010). However, imperfect symmetry may not necessarily mean flawed beauty (Enquist & Johnstone, 1997). The human face is arguably the most important vehicle for communication between people in everyday interactions. Expression is an important non-verbal method of communication, and there is a long and widely debated body of research dedicated to understanding why humans may have developed this
characteristic. For example, Darwin (1872/1998) proposed that humans across all cultures, as well as animals, have particular and distinct facial expressions that are produced as an involuntarily response to that emotion. Darwin (1872/1998) defined emotions as behavioural and physiological reactions that have helped humans and animals negotiate the challenges of survival throughout their respective evolutionary histories. He suggested possession of these emotional responses facilitates a greater likeliness of survival to reproduce and pass on the genetic trait. Emotional facial expressions are thought to be the vestiges of an entirely nonverbal communication system predating modern humans, as species prior to *Homo sapiens* did not possess the necessary oral physiology to articulate speech. For example, the fear response has assisted humans and animals in escape from danger, the anger reaction assisted humans and animals to fight rivals, and so forth. Wundt (1874) noted that facial expressions and gestures could effectively convey the internal mind state of the individual. In relation to art, expressiveness is traditionally defined in psychological terms as the way in which a person's facial and bodily expressions (i.e. stance, gait, and gesture) allow an observer to draw conclusions about the state of mind or personality of the observed individual (Arnheim, 1966). Expression, particularly in portraits, and self-portraits are of special interest in aesthetics.

In his influential work On Painting, Alberti, (1435; 2004) appraises the importance of facial and body expression in eliciting affective responses from those viewing a painting: "A “historia” will move spectators when the men painted in the picture outwardly demonstrate their own feelings as clearly as possible" (p.76). Arnheim, (1974) wrote extensively on expression in artworks, and agreed that facial expressions are an important way of communicating emotions in visual arts, and Gombrich (1982) suggested that suggested that artists have a pre-formed schema in depicting facial and bodily gestures that are grounded in both cultural ritual and tradition. Nicholls (2000) argued that regardless of our preference for symmetrical faces, we frequently choose to portray ourselves asymmetrically. Nicholls (2000) describes Giovanni Bellini’s portrait of Leonardo Loredan, Doge of Venice (c. 1501) as embodying the following four asymmetries that typically appear in portraiture: the expression of the face, the way the head is turned, the direction of lighting and the horizontal position of the eyes.

Explanations for asymmetry in facial orientation and presentation in artworks include a broad range of perspectives, yet there is still little agreement for the bases
of these asymmetries. One idea is the notion of hemispheric specialisation in emotional processing.
Figure 7. Modern and ancient portraits depicted with highly stylised features. Top left: Cave drawing of a face, c.27,000 B.P., La Grotte de Vilhonneur, Angoulême, France; Top right: Pablo Picasso, Head of a Woman, 1924, Tate Gallery, UK; Bottom left: Amadeo Modigliani, Head of a Woman (Anatolia), 1911-1912, Fogg Art Museum, Harvard University; Bottom right: Carved head found at Dolní Věstonice, c. 25,000-29,000 B.P., Brno Museum, Czech Republic.
The specific contributions of each hemisphere are widely debated, and there is compelling evidence for both. The “Right-hemisphere hypothesis” posits that the right hemisphere predominantly processes all emotions regardless of affective valence (Borod, Cicero, & Obler, 1998). By contrast, the “Valence-specific hypothesis” argues that the left hemisphere processes positive affective responses while the right hemisphere processes negative affective responses (Adolphs, Jansari & Tranel, 2001). Strong evidence suggests that the contralateral cerebral hemisphere controls the muscles of the lower part of the face. Thus facial asymmetry is recognised as a behavioural indicator of hemispheric specialisation (Borod, Haywood, & Koff, 1997). Emotional expressions are expressed more easily by the left side of the face (even those perceived unconsciously) than those on the right, suggesting a left hemispheric dominance (Levy, Heller, Banich, & Burton, 1983; Davidson, 1984). Negative facial expressions tend to induce a leftward facial asymmetry more so than positive facial expressions (Sackeim, Gur, & Saucy, 1978). Whether it is for the purpose of attracting a mate or expressing an emotion, expressive people are liked more than non-expressive people (De Paulo, 1992; Zaidel, Chen & German, 1995).

A widely discussed explanation for the left cheek bias proposes that the right cerebral hemisphere’s role in emotional regulation may explain the observation that the left side of the face exhibits more emotive expressions than the right side of the face (Borod, Caron, & Koff, 1981; Sackeim & Gur, 1978; Sackeim, Gur, & Saucy, 1978). Facial expressions, and in particular conscious facial expressions are also known to be asymmetrical (Sackeim & Gur, 1978; Ekman, Levenson, & Friesen, 1983). It has also been suggested that dextrals rate the left side of the face as displaying more intense emotional expressions compared to the right side, though this tendency is more consistent with negative rather than positive emotional expressions, and may reflect right hemispheric dominance in controlling voluntary emotional expressions (Lindell, 2013; Nicholls, Ellis, Clement, & Yoshino 2004; Nicholls, 2000; Powell & Schirillo, 2011; Sackeim & Gur, 1978). One explanation for the left cheek bias in female portraits suggests a greater inclination in females to express emotion (Nicholls & Roberts, 2002; Schirillo, 2000). Ekman et al., (1983) found a lower incidence of facial expressions in people who were asked to remember a past emotional event than in response to a recently viewed film. Scenes from films...
viewed in the left visual field are rated as more emotionally negative than those viewed in the right visual field (Dimond & Farrington, 1977).

Other empirical explanations for facial asymmetries in painted and photographic portraits and self-portraits are many and varied; social, emotional and gender differences (LaBar, 1973; McManus & Humphrey, 1973; Humphrey & McManus, 1973; Lindell, 2012; Schirillo, 2007); hemifacial asymmetries (Nicholls, Wolfgang, Clode, & Lindell, 2002).

McManus and Humphrey (1973) showed that there is a tendency for portraits (particularly those of females) to show the left cheek rather than the right cheek as females were viewed as more passive. McManus and Humphrey (1973) analysed 1,474 solo portraits from Western Europe painted between the 16th and 20th centuries. They found that in 68% of female portraits and in 56% of male portraits there was a left cheek bias. Overall, the left side of the face was more visible than the right, though the tendency was higher in females. This analysis prompted LaBar (1973) to examine photographs in a high school yearbook for the same phenomena. LaBar found that 63.4% of the photographs presented the left cheek. The students chose the pose (from a selection of four) they preferred to be published in the yearbook. The data showed that there was a trend for the senior staff and students to present the right cheek suggesting that high status allowed a more personal display. In support of this, McManus and Humphrey (1973) indicated that presentation of the left or right cheek by the sitter might depend on the similarity or dissimilarity in gender or status between the artist and model (i.e. left cheek bias: similar status/gender; right cheek bias: dissimilar status/gender).

More recent research has confirmed the left cheek bias, though it is observed more often in female portraits than those of males, suggesting a sex-related bias. For example, Benjafeld and Segalowitz (1993) asked people to rate eight portraits (four male portraits, and four female portraits) on a Semantic Differential scale. Half of the portraits presented the left cheek, and the other half presented the right cheek to the viewer. The same portraits were also shown in mirror-reversed versions. Portraits depicting the original orientation in which they were drawn presenting the right cheek were judged as more potent and active than portraits presenting the left cheek. This was true even when the portraits were mirror-reversed. The authors speculated that da Vinci (and indeed, other artists) might have preferred to draw the subject presenting the right cheek when seeking to depict a representation of those
characteristics. Conversely, Zaidel and Fitzgerald (1994) found a right cheek bias in female portraits (regardless of orientation) that contradicts the pattern of findings for sex-related bias in portraits. They concluded that the left cheek bias might relate to a convention in portraiture for artists to depict women in a less attractive orientation. However, this explanation conflicts with Chatterjee’s (2002) explanation of the change over time of the view of women as ‘active agents’.

Another suggestion for this gender bias is that maternal imprinting may determine facial side biases. Grusser, Selke, and Zynda (1985) found that dextral mothers are more likely to hold an infant in their left arms, thus the infant will imprint the left side of the mother’s face. Grusser et al. (1985) suggested that if this is the case, it is possible that imprinting also influences latent artists, who then go on to prefer to portray the left side of female faces in paintings. It may also arise from spontaneous behaviour, as there is good evidence of spontaneous right head turning in infants (Latto, 1996; McManus & Humphrey, 1973). However, Chatterjee (2002) argues that whilst this hypothesis may account for gender differences in portraits, it is unlikely that mothers stopped carrying their infants on their left arm despite a reduction in female portraits presenting the left cheek between the 15th and 20th centuries as gender-specific roles became less rigid (Powell & Schirillo, 2009). Neither, according to Chatterjee (2002), does it address social or personality factors (i.e. the left cheek bias was less present in women who were of high social status).

In relation to social explanations for the left cheek bias, Corballis and Beale (1976) observed that Renaissance portraits were commonly painted in and hung in pairs (see Fig. 8). The male (typically considered as more important) would often be positioned to the left and the female to the right (from the perspective of the viewer) and facing towards each other. This may relate to a tradition in many cultures of placing the bride to the left of the groom in formal ceremonies such as weddings. Thus, the female sitter presents her left cheek, and the male his right cheek. Chatterjee (2002) argued that other factors might be involved as a leftward bias is observed for both males and females. He also noted that the leftward bias frequently observed in solo male portraits could be a result of the inclusion of portraits that may have originally been part of a male paired set (see Nicholls et al., 1999; McManus & Humphries, 1973).
Figure 8. Marriage portraits depicting the male on the left showing the right cheek and female on the right showing the left cheek. Top: Attributed to Maestro delle Storie del Pane, Portrait of a Man and a Woman (possibly Matteo di Sebastiano di Bernardino Gozzadini (left) and Ginevra d'Antonio Lupari Gozzadini (right)), c. 1485–95. The Metropolitan Museum of Art, New York, Robert Lehman Collection, 1975; Centre: Lucas Cranach the Elder, Portraits of Dr. Johannes Cuspinian (left) and Anna Cuspinian (right), c. 1502, Oskar Reinhart Collection, Winterthur; Bottom: Frans Pourbus the Younger, Portraits of Willem van Vyve and his wife, Marie de Huelstre, 1591, Weiss Gallery, London.
Additionally, mechanical biases (such as handedness) and studio conventions (the use of mirrors in self-portraits) are among several possible explanations for the right facing bias (Latto, 1996; Nicholls, Clode, Wood, & Wood, 1999). For example, Humphrey and McManus (1973) suggested that the right-facing directional bias in portraits arises because right-handed artists find it easier to draw portraits in which the sitter faces to the left. However, the hypothesis does not account for gender differences.

Until relatively recently much of the research relating to portraits and self-portraits has focused on Western European paintings dating from the 15th to the 20th centuries, and until recently little interest has been shown in the photographic self-portrait as a source of research. However, the phenomenon of the photographic self-portrait, or ‘selfie’ (as they are widely referred to in the media) has begun to attract interest across a variety of research fields. Amateur photographic self-portraits have been around almost as long as the medium itself, but it was not until the development and wide availability of digital and phone cameras that it became ubiquitous (Rawlings, 2013). Digital cameras, unlike traditional analogue cameras, allow photographs to be taken, and re-taken, or edited, then shared on social media platforms.

A recent edition of “Frontiers in Psychology” (February, 2018) published a special section dedicated to selfies. The editors (Bruno, Pisanski, Sorokowska, & Sorokowski, 2018) outlined a series of broad, yet topical questions that relate to current research involving the selfie. The array of questions themselves demonstrates the vast potential for research: Topics included motivational, functional, and social factors driving selfie taking and posting; gender, age group, ethnic or cultural differences; the biological, perceptual, cognitive, and sensorimotor determinants affecting selfie-taking; the use selfies as media tools, psychological data, or as a diagnostic in assessing personality, stereotypes, or cultural norms; and lastly, the psychological nature of the selfie in relation to body image, mirror-images, painted self-portraits, and composition. However, selfies are still a new area of psychological research, and there are relatively few studies involved in examining the basis for compositional biases in selfies. Below I present a brief review of the research relevant to the work carried out for this thesis relating to compositional biases in selfies, as well as painted self-portraits.
From a psychological perspective, and also from the perspective of the research on compositional asymmetrical biases in self-portraits presented in Chapter 3, the processes involved in taking selfies are interesting in terms of the impact it has on social and cognitive behaviour, and as a form of real-world behaviour. Selfie-taking also reproduces some of the artist’s conventions when painting a self-portrait whilst looking in a mirror; selfies tend to be taken either with a smartphone camera (which previews a mirror image of the subject), or a digital camera in front of a real mirror (Bruno & Bertamini, 2013; Bruno, Bertamini, & Protti, 2015).

Research suggests that in self-portraits artists prefer to display the right side of the face (e.g., LaBar, 1973; Latto, 1996; Suitner & Maass, 2007), which appears to be consistent with the artists’ use of a mirror when painting a self-portrait (Lindell, 2013). For example, Humphrey and McManus’s (1973) analysis of self-portraits by Rembrandt found that he displayed his right cheek more (84%) compared to his left cheek (16%). However, emotional context influences which cheek is presented. Nicholls et al. (1999) found that when having photographs taken, people instinctively present the left cheek when asked to pose for a photo expressing emotion, and the right cheek when concealing emotion. Nicholls et al. (1999), suggest that these intuitive preferences for posing biases could be based on prior experience of responses to emotional expressions, or they could be controlled by latent brain mechanisms.

Analyses of Renaissance paintings and experimental studies involving asymmetries in facial expressiveness have found strong evidence of a right cheek bias (Blackburn & Schirillo, 2012; Lindell, 2012). A common notion is that as mirrors became cheaper and more readily available, the frequency of self-portraiture increased. Hall (2014) suggests that as mirrors, of one sort or another, have been around since ancient times, the increase in self-portraiture may have been a response to contemporaneous philosophical discussions on the exploration of the self. This notion is interesting, but it is also possible that an unconscious tendency in the artist to present the (more expressive) left side resulted in a mirror reversal of the face, which the artist then paints as the right side of the face (thus explaining the right cheek bias, Bruno & Bertamini, 2013).

While the Right-hemisphere hypothesis provides a plausible and interesting explanation, other interpretations are possible. Alternatively, directionality of reading and writing direction may account for the left cheek bias. For example,
Pérez-González (2012) suggests that left-to-right readers tend to show a left cheek bias, whereas right-to-left readers tend to show the right cheek bias. Another possibility is that studio conventions tended to favour placing a painter’s canvas to the right of the subject, as most painters are right handed. This arrangement allows the sitter to be seen without the artist needing to look over their painting arm (Humphrey & McManus, 1973). Additionally, the sitter may respond by turning their left cheek toward the sitter. For a self-portrait, this would entail the artist placing the mirror to the left of the canvas, thus producing the left cheek bias (Bruno & Bertamini, 2013; Nicholls et al., 1999). These conventions might arise from cultural factors; symbolic meaning attached to the right and left cheek may signal similarity or distance in status or gender (Humphrey & McManus, 1973; McManus & Humphrey, 1973; Schirillo, 2000; ten Cate, 2002). Similarly, Suitner and McManus (2011) suggest that the Spatial Agency Bias (Chatterjee et al., 1995; Chatterjee et al, 1999) may account for the left cheek bias, as passive recipients of action in paintings tend to display the left cheek poses (active agents will present the right cheek).

More recently, analyses of selfie databases and experimental studies have confirmed an overall left cheek bias. Manovich, Ferrari and Bruno, (2017) carried out an automated analysis of head rotation and emotional expression in selfies deposited in a large selfie database (the “SelfieCity” database). By using an automated method to analyse the selfies, Manovich et al. also addressed methodological issues noted in earlier studies relating to the ambiguities in categorising frontal and three-quarter selfie poses (see also Lindell, 2015). The analysis confirmed the left cheek bias in standard selfies and a more frequent right cheek bias in mirror selfies. Overall this pattern of association between selfie type and posing orientation was also present across different cultures and for both sexes despite a greater number of female selfie-takers, and fewer male mirror selfies. An additional analysis of ratings for emotional expression revealed an interesting difference in emotional expression between selfies showing the left cheek and those showing the right cheek. Selfies showing the left cheek elicited higher scores for stronger expressions, though the higher scores related to negative emotions. This trend was reversed for selfies showing the right cheek with higher scores for positive emotional expression, although this trend was weaker than for left cheek. These findings are consistent to some extent with the right-hemispheric specialization for
the expression of emotions that account for the left cheek bias (Nicholls et al., 2002; Nicholls et al., 2004).

Lindell (2017) investigated whether people consistently use the same facial posing orientations. She selected two hundred selfie-takers (100 male and 100 female) via Instagram (the social media platform). The most recent 10 single-subject selfies were then coded for type of selfie (normal: a standard selfie taken with a phone; mirror: where the selfie-taker photographs their reflection in a mirror) and facial orientation (left, midline: frontal or slightly left or right, and right). Lindell (2017) found that selfie-takers consistently adopted a preferred pose orientation. Furthermore, there was confirmation of an overall left cheek bias. Interestingly, a comparison of left and right cheek poses showed a stronger left cheek bias for mirror selfies than normal selfies that replicates the left cheek bias found in both photographic and painted self-portraits further supporting the Right- hemisphere hypothesis.

So far, the discussion has focused on lateral compositional biases in portraits. In the next section, I discuss the literature on directional preferences of motion in the context of both static images and film.

1.4.4. Composition and movement: motion and implied motion

According to Arnheim “motion is the strongest visual appeal to attention” (1954/1974, p.372). In Film as Art, Arnheim (1933/1958/1983) addresses the fundamental question of whether cinematic film (hereafter referred to as ‘film’) can be considered to be art, in the same sense as traditional art forms. Arnheim (1933/1958/1983) refuted the idea that film and photography are mere mechanical reproductions of reality. Arnheim did not carry out any specific empirical studies, and his writing is largely observational. However, he does note some incompatibility between the visual experience of film (e.g., the relativity of movement on film; reduction of depth; delimitation of the image, distance from an object) and perception of the real world. J.J. Gibson’s (1979) ecological theory of film perception suggests that such visual incompatibilities between the real world and the world in a film, as they are similar enough to enable the viewer to successfully perceive the visual information on the screen. Cutting (2002) argues that while both paintings and photographs are static, paintings are to be viewed as a depiction of an
event unfolding over time, and that this in many ways is similar to the visual experience of film.

Hochberg and Brooks (1996) argued there are at least five characteristics that distinguish the visual experience of film from real world visual experience. They proposed that: i) Motion pictures could provide movement-based information about three-dimensional spatial composition (i.e. motion depth cues) unavailable in static images. They also facilitate critical testing of theories and models by allowing us to study the variation of different elements of motion perception separately that covary rigidly under normal conditions; ii) Films can represent, through sequential views, scenes or objects that are very much larger than the size of the cinema screen (or other display), allowing researchers to study how people anticipate, comprehend, integrate and store visual information; iii) They also (through editing, close ups, etc.) represent movement and change, an essential characteristic of motion pictures. Thus, films, in a way that static images cannot sustain, can maintain levels of visual interest; iv) Films avoid the constraints of the real world, as scenes and events can be presented sequentially, or by allowing the comparisons or conjunctions between unrelated components (e.g. constructing computer generated images (CGI) allows the possibility of unlimited virtual visual experiences to be investigated and developed; see Neumark, 1995); and, v) they also represent a means with which to investigate a viewer’s mental representation, comprehension and recognition of visual objects and scenes and; v) events through the manipulation, omission or reduction of a variety of redundant features (i.e. actions, time periods, space).

There are empirical studies that have examined feature films as the basis for the studies of cinematographic techniques. None, thus far, have studied feature films in relation to compositional asymmetries, although much has been made in the film literature of the obsessive use of symmetry in the works of directors such as Stanley Kubrick (Kolker, 2010) and, more recently Wes Anderson (Thompson & Bordwell, 2014). James Cutting in particular has produced a large body of writing on feature films, but he has primarily focused on perception of temporal, dynamic events such as “field size” (how much subject matter can be seen within the camera’s field of view) and focal length (i.e. where the angle of view is dependent on the width of the lens) of camera shots and viewer attention (Cutting & Iricinschi, 2015; Cutting et al., 2010; Cutting et al., 2012), and shot length and facial size in relation to interpretation of expressions (Cutting & Armstrong, 2016). Troscianko, Meese and Hinde (2012)
studied the effect of screen size, scene type and “presence” (subjective immersive experience) of a full-length feature film. However, all but the latter of these studies have focused on using film stills rather than full-length feature films, and none have addressed explicitly compositional symmetry or asymmetry.

In contrast to films, paintings and photographs are characteristically static, but their depiction of any implied dynamic movement can strongly influence not only its spatial organisation but also its aesthetic evaluation by the viewer (Arnheim, 1951; Palmer, 1991). Arnheim (1958/1983) argues that composition or “scenography” (the spatial composition of objects, lighting, structures etc. within the performance environment or film set) is part of a broader set of spatial aspects of a film, and that in films, composition is likely to be even more important than in paintings. Usage of this term differs amongst authors, but the following definition is generally agreed to be an accurate representation of the elements involved: "the manipulation and orchestration of the performance environment. The means by which this is pursued are typically through architectonic structures, light, projected images, sound, costume and performance objects or props" (McKinney & Butterworth, 2009, p.4). Indeed, given that the technique of montage (the way in which temporal and spatial visual events are pieced together via camera angles and film editing, Cutting, Brunick, DeLong, Iricinschi, & Candan, 2011; Gibson, 1979) can emphasize and manipulate both development in time and development in space, it is likely that aesthetic criteria for a film may differ from those used to assess a painting.

In artworks, representation of movement is often achieved by depicting an object in an unstable pose or by breaking the symmetry of the composition (as in examples seen in Fig. 9), as well as repetition. Breaking symmetry and can introduce perceptual effects such as dynamic balance (Attneave, 1955; Arnheim 1974, 1982; Gombrich 1982). Depicting convincing dynamic objects or scenes is challenging for an artist. Cutting (2002) states: “Words often do little justice to motion, and it might appear that static images could do little better. How can one depict motion in a medium where none can exist?” (p.1165). Aside from the issue of lack of temporal cues, there are ambiguities in the direction and speed of the objects in a static image (Ivry & Schlerf, 2008; Mamassian, 2008). However, the presence of diagonals in a painting, for example, can suggest that the elements in a painting are structured in a left-to-right or a right-to-left sequential order (Arnheim, 1974).
The positioning of figures in a left-to-right, or right-to-left sequence may influence implicit perceptions of depicted movement. For example, objects or figures portrayed as moving from left to right seemed to move faster than when the same figures are caused to move from right to left (Gaffron, 1950). Freimuth and Wapner (1979) manipulated not only the directional cues in pictures, but also the location of the object of principal interest. The findings indicated that whilst location of interest had little effect on preference, directional cues appear to influence the preference for paintings with left-to-right directionality in dextral subjects.

However, only eight paintings were used in the analysis, and no data was reported for sinistrals. Mead and McLaughlin (1992) extended this approach by not only identifying the location of principal interest, but also the location of greatest weight in a picture. They then compared the influence of both variables and also directional cues on preferences of both dextral and sinistral participants. Dextrals and inverted sinistrals (left-handers who write above the line and with the pencil pointed down the page) preferred paintings with implied motion proceeding from left to right over mirror-reversed versions and those with weight positioned in the left portions of the picture space. Mead and McLaughlin (1992) suggested that preference is therefore greatest when pictorial cues direct attention to the right, placing more of the picture in the left visual field, and is thus processed by the right cerebral hemisphere.

Recent neuroimaging studies have found strong evidence that one of the main areas involved in the analysis of implied motion is the extrastriate visual area medial temporal/medial superior temporal cortex (MT/MST). Kourtzi and Kanwisher (2000) showed participants static photographs of athletes in action and at rest. They used functional magnetic resonance imaging (fMRI) to assess whether the MT/MST, brain areas known to be involved in the analysis of physical stimulus motion, also process implied motion from static images. They found stronger fMRI activation within MT/MST relating to the viewing of photographs with implied motion compared to photographs without implied motion. Saygin, McCullough, Alac, and Emmorey (2010) also measured fMRI activity in the MT area whilst people listened to recordings of sentences implying motion or stasis. They found that increased activity in the MT area when participants heard sentences that implied movement, than those that implied stasis. Additionally, Saygin, Cook, and Blakemore (2010) measured activity in the fusiform facial area, an area not associated with motion.
analysis, but found no activity. These results suggest that the MT regions of the brain involved in the visual analysis of motion are not only engaged in processing implied dynamic information from static images, but also respond to verbal representations of motion. McBeath, Morikawa, & Kaiser (1992) observed that when motion is seen to move in either of two directions, people tend to perceive the objects move in the direction they face. Additionally, where a single object was perceived to face in either of two directions, the direction of apparent motion is biased in accordance with that intentional construal. The leftward bias is a robust dynamic pattern that could also be accounted for by asymmetry in reading direction, as subjects whose dominant language reads from left to right tend to exhibit a leftward motion bias (Morikawa & McBeath, 1992). McLaughlin and Kermisch (1997) also found that dextrals preferred paintings that implied left to right motion to the mirror-reversed (therefore, right to left) versions.

The Spatial Agency Bias theory (discussed earlier in this introduction, pp. 22-25) proposed by Chatterjee et al. (1999) offers an interesting explanation of left-right preferences in directionality in relation to language development. Chatterjee et al. (1999) suggest that the left-right directionality bias when perceiving action are primitive spatial representations and schema processed by the left-hemisphere during the encoding of visual events. Chatterjee et al. suggest this is a result of opportunistic deployment of left hemispheric spatial attention circuits during language development, thus: “An overlap of neural circuits mediating spatial attention, the directional representations of events and the instantiation of verbs, may provide the neural link between the spatial and propositional representation of events” (p. 401). Further evidence for the involvement of language in directional biases suggests that culture exerts a strong influence on hemispheric lateralisation. Maass and Russo (2003) carried out two cross-cultural studies comparing Italian and Arab participants, investigated whether directional biases are a function of hemispheric lateralisation or writing direction (left-to-right in Italian, right-to-left in Arabic). Both studies found a reversal of directional bias in Arabs. Italians tended to position the subject to the left of the object, and Arabs tended to position the subject to the right of the object. Maass and Russo (2003) also speculate that people may still follow the directional bias specific to their writing habit on tasks such as recognition or visualisation where writing and reading unnecessary. These findings are particularly interesting and relevant to the research in Chapter 5 of this thesis, and are in accord with other
research relating to scanning and writing direction (e.g., Nachshon, 1985; Nachshon, Argaman, & Luria, 1999).

In relation to the depiction of motion, Cutting (2002) noted that artistic conventions for representing motion, especially speed, in drawings and paintings often involves depicting objects leaning forward into their movement (“affine shear”). This graphic convention may be based on the idea that people and animals lean forward when they are running. For example, Bertamini et al. (2011) looked at three data sets of side–on pictures of animals. For the pictures by George Stubbs (1989) and Bewick (1790), there was no significant facing bias, however, for the medieval bestiary (c.1240, Barber, 1999), there was a significant right-facing bias. Walker (2015) observed that many of the animals illustrated in the bestiary are depicted as though in motion (e.g., flying, swimming, running), and therefore are not in a static pose. Given the lack of a significant lateral bias in the Bewick and Stubbs picture sets, Walker (2015) concludes that a significant right-facing bias may exist when animals are depicted moving laterally in an active pose, and less so when depicted in an active pose but not moving laterally. This, he states, suggests that the rightward facing bias is exclusive to depictions of movement.

In Palmer et al.’s (2008) studies of the Inward bias, right-facing objects were preferred left-of-centre and left-facing objects right-of-centre. They found no effect of implied motion in animate and inanimate objects but the objects were not depicted as moving. Palmer and Langlois (2017) examined inward biases with objects (human figures diving or falling forwards or backwards) depicted moving in an implied direction and speed by asking participants to place them in the most aesthetically pleasing position. Both inward-facing and inward-moving figures showed evidence of compositional biases. However, there was stronger evidence for the motion-based bias in which backward divers or fallers were preferred moving inward but facing outward. A second experiment found inward motion or facing biases were present using images of humans, horses, and cars moving at different speeds. Surprisingly, there was a preference for faster moving objects to be closer to frame centre (less space in front of them) than slower moving objects. Palmer and Langlois suggested the Inward bias (and the Anterior bias, Bertamini et al., 2011) might be combined effects of prospective, future-oriented biases, and retrospective, past-oriented biases.
1.5. Aims and Overview of research

1.5.1. Aims of the research

That artists are able to explore and manipulate aspects of the visual world to produce works of art for people to marvel at or, indeed, deride is fascinating. When we walk into a gallery or a museum, we may be drawn to a particular painting and compare that artwork’s pictorial virtues with the neighbouring paintings. From a psychological point of view, what is interesting, are the decisions an artist makes when creating the artwork, and most importantly the factors that provoke our aesthetic responses to the picture.

One of the most important properties attributed to any piece of art is whether it has good “composition” (i.e., the choices of colour, medium, themes, where objects are placed on a canvas, etc.). The art theorist and psychologist Rudolf Arnheim (1982) defined composition as an “arrangement of visual elements creating a self-contained, balanced whole, which is structured in such a way that the configuration of forces reflects the meaning of the artistic statement” (pp. 215–216). These ideas are central to the research contained in this thesis.

The scope of the research in this thesis focuses on examining and understanding whether human aesthetic preference of visual art is influenced by compositional biases. The decision to focus on left-right lateral compositional biases was underpinned by my undergraduate projects (see Bertamini, Bennett, & Bode, 2011) that in turn, were informed by my career as a visual artist. A “real world” approach in investigating aesthetic preference is challenging, but given my background it was important to employ stimuli and settings with ecological value.

Visual art and art production of some sort is present in every world culture, and an important debate in empirical aesthetics focuses on the evolutionary, biological and cultural mechanisms that drive aesthetic preference. If aesthetic preference is driven by biological factors (i.e. hemispheric specialisation), how do these mechanisms influence aesthetic preference for the way in which such diverse objects are composed? Similarly, if aesthetic preference is driven by cultural factors (i.e. directional reading and writing biases), does it influence preference for specific compositions? In attempting to address these questions, data was collected from participants in the UK, Egypt, and Italy (Chapters 2, 3, & 4), and American, Egyptian, Japanese and Italian films were analysed in Chapter 5. Previous research
has investigated preference for compositional asymmetric biases in static images such as paintings and photographs. The current research extends this research by examining whether the same mechanisms applied to moving images such as feature films, and photographic self-portraits.

Another interesting aspect of the investigation of aesthetic judgment is the expert or non-expert status of the viewer, and in this thesis I have focused on the non-expert. Experts (artists, art historians, curators, etc.) are important assets in understanding aesthetic judgment and preference both as viewers and creators. Untrained people are equally important and interesting, because they are less likely to make judgements informed and influenced by an art education. For example, facial biases have been studied in paintings of old masters, but the phenomenon of the “selfie” allowed me to explore these biases in the context of a new and untested social behaviour by non-experts.

The topics that have been investigated in this thesis are to some degree, a reflection of a diverse subject area that comprises an almost infinite array of visual stimuli that can be aesthetically evaluated as well as empirically examined. The issues relating to human aesthetic preference for compositional lateral asymmetries explored in this thesis encompass cross-cultural factors influencing preference for symmetry and complexity in the aesthetic evaluation of novel abstract patterns, to contextual influences on aesthetic preference for facial side biases and positioning in photographic self-portraits and motion pictures. It also explores how composition acts as a link between the way in which the artist conveys to others the meaning or impression of a social interaction, scene or object.

1.5.2. Overview of Chapters

The following four chapters (Chapters 2-5) present the empirical studies that form this thesis. In two of the papers, I (Carole Bode) am the principal author and second author in the other two papers. All research was done together with my supervisor Marco Bertamini, who was involved in planning the studies, principal author on one of the papers (Bertamini, Bode, & Bruno, 2015) and also contributed to the other three manuscripts. Nicola Bruno (Università di Parma, Italy) was principal author on one paper (Bruno, Bode, & Bertamini, 2015) and a contributing author on another (Bertamini, Bode, & Bruno, 2015). Mai Helmy (University of
Menoufia, Egypt) collected data on two papers (Bode, Bertamini, & Helmy, 2016; Bode, Helmy, & Bertamini, 2017). All four papers have been published in peer-reviewed journals.

The research for this thesis is split into two broad areas. Chapters 2 and 3 are concerned with examining the principles of symmetry and asymmetry in static images. Chapters 4 and 5 extend the research of compositional asymmetries to moving images. Finally, the thesis concludes with a brief discussion of the main findings, and future work. The thesis is organised as follows:

Chapter 1 provides an overview of key philosophical and theoretical frameworks of aesthetic preference as well as a review of the literature on known compositional lateral symmetries and asymmetries. Responses elicited by particular images may determine whether an image succeeds or fails depending on an individual’s social and cultural experiences, as well as their physiological and neurological states. Therefore, the cultural, biological, and individual contexts in which images are viewed are also important issues to address in determining aesthetic preference. A review of the methodological and empirical evidence relating to aesthetic preference for compositional lateral symmetry and asymmetry is also presented. The strengths and weaknesses of relevant investigative techniques are discussed.

Chapter 2 addresses some of the fundamental issues examined in the previous chapter regarding universality in preferences for symmetry from a cross-cultural perspective. It also provides the opportunity to discuss another important topic that has long interested researchers of aesthetics: complexity. Chapter 2 presents research that compares symmetry preferences for novel abstract patterns across naïve British and Egyptian groups. Previous comparisons between Britain and Egypt (Souefi & Eysenck, 1971, 1972) confirmed some degree of universal agreement in preferences for simple abstract symmetry.

In Study 1, I asked naïve participants in Egypt (N = 200) and Britain (N=200) to rate the beauty of novel abstract patterns. Six classes of symmetry (asymmetric, 90° rotation, 180° rotation, horizontal, vertical, and horizontal-vertical patterns) were randomly generated in Psychopy (an open source, stimulus development, presentation and control software, Peirce, 2007, 2009) and constructed using a black and white 10 x 10 matrix. The resulting patterns varied in complexity. Four different sets of patterns (10 * 6 = 60) were created and displayed on separate
sheets of paper. We used a 10-point rating scale from 0 - “extremely ugly” to 10 - “extremely beautiful”. Methodologically, using rating measures to investigate preference is a well-established and useful paradigm in aesthetics, particularly when the number (N) of items to be measured is large, as was the case for this study. As observers may find it difficult, especially at the onset of trials, to make consistent ratings, we decided to display the entire set of patterns together with instructions to indicate the most and least liked alternatives to anchor the response scale (Leder et al., 2004; Leder et al., 2005). Participants were given only one sheet and asked to rate how much they liked each pattern. They were allowed to take their time, rate the patterns in any order, and they could change their rating before completing the task. Ratings for each item were then averaged as a measure of preference.

The study confirmed the similarities in preferences for symmetry found by Soueif and Eysenck (1971, 1972). Differences in preference for complex patterns (British group) and simpler patterns (Egyptian group) prompted a further study. In Study 2 I analysed the British and Egyptian data from Study 1 for differences in preferences for complexity. Visual complexity has been widely investigated since the time of Fechner (1860/1966) yet there is still disagreement regarding its taxonomy and measures. Criticisms of inconsistencies across studies have focused on the types of stimuli used to investigate complexity (Marković & Gvozdenović, 2001). Non-figurative stimuli, such as black and white grid patterns (e.g., Palumbo, Ogden, Makin, & Bertamini, 2014; Bertamini, Makin, & Pecchinenda, 2013) have the advantage of avoiding the effects of semantic associations and memory processing on aesthetic evaluation (see Friedenberg & Liby, 2012; Jacobsen & Höfel, 2002, 2003). Three different measures of complexity were used. GIF ratio is acknowledged to be a reliable predictor of visual complexity (see Forsythe et al., 2011). The size of all the black regions for each pattern were averaged, providing a number for each pattern that can be as low as 1 or as high as 40 if all black cells are connected and form a single, solid region. I called this measure average blob size (ABS). The third measure of complexity is edge length. Edge length can be described as a measure of the "crookedness" in a pattern (see Gauvrit et al., 2016). Two people independently counted the number of edges of each black cell adjacent to the white space within each pattern. I found a greater preference for simplicity in Egyptian participants previously noted by Soueif & Eysenck (1971).

In Chapter 3 previous research on asymmetries in facial side biases was
extended to posing biases in selfies taken by non-experts. Having explored the fundamental issues of preference for symmetry and complexity, it was important to address the way in which symmetry and asymmetry can affect preferences in the production of actual “artworks”. Previous analyses suggest that artists prefer poses showing the left side of the subject’s face when composing a portrait, but showing the right side when composing their own self-portrait (Powell & Schirillo, 2009).

Artists may prefer compositions with key features on the right of the picture. We were interested in examining whether the findings in previous studies (e.g., Humphrey & McManus, 1973; McManus & Humphrey, 1973, 1974) could be generalised to self-portraits by non-experts. Posing biases of 104 British schoolchildren in individual photographic self-portraits (“selfies”) as well as duet self-portraits in which they included a friend (“wefies”) were analysed. All photographs were independently measured and inspected and classified into five categories: unambiguously showing the left side of the face, slightly showing the left side, frontal, slightly showing the right side, unambiguously showing the right side (left and right were defined in relation to the person’s face). These criteria were developed in earlier work on solo selfies (Bruno & Bertamini, 2013; Bruno et al., 2015). To test for side biases, chi-square tests of goodness of fit allowed comparisons of the data against the null model $p$ (right versus left side shown) =.5. In the selfies, there was a left cheek bias in the selfies, and a bias for placing the selfie taker on the right in wefies.

In wefies there was a bias for people to show two left cheeks over two right cheeks. These biases are similar to those reported for selfies in adults and for portraits and self-portraits by artists in the 16th-18th centuries. Thus, these results provide new evidence in support of a biological basis for side biases in portraits and self-portraits independently of training and expertise.

The medium of cinematic film is a relatively unexplored artistic genre in relation to empirical aesthetics. Thus, the research conducted in Chapters 4 and 5 extends the knowledge of the effects of compositional asymmetries in the context of motion pictures. Chapter 4 assessed whether mirror reversal of films affects viewer preference. As far as I am aware, this was the first time such a study had been carried out. A reversed image can differ subtly from the original image, and viewers may not detect the change in orientation. We predicted that this might affect the viewer’s aesthetic experience in watching a well-known film. We asked one group of people
to estimate how long it would take them to notice if the world, pictures in a museum, or a film had been left-right reversed. The majority said they would take less than an hour. To test this hypothesis, we invited people to a cinema to watch two films by the Japanese film director Akira Kurosawa (1910-1998). The study revealed that it is possible to enjoy watching a film without noticing the mirror reversal. I found that people who had seen the film before (within the last 5 years) reported liking the scenography more than people who had not seen the film before, but only when the film was shown in the original orientation (even though they did not consciously recognise that the reversed version was different). This can be interpreted as evidence of a composition-specific exposure effect. An additional study using two film clips was carried out in Italy. Once again, the reversal went undetected.

In Chapter 5 I extended the previous study (see Chapter 4) of compositional symmetries and asymmetries in films. I analysed three compositional aspects: a) facial side biases, b) the position and orientation of the face on screen, and c) the lateral movements of the actor within the scene. The creation of the dataset involved watching the film and coding the current image of the lead actor to a set of fixed categories. A simple key press marked the transition from one category to another and was recorded with a timestamp (to compute the category duration).

After completing a first analysis, I decided to add a second wave of coding, with a new set of coders. I included the two coding groups (waves) as a factor in the analysis. Note also that a category has no direct relation to other possible ways to segment a film, such as screen shots. For instance, if the face and position of the actor was the same between two screen shots, these count as a single event in the analysis.

Unlike in paintings, there was no evidence of a left cheek bias in the films that were analysed. The data confirmed that position and facing direction are related, i.e. the actor tended to face toward the centre of the screen (i.e. an Inward bias). There were greater frequencies of movements from left to right, which may explain the lower than expected frequency of the left cheek. Interestingly, the pattern of results from Western directors did not extend to the films by Chahine, which may be influenced by reading direction.
Chapter 2. A cross-cultural comparison for preference for symmetry


Beauty adds to goodness a relation to the cognitive faculty: so that "good" means that which simply pleases the appetite; while the "beautiful" is something pleasant to apprehend

St. Thomas Aquinas, Summa Theologica, 1265-1274, I–II, q. 27, art. 1, 3
2.1. Abstract

The aesthetic appeal of symmetry has been noted and discussed by artists, historians and scientists. To what extent this appeal is universal is a difficult question to answer. From a theoretical perspective, cross-cultural comparisons are important, because similarities would support the universality of the response to symmetry. Some pioneering work has focused on comparisons between Britain and Egypt (Soueif & Eysenck, 1971, 1972), including both experts and naive subjects. These studies confirmed some degree of universal agreement in preferences for simple abstract symmetry. We revisited this comparison after almost half a century. We compared preferences of naive students in Egypt (n = 200) and Britain (n = 200) for 6 different classes of symmetry in novel, abstract stimuli. We used three different measurements of complexity: Gif ratio, Edge length and the average cell size (average blob size, ABS). The results support Soueif & Eysenck’s findings regarding preferences for reflectional and rotational symmetry, however they also throw new light on a greater preference for simplicity in Egyptian participants already noted by Soueif & Eysenck (1971).
2.2. Introduction

Symmetry has long been associated with universal ideals of orderliness, harmony and proportion, and as a concept that is closely related to beauty (Bertamini, Makin & Rampone, 2013; Pollio, 1960; Zaidel & Hessamian, 2010). The relationship between visual symmetry and beauty is a subject of interest for artists, scientists and mathematicians (McManus, 2005; Washburn & Crowe, 1988; Weyl, 1952) and symmetry has been proposed as a fundamental principle of aesthetics (Ramachandran & Hirstein, 1999). However, empirical analysis of symmetry preference and also of preference for order and simplicity is a challenge. Many factors have been suggested to explain preference for symmetry in terms of biological signals of mate quality (Møller, 1992), the anatomy of the human brain (Eisenman, 1967; Herbert & Humphrey, 1996), a need to recognize objects (Enquist & Arak, 1994), and prior experience (Schwarz, 1998). Some authors, like Kubovy (2000) argue that individual differences render futile any attempt at analysis of the factors that may embody beauty.

Not all types of symmetry have equal salience to the viewer, in particular reflectional symmetry is more easily detected than others, and a vertical axis of reflection is more salient than a horizontal axis (Mach, 1959; Corballis & Roldan, 1975). Detection times for symmetry are also fastest for vertical symmetry compared to horizontal (Julesz, 1971; Palmer & Hemenway, 1978). The sensitivity of the human visual system to symmetry, and reflectional symmetry in particular, has been confirmed by neurophysiological work (Bertamini & Makin, 2014; Makin, Rampone & Bertamini, 2015; Sasaki, Vanduffel, Knutsen, Tyler, & Tootell, 2005). This evidence about a tuning of the visual system to symmetry suggests a very fundamental role of symmetry within the visual system. With respect to preference, however, cultural factors may also influence what people prefer. Darwin (1871) noted that whilst many people attempt to enhance physical traits through permanent and temporary ornamental embellishments, and bodily modifications, preferences for these (beauty) traits differ across cultures. Washburn (1999) for instance, has suggested that the salience of symmetry has been used in art as a metaphor for describing important cultural principles and relationships. With respect to cross-cultural comparisons, Masuda, Gonzalez, Kwan and Nisbett (2008) examined cultural variations among East Asians and Americans in visual art. Their analysis of
Carole Bode

traditional East Asian and Western art found that traditional Western art tends to be object-focused (attention is focused on discrete objects seen from a single viewpoint) whereas traditional East Asian art is principally context-inclusive (attention is focused on the relationships between multiple objects from multiple viewpoints). In the special case of preference for symmetrical faces, Pisanski and Feinberg (2013) recently reviewed the literature and interpreted the cultural differences in terms of evolutionary adaptations. For example, facial symmetry may be less important in countries where parental input in offspring is most valued, and more important in regions where disease resistance of offspring is stronger.

In the context of aesthetic judgements of beauty in visual images, complexity (along with order) is a key characteristic influencing preference for an image (Nadal, Munar, Marty, & Cela-Conde, 2010). Complexity is commonly defined as the amount of detail the image contains (Snodgrass & Vanderwart, 1980). However, definitions of complexity may differ from study to study (Gauvrit, Soler-Toscano, & Guida, 2017; Palumbo, Ogden, Makin & Bertamini, 2014). Lack of agreement in terms of the methods and measures used to examine complexity and aesthetic preference has led to varied and sometimes contradictory results, particularly when based on subjective human judgments.

Some authors have tried to formalise indices of order and of complexity to explain human preference of symmetrical patterns in relation to beauty. Birkhoff (1932) proposed a measure of aesthetic pleasure where attraction to an object (M) depends on the ratio of order (O) and complexity (C) perceived by the observer. He created examples of polygons that could be used as stimuli (Birkhoff, 1932). Critiques of Birkhoff’s formula have focused on low or negative correlations for preference of polygons, its failure to address the issue of individual differences when making aesthetic judgments, and on the nature of the polygons used, some of which may have semantic associations (see Eysenck, 1942).

Eysenck (1941) developed his own formula: \( M = O \times C \) utilising Birkhoff’s polygons, but avoiding those with strong semantic associations such as the swastika and Star of David. Overall, Eysenck demonstrated that his formula provided good correlations for order and complexity in preference for polygons, and predicted that the formula could be used to assess aesthetic preference in stimuli other than polygons. Eysenck and Castle (1970) asked groups of British male and female artists and non-artists to rate the aesthetic pleasantness of Birkhoff’s polygons on a 7-point
scale (7= most pleasing, 1= least pleasing). They speculated that though Birkhoff’s formula predicted higher correlations between his aesthetic formula and artists, it was also possible that there would be no difference between artists and non-artists in making aesthetic judgments. Whilst Birkhoff’s formula correlated with the artists' preference scores better than the non-artists' scores, most of the factors across the two groups were similar. The pattern of preferences showed that artists preferred simple polygons, and the non-artists preferred complex ones. For this different set of polygons, artists’ preferences correlated with Eysenck’s (1968) simplicity factor suggesting a preference for simple polygons.

Soueif and Eysenck (1971) compared cross-cultural preferences for polygonal figures (Birkhoff, 1932) in British and Egyptian groups of artists and non-artists. They found some differences in preferences for simplicity and complexity. British artists preferred simpler polygons compared to British non-artists who preferred more complex polygons. For Egyptians there was a less marked trend in the opposite direction, specifically, the Egyptian artists preferred complex polygons and the Egyptian non-artists tended to prefer simple polygons. However, differences were small, and Eysenck and Soueif concluded that the results supported the view of universal preferences more than the expectations of large cultural differences in aesthetic preference. A second study (Soueif & Eysenck, 1972) analysed preference for Birkhoff’s polygons (1932) in Egyptian artists and non-artists in comparison with British artists and non-artists. They also found that age was related to preference on certain polygons, suggesting that there may be differences in preferences for specific polygons within different age groups and greater variability with age. There were some cultural differences between the two groups in preference for certain polygonal figures. For example, the British demonstrated a stronger preference for cruciform shapes than the Egyptians. They speculated that these would have more subjective meaning in a Christian culture than in an Islamic culture.

It should be noted that the Islamic culture has a long tradition of abstract, geometric based art (Abas & Salman, 1992). Indeed historically, representational art has not been practiced in the Islamic world, especially in relation to the depiction of humans and animals. This is one reason that makes the cross-cultural comparison interesting. There is strong evidence to suggest that exposure to and familiarity with visual stimuli may increase our preference for those stimuli (“mere exposure”, Zajonc, 1968). However, over exposure or massive familiarisation may affect
subsequent preferences in complexity. People who were familiarised with simple patterns subsequently tended to prefer complex stimuli, and those familiarised with complex patterns showed a tendency to prefer simple patterns (see Tinio & Leder, 2009).

Recent studies have examined complexity and aesthetic preference using quantitative measures of complexity: GIF compression rates, density, the number of elements and edge length. In the case of the GIF, the idea is that the application of a compression algorithm will achieve greater reduction in size for pattern that a lower in algorithmic complexity. Observers showed a preference for polygons with greater complexity in contour length and in the number of concavities (Friedenberg & Bertamini, 2015); a correlation between GIF ratio and edge length suggesting a preference for intermediate density over the number of elements in binary chequerboard patterns (Friedenberg & Liby, 2016); and image compression of the contours in nonsense shapes correlated with subjective human judgments for the same shapes whilst avoiding familiarity biases (Forsythe, Mulhern, & Sawey, 2008). Gauvrit et al. (2017) reanalysed the data from the study carried out by Friedenberg & Liby (2016) using entropy (in this context, entropy refers to the density of black and white cells in a pattern) and algorithmic complexity (GIF ratio and Block Decomposition Method) and Edge length (the complexity of the edge created by the cells, thus related to the ‘crookedness’ of the pattern) as additional measures of complexity. They found that people showed an overall preference for high entropy, and low algorithmic complexity, when controlling for entropy. They also found that aesthetic judgments positively correlated with total Edge length, supporting the findings by Forsythe et al. (2008). In other words, people prefer some, but not all, types of complexity depending on the balance of the number of elements, ‘crookedness’ and density.
2.3. Study 1: A study of symmetry preference in two cultures

Soueif and Eysenck (1971; 1972) studied preference for shapes, using stimuli that varied both in complexity and familiarity in ways that were not controlled. The nature of their stimulus set makes interpretation difficult. In our study we compared British and Egyptian participants but, unlike Soueif and Eysenck, we focus on preference for symmetry. We created a controlled set of patterns made up of a square matrix with black and white cells (10 x 10). There were six classes: asymmetric, 90° rotation, 180° rotation, horizontal, vertical, and horizontal-vertical. In general a preference for regularity is well documented, with a particularly strong preference for reflection and rotation (Makin, Pecchinenda & Bertamini, 2012).

As mentioned earlier, Birkhoff’s polygons have been criticised because of possible associations with known objects and symbols. Abstract, non-figurative images are likely to contain fewer confounds than figurative images (Friedenberg & Liby, 2016; Forsythe et al., 2008). It should also be noted that in the forty years since Soueif and Eysenck carried out their experiments, both British and Egyptian cultures have undergone major technological changes in terms of communication and media that have increased access to each other’s cultures and visual media. We were interested to see whether our study (using untrained participants) would confirm the preferences Soueif and Eysenck found in Egyptian and British groups, further supporting their idea of a universal preference for symmetry.

None of the participants were artists, the majority being undergraduates of social science courses. As Eysenck and Castle (1970) noted, artists are trained to appreciate order and symmetry in the visual world. Therefore, we chose not to use art students in our study in order to avoid any confound related to art school training. The groups were tested in their respective countries, and they were native speakers in either English (Britain) or Arabic (Egypt). In European cultures, people read from left to right, and in Arabic countries people read from right to left. Acquired skills, such as reading and writing, may affect perception of visual stimuli and thus, aesthetic judgments (see Nachson, 1981; Nachson, Argamon & Luria 1999). Therefore reading direction is also an important difference between the groups. It is important to note that though the entire Egyptian group reported learning English (mean age 9.97 years), and inevitably exposure to British culture is greater in Egypt than vice versa, the key point is that the two cultures remain different in many ways.
2.4. Methods

2.4.1. Participants

Two hundred British students from the University of Liverpool, UK (mean age: 24.83 years; n = 51 males and n = 149 females) and two hundred Egyptian students (mean age: 19.83 years; n = 117 males and n = 83 females) from the University of Menoufia, Egypt took part in the study. All data used in the study were analysed anonymously. The research was conducted in accordance with the ethical standards of the University of Liverpool (https://www.liverpool.ac.uk/research-integrity/policies-guidance/) and with the University of Menoufia. Participants read and signed a consent form that explained the task and asked them for permission to use their data.

Participants were restricted to native British speakers and native Egyptian speakers. Both groups of participants were asked whether they had studied a second language. The Egyptian students were also asked if, and from what age, they had studied English (100 % answered yes: mean age: 9.97 years). Additional questions included handedness, age, sex and subject studied. Some of the students were rewarded with course credits to take part, and all were naïve regarding the experimental hypothesis.

2.4.2. Stimuli

The stimuli were based on a black and white matrix (ten by ten elements). Ten patterns were randomly generated from each of the following classes of symmetry: asymmetric, 90° rotation, 180° rotation, horizontal, vertical, and horizontal-vertical (see Figure 7). We coded these six classes of symmetry as: a, cc, c, h, v and hv respectively. The patterns (10 * 6 = 60) were arranged on an A4 sheet of white paper in landscape format (Set A). Each pattern had a small box placed underneath in order for the participant to record a preference score. A second sheet of patterns was produced (Set B) using the same patterns, but presented in a different random order. The original sheets forming Set A and Set B were then mirror reversed in order to produce two further sets of patterns (Set AA and Set BB).
Figure 10. The 60 patterns used in the experiment: Versions A (top) and B (bottom) are the two randomisations. The codes in the bottom left corner were not present on the sheets used in the experiment. Two more versions (AA and BB) were used which were the mirror reversal (around the vertical axis) of these patterns.

2.4.3. Procedure

Each participant was asked to look at the sheet of paper and then rate each pattern. They used a scale ranging from 0 – ‘extremely ugly’ to 10 – ‘extremely beautiful’ and entered the number in the box below the pattern. Each participant was presented with only one version of the patterns, and they could rate the patterns in any order.
they wished. They were allowed to take as much time as they needed, and to change a response before submitting the response sheet.

2.4.4. Results

Figure 8 provides a visual summary of the responses for each of the six classes. The ten patterns are ranked in terms of preference and the images are shown above each graph. In general one can see many similarities between the two groups, with ratings towards the low end of the scale for asymmetrical patterns, and high ratings instead for the patterns with reflectional symmetry.

We carried out a mixed ANOVA. We tested a within-subjects Symmetry factor with 6 levels (asymmetry, 90° rotation, 180° rotation, horizontal, horizontal-vertical, and vertical), and three between-subjects factors; Country (English speakers and Arabic speakers), Orientation (Original or Mirror reversed) and Sex (male and female), and Age as a covariate. We also tested the different classes of Symmetry using a series of contrasts in which the reference group was always the asymmetrical category of patterns (the ‘a’ class).

We confirmed that there was a difference between the levels of Symmetry [F(5, 1955) = 52.76, MSE= 74.24, p< 0.001, n_p²= 0.119], and a significant effect of Country [F(1, 391) = 4.26, MSE= 5.30, p= 0.040, n_p²= 0.011]. There were no effects of Orientation, Age or Sex. Overall preference ratings were higher by Egyptians. The largest difference was for the horizontal-vertical class in which the average rating by the British was 5.79, and 7.27 for Egyptians. In terms of interactions, there were significant interactions between Symmetry and Country [F(5, 1955) = 27.56, MSE= 38.77, p < 0.001, n_p²= 0.066] and Symmetry and Sex [F(5, 1955) = 4.60, p= 0.006, n_p²= 0.008]. There were significant three way interactions between Symmetry, Orientation and Country [F(5, 1955) = 2.22, MSE= 3.12, p= 0.050, n_p²= 0.006] and Symmetry, Country and Sex [F(5, 1955) = 2.34, MSE= 3.30, p= 0.039, n_p²= 0.006] . These potentially interesting interactions are shown in Figure 9. This graph also shows the higher values for the Egyptian group in general, although for the asymmetrical patterns the Egyptian average was lower than the British average, showing a tendency for the Egyptians to provide a greater range of responses (i.e. use of the full extent of the scale).
Figure 11. Preference scores for asymmetric, 90° rotation, 180° rotation, horizontal, horizontal-vertical and vertical patterns by country (English speakers and Arabic speakers). Data from all four experimental pattern sheets (A, B, AA and BB) were combined. The images of the stimuli are shown above the graph and they allow a direct comparison between the groups in terms of the ranking.

In terms of linear contrasts, when any of the six symmetry classes were tested against the asymmetrical class all these comparisons were significant (all $p$s <0.001). This is not particularly interesting as it only shows that all participants systematically rated the asymmetrical patterns as the least beautiful. The next step of the analysis is very important. We were interested to see if the way British and Egyptian participants responded to symmetry was different for each class of symmetry using the asymmetrical class as reference. In other words, whether the specific advantage...
of, say, vertical symmetry over asymmetry was similar or different in the two countries.

Figure 12. Top: Estimated marginal means comparing male and female preferences for the experimental stimuli patterns in British and Egyptians. Bottom: Estimated marginal means comparing for the original versions (A and B) and mirror reversed versions (AA and BB) of the experimental stimuli patterns.

We found that of the nine contrasts only 4 were significant. There were interactions for Country and the contrast between asymmetry and vertical symmetry \( [F(1, 391) = 23.55, \text{MSE}=87.24, p<0.001, n_p^2=0.057] \), for Country and the contrast between asymmetry and horizontal-vertical symmetry \( [F(1, 391) = 68.00, \text{MSE}=260.71, p<0.001, n_p^2=0.148] \), for Country and the contrast between asymmetry and 180° rotational symmetry \( [F(1, 391) = 5.49, \text{MSE}=19.99, p=0.020, n_p^2=0.014] \), and for Country and the contrast between asymmetry and 90° rotational symmetry \( [F(1, 391) = 5.01, \text{MSE}=87.24, p=0.026, n_p^2=0.013] \). There was an interaction for Sex between asymmetry and the contrast for 180° rotational symmetry \( [F(1, 391) = 9.16, \text{MSE}=17.38, p=0.003, n_p^2=0.023] \). In the three way contrast between Symmetry, Country and Sex there were interactions between asymmetry and 90° rotational symmetry \( [F(1, 391) = 4.38, \text{MSE}=17.48, p=0.037, n_p^2=0.011] \).
and asymmetry and horizontal symmetry \( F(1, 391) = 4.90, \text{MSE}=6.43, p= 0.028, \quad n^2_p = 0.012 \). The results for the vertical and horizontal-vertical symmetry confirm that the most salient reflection symmetries were the ones containing vertical symmetry (see Fig. 9), and that these were rated differently between the two groups of participants.

2.5. **Study 2: Correlations of cultural preference and measures of Visual Complexity**

2.5.1. **Visual Complexity**

In this next analysis we examined whether the pattern preferences of the British and Egyptian groups correlated with measures of visual complexity. We analyse three measures of complexity. The first is the GIF ratio defined as the ratio between the size of the original image and the size of the compressed image. This measure has been shown to correlate with human judgments of complexity (Forsythe et al., 2011; Forsythe, Mulhearn, & Sawey, 2008; Palumbo et al., 2014). Because this is a measure of how much compression a computer can obtain, it can be seen as a proxy for Kolmogorov complexity, which is defined as the length of the shortest computer program that produces the pattern as output. Importantly, given the definition, as the pattern gets simpler the GIF ratio gets bigger.

We also used a second measure much more specific to the nature of our stimuli comprising the number of black and white cells in each matrix. Each individual pattern was made up of a total of 100 cells. There were always 60 white cells and 40 black cells. For each pattern we counted the size of all the black regions in terms of the number of black cells that were connected. Two cells were defined as connected if they shared one side. We then averaged the size of all the black regions for each pattern separately. This provides a number for each pattern that can be as low as 1, if the black and white cells tend to alternate, and therefore there is no region larger than 1, or as high as 40 if all black cells are connected and form a single, solid region. We call this measure **average blob size** (ABS).

The third measure of complexity is **edge length**. We counted the number of edges of each black cell adjacent to the white space within each pattern. Two individuals did the counts independently. Edge length can be described as a measure of the "crookedness" in a pattern (see Gauvrit et al., 2016). For example, patterns
with few convex regions will have a small number of edges, while complex irregular patterns with many regions or concave regions will have a large number of edges (see Fig. 10.).

We tested the correlation between the average number of squares (ABS), the GIF Ratio, and the average edge length for each pattern. We also tested the average preference scores for each pattern in the Egyptian and British groups, and British males (n= 51) and females (n=149) and Egyptian males (n= 83) and females (n= 117). For all correlations the measures are based on the total number of patterns (60).

The means and standard deviations (N= 60) for the correlations are shown in Table 1. The first interesting correlation is between GIF ratio and ABS. As they both increase with simplicity we expect a positive correlation. The Pearson correlation was \( r = 0.413 \) (N= 60, p<0.001). It may also be worth noting that overall British and Egyptian responses were highly correlated, (\( r = 0.868 \), N= 60, p<0.001).

Figure 13. Top: a random, asymmetric pattern, and a horizontal-vertical pattern and the corresponding edge length of the black portions of the pattern perimeter. Bottom: the same patterns with the corresponding number of elements or ABS. The highlighted areas define a single element.

With respect to the comparison between British and Egyptian ratings, for the British group there were no significant correlations between preference and complexity, and no trend in that direction. For the Egyptian group there was a positive correlation between GIF ratio and preference (\( r = 0.260 \), N= 60, p= 0.045), and a positive correlation between ABS and preference (\( r = 0.303 \), N= 60, p= 0.018).
There was a significant positive correlation between GIF ratio and preference in Egyptian females \((r = 0.266, \ N= 60, \ p=0.040)\) but none for Egyptian males, or British males and females. There were significant correlations between ABS and preference in Egyptian males \((r = 0.292, \ N= 60, \ p=0.024)\), and ABS and preference in Egyptian females \((r = 0.309, \ N= 60, \ p= 0.016)\), but none for either British males or females.

There were significant negative correlations between Edge length and ABS: \((r = -0.648, \ N= 60, \ p< 0.001)\), and for Edge length and GIF ratio: \((r = -0.714, \ N= 60, \ p< 0.001)\). Interestingly, there was a negative correlation between Edge length and preference for complexity in the Egyptian group \((r = -0.363, \ N= 60, \ p= 0.004)\), but no significant correlation between Edge length and preference in the British group.

There were negative correlations between Edge length and preference in Egyptian males \((r = -0.350, \ N= 60, \ p= 0.006)\), and also in Egyptian females \((r = -0.369, \ N= 60, \ p= 0.004)\), but no correlation for either British males and British females. In terms of preference of complexity, these results show a consistent pattern of correlations between complexity and preference for both males and females.

The correlations are shown in Tables 2 and 3, and the pattern is shown in the scatter graphs of Figure 9. There are two analyses because we noted an outlier in the case of ABS: the value for pattern HV7 reached the maximum (40). We therefore report the correlations with and without this item. The results were very similar with and without pattern HV7. These results show a preference for simpler patterns in the Egyptian group but not in the British group.

Table 1. Means and standard deviations for the correlations for complexity measures, Egyptian and British groups preferences, and male and female preferences for both countries.

<table>
<thead>
<tr>
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<th>Mean</th>
<th>Standard Deviation</th>
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<tr>
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\(N = 60\)
Table 2. Correlations between Preference for the 60 patterns in the two groups (Egypt and Britain), and three indices of complexity: number of edge lengths, average blob size (ABS) and GIF ratio. Correlations for British males (N = 51) and females (N = 149), and Egyptian males (N = 83) and females (N = 117) are in grey. **. Correlation is significant at the .01 level (2-tailed). *.Correlation is significant at the .05 level (2-tailed).

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Table 3. Correlations between Preference for the 60 patterns in the two groups (Egypt and Britain), and three indices of complexity: number of edge lengths, average blob size (ABS) and GIF ratio. Correlations for British males (N = 51) and females (N = 149), and Egyptian males (N = 83) and females (N = 117) are in grey. The table excludes one outlier (N = 59). ** Correlation is significant at the .01 level (2-tailed). * Correlation is significant at the .05 level (2-tailed).

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2.6. Discussion

In our study we compared preferences for abstract symmetry in two groups of individuals, one in Egypt (native language Arabic) and one in Britain (native language English). In this context, our study is closely related to a study conducted in 1971 by Soueif and Eysenck (1971). Unlike the Soueif and Eysenck studies we wanted to test non-artists in order to assess whether people without special training differed in preferences for symmetry. Because our stimuli were different it was more likely they would avoid problems of semantic associations, and they also compared different types of regularities. Abstract stimuli, such as the binary black and white chequerboard patterns we employed are provide a more objective, robust method of measuring complexity, and are easier to interpret (see Bertamini, Makin & Pecchinenda, 2013; Corballis & Roldan, 1975; Gauvrit et al., 2016; Royer, 1981). Abstract images may also be less vulnerable to a familiarity bias (Forsythe et al., 2008). However, previous studies involving aesthetic judgments of visual art have shown that whilst people prefer representational art to unfamiliar, abstract images, they will also give higher ratings to those abstract images to which they can attribute some figurative, ‘real world’ quality in an attempt to make sense of the image (Forsythe et al., 2011; McWhinnie, 1987).

A typical feature in Islamic art is that it incorporates abstract, geometrical designs (Abas & Salman, 1992; Gonzales, 2001). These designs and patterns are used widely across Islamic cultures. An example is shown in Figure 11. Everyday exposure to, and thus familiarity with such geometric patterns may explain the higher ratings by the Egyptian group, in the sense that abstract patterns found in Arabic art are similar to the matrices we used and are less novel to the Egyptian group than the British group. We found an overall pattern of preference for symmetry, and a dislike for asymmetry that was similar across the two cultures. Overall the Egyptian group rated the symmetrical patterns higher and there were bigger differences between the scores for asymmetry and symmetry (that is they used the scale of scores to a fuller extent in comparison to the British group). In the Egyptian group the most salient symmetry (around the vertical axis) was given particularly high scores. We speculate that the lower preference ratings across all symmetries from the British group, and the higher ratings from the Egyptian group
may be due in part, to a dislike of the unfamiliar, abstract patterns amongst the British group.

Figure 14. Ceramic tile (8-9th century) with geometric pattern from the Transoxiana region. Now in the Louvre museum (catalogue number LOU 098).

The interaction between symmetry, preference and orientation is potentially very interesting (see Fig. 9, top). First of all, as the figure for the interaction between symmetry, preference and orientation shows, the effects are significant but mostly subtle. The British gave 180° rotational symmetry the highest scores, with horizontal-vertical symmetry as the next highest scoring symmetry. Interestingly, the British show a slightly higher preference for asymmetry, horizontal, 90° and 180° rotational symmetries in the mirror-reversed orientation. The British ratings for vertical symmetry are similarly rated in both orientations. The reverse was true for the Egyptians, who gave horizontal symmetry the highest scores, with 180° rotational symmetry next. More interestingly, there is a relatively high score from the Egyptian group for vertical symmetry in the mirror reversed (right to left) version relative to the original (left to right) version. We tentatively suggest that overall Egyptian
preference for patterns with vertical axes in the mirror reversed orientation, may be further enhanced by the numerous factors including familiarity, (Tinio & Leder, 2009), ease of interpretation (McWhinnie, 1987) and reading direction (Chokron & De Agostini, 2000; Nachson, Argamon, & Luria, 1999). The same factors, though replacing novelty for familiarity, may explain the British lower ratings overall, preference for multiple symmetries, and a slight preference for patterns in the mirror reversed orientation.

Overall, like Soueif and Eysenck (1971; 1972) and Eysenck and Castle (1970) we found no large differences in preference for the patterns between females and males in either the British or Egyptian groups. However, the interaction (see Fig 9, bottom) between symmetry, preference and sex is interesting. British males liked asymmetry better than females (m= males: 3.12; females: 2.56). British males also gave higher ratings than British females to all symmetries, particularly to vertical symmetry (m= males: 5.68; females: 4.91), except 90° rotational symmetry, which British females rated higher (m= males: 6.32; females: 6.66) than males. On average Egyptian males (m=3.70) rated horizontal symmetry slightly higher than Egyptian females (m= 3.36) but other than this, both male and female Egyptians gave similar ratings for the different classes of symmetry.

It is possible that there are sex differences in preference for specific symmetries in relation to human judgments of visual art and abstract patterns (see Bernard, 1972; Humphrey, 1997; Johnson & Knapp, 1963). It is also possible that male and female aesthetic judgments for symmetry are based on a difference in perceived complexity. Previous research suggests the number of elements a pattern contains determines its complexity, and the structural organization (i.e. whether the pattern has a single axis or multiple axes of symmetry) of the image may reduce or increase this perception (Chipman, 1977; Ichikawa, 1985). However, for us the most important difference is the relative position of the different types of symmetry with horizontal-vertical being the preferred symmetry for Egyptians and 180° rotation for the British, a pattern of preferences similar to those described by Soueif and Eysenck (1971; 1972). A 3-way interaction with a factor that has six levels is difficult to interpret and it may suffer from the possible risk of multiple comparisons. Finally, in our study both group of participants contained more females than males. A more detailed analysis of sex as a factor will therefore remain as a topic for further research.
Soueif and Eysenck (1972) found some differences in preference for polygons when they analysed the preferences of younger and older participants. They speculated that greater variance in the age range of a group may elicit greater differences in preference for polygons within that group. Although there was a somewhat greater variance in the ages of the British group (18 to 63 years) compared to the Egyptian group (18 to 26 years) we found no such effects or interactions of age on preference for abstract patterns.

The analysis of the specific images in our dataset of 60 images for preferences of complexity also revealed a relationship between preference and simplicity in the Egyptian group. This correlation was absent in the British group. We used three different measures of complexity: GIF ratio, ABS, and Edge length, all of which correlate with different aspects of complexity. These measures are also unaffected by familiarity biases, such as those commonly found in subjective judgments of complexity (see Forsythe, Mulhern & Sawey, 2008). There were negative correlations between all three measures. This may not be so surprising if we consider the processes involved. ABS measures the scale or volume of elements, GIF ratio measures the algorithmic complexity of an image, and Edge length measures the dispersion of elements within an image. Thus, in real terms, we have two measures of simplicity (ABS and GIF ratio) and one measure of complexity (Edge length). The differences between these measures are demonstrated not only by the negative correlations between the British group and preference, but also by that of the three measures, only Edge length appears to correlate strongly with preferences of the Egyptians (both as a combined group, and also when separated into male and female groups) and simpler, less complex patterns. This is also supported by the positive correlations between ABS and the Egyptians (again as a combined group and separate male and female groups). The positive correlation between the Egyptian females and GIF ratio disappeared with the removal of an outlier (HV7). However, the pattern remained the same: the correlations showed a consistent pattern of preference for simpler patterns in Egyptians than the British. Additionally, in terms of preference of complexity, these results show a very consistent pattern of correlations between complexity and preference for males and females in both groups. One interesting explanation for the higher ratings for simple stimuli by the Egyptians is that over familiarisation with one group of stimuli may not only subsequently affect preference ratings for those stimuli, but also later result in higher
ratings for stimuli that are the structural opposite (Tinio & Leder, 2009). The Egyptian group may be very familiar with everyday objects and images that are decorated with complex, geometric art, and therefore over familiarisation with this type of art could result in a preference for novelty (Biederman & Vessel, 2006). The more complex rotational patterns used in the study may have elicited the opposing preferential responses in the Egyptians, and indeed, those of the British.

We can not statistically argue that Edge length is superior to GIF ratio or ABS as a measure of complexity. It simply measures a different aspect of complexity (i.e. dispersion) and this may explain the negative correlation with the British group. The preferences of British group appear to be consistent with a preference for intermediate density stimuli (Friedenberg & Liby, 2016), and the notion that people prefer patterns with high entropy and low algorithmic complexity (Gauvrit et al., 2017). We can only speculate given the lack of comparative data for our findings, but this notion may be reversed for the Egyptian group for certain patterns. We cautiously suggest that the differences in ratings for asymmetry and symmetry indicate this as a possibility. What is interesting is that all three measures provide a compelling story: that Egyptians appear more sensitive to these particular patterns than the British group, and this merits further investigation.
Chapter 3. Composition in portraits: selfies and wefies reveal similar biases in untrained modern youths and ancient masters*

* This Chapter has been published as Bruno, N., Bode, C., & Bertamini, M. (2015). Composition in portraits: Selfies and wefies reveal similar biases in untrained modern youths and ancient masters.

“Sensitive people faced with the prospect of a camera portrait put on a face they think is the one they would like to show to the world... Every so often what lies behind the facade is rare and more wonderful than the subject knows or dares to believe.”

Irving Penn
3.1. Abstract

Previous analyses suggest that artists prefer poses showing the left side of the subject’s face when composing a portrait, but showing the right side when composing their own self-portrait. There is also some evidence that artists may prefer compositions with key features on the right of the picture. Do these findings generalize to spontaneous, pseudo-artistic productions by individuals with no formal training in painting and art history? To investigate this issue, we tested a sample of 104 British schoolchildren and teenagers (mean age = 13.8 years; 80 females). We analysed posing biases in individual photographic self-portraits (“selfies”) as well as of self-portraits including also the portrait of a friend (“wefies”). Our results document a bias for showing the left cheek in selfies, a bias for placing the selfie taker on the right in wefies, and a bias for showing two left cheeks over two right cheeks, again in wefies. These biases are reminiscent of what has been reported for selfies in adult non-artists and for portraits and self-portraits by artists in the 16th-18th centuries. Thus, these results provide new evidence in support of a biological basis for side biases in portraits and self-portraits independently of training and expertise.
3.2. Introduction

Portraits and self-portraits are an engaging form of visual art that can be enjoyed, and studied, adopting several different approaches (Brilliant, 2004; Calabrese, 2010; Crozier & Greenhalgh, 1988; Ferrari, 2002; Hall, 2014; Woodall, 1997). In this paper, we study factors affecting how visual artists and photographers arrange their subjects in their created image. This is usually referred to as the issue of composition, and composition has been studied extensively with regard to general theoretical constructs such as balance, dynamics, and harmony (see, for instance, Arnheim, 1954, 1982). However, in the present paper, we focus on one specific aspect, namely, posing choices with regard to the subjects of portraits and self-portraits and in particular the choice of head rotation. Our interest in this issue stems from an intriguing bias that has been found to affect posing choices in portraits and self-portraits, and that may be related to the lateralisation of functions in the human brain.

Based on analyses of art history books and exhibition catalogues, several lines of evidence suggest that artists prefer poses showing the left side of the subject’s face when composing a portrait, but showing the right side when composing their own self-portrait (LaBar, 1973; Latto, 1996; McManus & Humphrey, 1973; Nicholls, Clode, Wood, & Wood, 1999; Powell & Schirillo, 2009; Suitner & Maas, 2007). What causes these biases is at present not completely understood. It has been suggested (Nicholls et al., 1999; Nicholls, 2000; Lindell, 2013; Powell & Schirillo, 2011) that a common cause might be identified in the right-hemispheric specialization for the expression of emotions, which tends to make most of us more expressive on the left side (the right-hemisphere hypothesis; Sackeim, Gur, & Saucy, 1978; Prete, Laeng, Fabri, Foschi, & Tommasi, 2015). In support of this proposal are data confirming asymmetries in facial expressiveness (Blackburn & Schirillo, 2012), as well as historical analyses suggesting that a right bias in self-portraiture emerged when cheap large mirrors became available (Bruno & Bertamini, 2013) and disappeared when photography became widely available (Bruno & Bertamini, 2013; Lindell, 2012). This is consistent with a spontaneous tendency to present the left side for expressiveness, for the mirror reversal will then cause the artist to paint an image presenting the right side of the face (which is the anatomical left side). Although the right-hemisphere hypothesis provides an
attractive explanation, other interpretations are possible. For instance, it is possible that studio conventions tended to favour placing a painter’s canvas to the right of the subject, as most painters are right handed and this arrangement optimizes the visibility of the subject avoiding occlusion by the hand holding the brush. For a self-portrait, this would entail placing the mirror on the left of the canvas, possibly producing the bias (for discussions of this possibility, see Bruno & Bertamini, 2013; Nicholls et al., 1999). Alternatively, conventions might arise from cultural factors, such as meanings attached to the right and left cheek as symbolizing similarity or distance in status or gender (Humphrey & McManus, 1973; McManus & Humphrey, 1973; Schirillo, 2000; ten Cate, 2002).

In two recent papers, it has been suggested that the right-hemisphere hypothesis can be tested by studying selfies (Bruno & Bertamini, 2013; Bruno, Bertamini & Protti, 2015). Selfies, as baptized in social media tags, are photographic self-portraits taken by non-professionals. They represent a form of pseudo-artistic real-life behaviour that affords a unique opportunity to test principles of art production in populations uncontaminated by academic training. In addition, they represent a natural experiment that reproduces putative studio settings for artists’ self-portraits. This is so because most selfies are taken either while monitoring the image in the preview screen of a smartphone (which presents a mirror image) or while holding a digital camera in front of an actual mirror. In two earlier papers, we reported results consistent with a left side bias (and therefore with lateralized expressiveness) in a large sample of selfies collected in controlled conditions (Bruno & Bertamini, 2013) as well as in even larger sample of selfies spontaneously posted on the photo-sharing social medium Instagram (Bruno, et al., 2015).

In this paper, we sought to extend our paradigm in two novel directions. First, we wished to examine selfies in a sample of younger selfie-takers (schoolchildren and teenagers). Our previous work assessed mostly young adults (who post the majority of selfies on digital media, see Tifentale & Manovich, 2014) and a smaller subset of older adults (in the studies that collected in-lab selfies from students but also colleagues and acquaintances). Given that most of these individuals were unlikely to have formal artistic training, left side biases in these populations might have a possibly innate, psychobiological basis: Most participants may prefer poses presenting their most expressive side (Nicholls et al., 1999). Younger participants, however, are even less likely to have had exposure to art academies or
formal training in art history. Thus, if the left side bias reflects psychobiological, as opposed to cultural factors, we expect to see the same bias that was previously found in adults in the earlier studies. Alternatively, if younger selfie takers do not show a bias, this would be evidence that the bias may be affected by exposure to cultural factors.

Second, we wished to explore side biases in selfies involving more than one portrayed individual. Specific predictions are harder to make here, but some general expectations can nonetheless be discussed based on potential relationships to painted portraiture. Figure 15 captures this idea. Group selfies, often also called “usies” or “wefies”, have also become a widespread spontaneous behaviour. In our study, we asked young participants to first take a standard selfie and then to take a second selfie together with a friend. In the former, the selfie-taker is in a situation somewhat analogous to that of a painter composing a self-portrait.

Figure 15. Selfies and wefies are somewhat analogous to well-travelled genres in the figurative arts. Top: typical selfie and wefie (source: Instagram). Bottom: Rembrandt van Rijn, Self-portrait (detail), and Jan Vermeer, The Procuress (detail – the figure on the far left is believed to be Vermeer’s self-portrait). All images are public domain.
This situation is fully comparable to that of our previous selfie studies. If side biases depend on implicit asymmetries in facial expressiveness, therefore, one might expect to see again a left side bias. In the latter, selfie-takers are placed in a more complex situation. On one hand, they are composing a self-portrait. On the other, they are combining this with a portrait of the friend. Several compositional choices become relevant, including the decision whether to place the friend on their left or right side, the decision concerning which side of their own face to present to the camera, and the decision concerning which side of their friend’s face to attempt capturing in the image. With regard to composition, the above situation may to thought to bear some analogy to paintings portraying one or more characters but including a self-portrait of the artist. Although it was common especially in certain historical periods (see e.g., Calabrese, 2010), to the best of our knowledge this genre has never been studied even in paintings and there are currently no analyses of compositional biases that may be present. This paper therefore represents the first investigation into how the presence of others may affect posing biases in portraiture and photography.
Some investigators (Gaffron, 1950; Wölfflin, 1928) have suggested that viewers prefer pictures with key content on the right side. Consistent with this proposal, Corballis and Beale (1976) noted that, especially during the Renaissance, portraits of husband and wife were often painted as pairs to be hung with the female on the left and the male (who would typically be considered more important in that period) on the right. This right side preference in composition has been attributed to hemispheric functional asymmetries (Levy, 1976) or to scanning direction in reading (Nachson, 1999). Based on this hypothesis, the position of Vermeer’s self-portrait in Figure 12 (bottom right) may reflect a choice to emphasize the picture’s main characters and underplay the role of the painter-author. The left positioning of the girl holding the phone in Figure 15 (top right), conversely, may reflect a choice to emphasize the role of the selfie-taker. Because in smartphones the preview image is mirror-reversed, but the image file is saved as taken from a front camera (non-mirror-reversed), a saved image with the selfie-taker on the left signals a preference for a (mirror-reversed) preview image where the selfie-taker is on the right. However, it is currently unknown whether systematic biases of this kind can be reliably detected in corpora of group portraits, and how they might relate to biases stemming from a right-hemisphere predominance for facial expression of emotions.

3.3. Methods

3.3.1. Participants

104 schoolchildren and teenagers volunteered to participate in the study. The age of the participants ranged from 9 to 16 years (M = 13.8, SD = 2.27). Eighty of the participants were females, and nine participants were left-handed. Handedness was determined based on preferred writing hand, which is considered the best single-item self-report measure of handedness (Rigal, 1992). All were recruited during the Big Bang Northwest Science Fair at Aintree racecourse, Liverpool. The event was organized by MerseyStem, part of the Stemnet, a UK-wide ambassador programme to bring science and engineering to life for young people. The event was organized in close collaboration with MerseyStem, for which two of the authors are volunteers (MB and CB).

3.3.2. Ethics
The study was approved by the University of Liverpool Research Governance Committee (application number IPHS-1314-315) and fully complied with the Ethical Standards of the Italian Board of Psychologists (see http://www.psy.it/codice_deontologico.html ). We worked closely with the organizers MerseyStem. Parents were provided with information about the Fair in advance and signed a form to allow children to take part in a series of scientific activities, this form included information about the taking of photographs. On the day of the event, the teacher in charge of each class signed a specific consent form. As the study was run in the UK, approval from the Ethics Committee on Clinical Research of the University of Parma was deemed unnecessary.

3.3.3. *Materials*

A large inflatable “pod” was used to provide a controlled surround for selfie-taking (Fig. 16). The pod was made of translucent white plastic, which ensured a homogeneous illumination in the inside and a constant, featureless background to each image. A smartphone (iPhone 5) was provided to take the selfies. Printed versions of their images were given to all participants.
3.3.4. Procedure

Before participation, consent forms were presented to the children and the accompanying adults and all relevant signatures were obtained. Experimenters explained that each participant was expected to take two selfies, one alone and one with a friend. We will refer to these two pictures as “solo” and “duet” selfies. We defined duet selfies as a special case of group selfies when only two individuals are portrayed. The choice of the friend was made by the participant after taking the solo selfie, and given the location it was typically one of the other people in the same group who had come to visit the booth. To avoid practice effects, participants were not allowed to serve as friends before taking the solo selfie. Instructions emphasized that both selfies had to be taken while holding the smartphone with both hands, using the smartphone preview screen to select a pose, and using one of the thumbs to record the image. Participants were explicitly encouraged to try out different poses, including three-quarter poses. Care was taken to always also remind the participants not to put their hands in front of the face, and to avoid placing a finger in front of the smartphone camera. Participants were also explicitly told that they could take as much time as they needed to complete the task. Apart from these instructions, participants were free to try different positions for the camera and in some cases these were higher or lower than their line of sight. Nevertheless, the range was limited by arm length and by the need to produce a selfie. Finally, experimenters explained that the solo selfie was to be taken in the “portrait” orientation (longer side of the phone vertical), using either the left or right thumb to record the photograph using the phone touchscreen (this was randomized across participants), whereas the duet selfie was to be taken in the “landscape” orientation (longer side horizontal) and keeping the phone in the orientation set by the experimenter (camera on the left or on the right, also randomized across participants). Orientations were varied between solo and duet selfies to adhere to standard practice for these kinds of pictures but also, crucially, to minimize compositional carry-over effects from one picture to the other. In addition to the preliminary verbal explanation, experimenters also physically demonstrated how all was to be done, monitored the children while they took the selfie, and provided additional instruction if needed. Once participants had taken the two selfies, questions about the participant age, handedness, and regular
use of a smartphone camera were verbally read and the corresponding responses recorded.

Figure 16. The “Sweaty Betty selfie pod” provided a controlled environment for taking the selfies, and ensured all photographs had the same homogenous background without directional illumination.

This concluded participation. All photographs were recorded anonymously on secure digital media, were not made public in any way, and were used along with the demographic information only for the purposes of research.

3.3.5. **Analysis**

All pictures were inspected by the second author (in Liverpool) and by an undergraduate assistant (in Parma). The latter was fully naïve to the aims of the study. All selfies were classified into five categories: unambiguously showing the left side, slightly showing the left side, frontal, slightly showing the right side, unambiguously showing the right side. Left and right were defined in relation to the
person’s face, and the classification was based on criteria developed in our earlier work on solo selfies (Bruno & Bertamini, 2013; Bruno et al., 2015). In the current solo selfies, the two raters produced exactly the same classifications, as expected based on our previous usage of this procedure. However, in duet selfies discrepancies emerged between the two raters in 7 out of 104 images. To resolve these discrepancies, these duet selfies were re-examined jointly by the first and the last author. Re-examination revealed that these discrepancies had arisen due to confusions as to who was the selfie-taker and who was the friend by one the raters. The correct classifications could therefore be readily determined and corrected as appropriate. To test for side biases, we used chi-square tests of goodness of fit to compare the data against the null model $p$ (right vs. left side shown) = .5.

3.3.6. Results

Almost all participants (93, corresponding to 90% of the sample) declared that they used a smartphone camera regularly. The large majority (about 80%) of volunteering schoolchildren were females. Because we have no data on the proportions of males vs. females attending the Big Bang Science Fair, we cannot determine if this reflects a greater interest in selfie-taking by female youths in comparison to males, or merely a larger number of females attending the fair. We note, however, that in large-scale analysis of selfies voluntarily posted on Instagram, Tifentale and Manovich (2014) found that females were more likely to post than males, suggesting that selfie-taking is more of a female than a male leisure activity. It is possible that our sample reflects the same trend. However, our interest was not in sex differences in selfie-taking frequency but in posing biases. To evaluate these biases we compared poses emphasizing the left or right cheek. We will not address frontal poses as these would not reflect the choice between showcasing one’s left or right cheek, which is the aim of the present analysis.

3.3.7. Solo selfies

For solo selfies, raw frequencies of each posing category are presented in Table 4. The distribution shows a clear side bias. Out of the 43 selfies that are unambiguously showing one cheek more than the other (“left” and “right” in the table), 29 (67.4%) show the left cheek, [$\chi^2(1) = 5.2, p = .023$]. In the 31 poses which
are classified as slightly turning to the left or right, 23 (74.2%) are in the “slightly left” category, \[\chi^2(1) = 7.3, p<.008\]. When choosing a pose for their selfie, children tend to present the left side of their face to the smartphone, resulting in a right-sided preview image (due to mirror reversal), which they record as their selfie by pressing the appropriate button. This is similar to what most painters are believed to have done when producing self-portraits before the invention of photography: presenting the left cheek to a mirror and copying the right-sided mirror image on the canvas. The only difference is that the painter’s self-portrait displayed a right-sided pose (but this was presumably the painter’s left), whereas for selfies this resulted in a left-sided saved image (correctly corresponding to the participant’s left side). This is a consequence of the default setting of the smart phone when using the front camera.

3.3.8. Duet selfies

For duet selfies, we first of all looked at relative positions in the picture. In the large majority of duet selfies, selfie-takers positioned the friend on their own left, resulting in a preview screen showing the selfie-taker on the right of the image, in turn resulting in a saved picture showing the selfie-taker on the left. Out of 104 images, there were 93 such duet selfies (88.6%). We are unable, at present, to provide a strong explanation for this bias, although we note that it is consistent with earlier proposals that viewers prefer pictures with key content on the right side (Gaffron, 1950; Wölfflin, 1928; see Introduction). Alternatively, it might be suggested that such a strong bias is due to handedness. Right-handers might be used to holding the phone with their right hand when taking group selfies, holding the phone off to the right in order to keep the arm out of the picture, and therefore having the habit of placing friends on their left when taking group selfies.

Table 4. Frequency of each posing category for the solo selfies

<table>
<thead>
<tr>
<th></th>
<th>Left</th>
<th>Slightly left</th>
<th>Frontal</th>
<th>Slightly right</th>
<th>Right</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>29</td>
<td>23</td>
<td>30</td>
<td>8</td>
<td>14</td>
<td>104</td>
</tr>
</tbody>
</table>

Because of this habit, right-handers might prefer a similar composition in the duet selfies in this experiment. However, this explanation predicts the opposite pattern for left-handers, a prediction that is not borne out by the present data. Although only nine participants reported being left-handed, seven of these still
positioned themselves on the left of the picture. Before speculating about other possible causes, we suggest that further data should be collected on duet selfies to determine if the bias generalizes to other participant groups and conditions. It is nonetheless important to take this bias into account when interpreting posing biases, which is what we do next.

To study posing biases in duet selfies, we first looked at poses of selfie-takers. Raw frequencies for each posing category are presented in the row totals of Table 4, where we observed many fewer frontal poses (8) relative to the solo selfies (30). In addition, a side bias is evident again but in the opposite direction relative to single selfies. Out of the 62 selfies that unambiguously showed one side of the face, 43 (69.4%) showed the right side, \( \chi^2(1) = 9.3, p < .003 \).

Next, we looked at poses of friends, whose raw frequencies are presented in the column totals of Table 5. As for the poses of selfie-takers, there was a strong reduction of frontal poses (5) relative to the solo selfies (30). However, in contrast to poses of selfie-takers the poses of friends showed an obvious bias for showing the left side of the face instead of the right. Out of the 72 selfies that unambiguously showed one cheek more than the other, 66 (91.7%) showed the left cheek, \( \chi^2(1) = 50, p < .00001 \). In the 27 cases that were classified as slightly turned, 22 (81.4%) were in the “slightly left” category, \( \chi^2(1) = 10.7, p < .002 \). The direction of the side biases for selfie-takers and friend suggests that selfie-takers preferred to compose the image such that both portrayed faces were looking towards the centre of the frame. This would tend to occur if the smartphone (and therefore the preview screen) were held more or less in a central position in front of the two portrayed individuals.

Table 5. Frequencies of each posing category for selfie-takers and friends in the duet selfies (L: unambiguously left; SL: slightly left; F: frontal; SR: slightly right; R: unambiguously right).

<table>
<thead>
<tr>
<th>Selfie-taker pose</th>
<th>L</th>
<th>SL</th>
<th>F</th>
<th>SR</th>
<th>R</th>
<th>Total (selfie-taker)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>13</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>19</td>
</tr>
<tr>
<td>SL</td>
<td>7</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>F</td>
<td>6</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>SR</td>
<td>12</td>
<td>6</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>R</td>
<td>28</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>43</td>
</tr>
<tr>
<td>Total (friend)</td>
<td>66</td>
<td>22</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>104</td>
</tr>
</tbody>
</table>

Assuming that both would be looking at the preview to check their pose, this would naturally bring them to rotate the face in the direction of the centre. If selfie-
takers prefer to place friends to their left, then the rotation would cause selfie-takers to expose more the right cheek, and the friends to expose more the left cheek. To test this account, we looked at the more complex pattern of frequencies for each observed pair of poses by selfie-takers and friends. These are presented in the body of Table 5. The most frequent pair, by far, is the selfie-taker showing the right cheek and the friend showing the left cheek (28 pairs out of 104 or 26.9%). This confirms a tendency for both individuals to rotate the faces towards the centre of the image, in a context where the friend tends to be on the left of the selfie-taker. However, remarkably even in this much more complex situation a global preference for the left cheek emerges. As many as 13 pairs of selfie-taker + friend duet selfies have both individuals show the left cheek more than the right, whereas only 3 pairs have both of them showing the right cheek. This is a smaller but nonetheless significant bias, \[\chi^2(1) = 6.25, p < .02\].

We stress that posing choices in duet selfies were not dictated by the nature of the task but seemed to reflect spontaneous tendencies, at least in this group of participants. Task mechanics did not favour a central position of the camera relative to the two people being photographed. On the contrary, it would seem more natural, given that the smartphone was held with two hands, that the selfie-taker would have kept the smartphone in front of him or herself, which would tend to generate frontal poses for the selfie-taker and right-sided poses for the friend, or perhaps some combination of slightly rotated poses. Instead, the most frequently observed pair was, by far, that involving an unambiguous right cheek for the taker and left cheek for the friend, and the left–left pair was much more frequent than the right–right pair. These findings suggest that there may be a tendency for selfie-takers to try to capture the friend’s left side and, to some extent, also their own left side in the duet selfies. This speculative conclusion could be examined by counterbalancing the position of the friend in a future study.
3.4. Discussion

Our results provide new data on compositional choices in nave self-portraits. In standard (solo) selfies, we found a strong preference for poses showing the left cheek. This bias is similar to previously reported side biases in portraiture and self-portraiture. In particular, these results are consistent with previous adult studies documenting left side biases in selfies (Bruno & Bertamini, 2013; Bruno et al., 2015; Lindell, 2015), in painted portraits (McManus & Humphrey, 1973; Nicholls et al., 1999), and photographed portraits (LaBar, 1973), as well as with studies that documented right side biases (presumably corresponding to the left side after mirror reflection) in painted self-portraits (Humphrey & McManus, 1973; Latto, 1996) before photography made mirrors less necessary for self-portraiture (Lindell, 2012).

In photographs that were both a self-portrait of the selfie-taker and a portrait of a friend (duet selfies), we found a strong preference by selfie-takers to have the friend on their left, resulting in preview screens with the taker on the right and in a head rotation bias for showing the left cheek of the friend and the right cheek of the taker. These results are consistent with previous reports that artists tend to place key content on the right of the image (assuming that selfie-takers would consider their own the key image in the wefie; Gaffron, 1950; Wölflflin, 1928), and with the preference for compositions having objects facing into rather than out of the picture frame, documented not only in artists but also in naive participants (Palmer et al., 2008). Thus, a set of selfies and wefies by modern youths reveals comparable biases to self-portraits and portraits by master painters over the history of the visual arts.

Assuming that our group of young selfie-takers had no academic training in painting, portraiture, and art history, these findings support an account of posing preferences in terms of biologically determined asymmetries over an account based on culturally induced conventions. The current data were collected in a field study at an event spontaneously attended by our participants. Along with the opportunity to recruit participants in the desired age range, this had the advantage that the collected selfies were representative of a typical aspect of spontaneous selfie-taking, that is, recording one’s presence at a place or event. However, this form of data collection also carried with it some limitations. The most obvious is that we had only partial control on participant selection. As a consequence, our sample was strongly unbalanced with regard to participant sex (we tested mostly females) and handedness.
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(we had few left-handers). This prevented us from assessing potential moderating effects of these variables. In particular, it has been suggested that the left-cheek posing biases are stronger for portraits of females (Lindell, 2013; Nicholls, Clode, Lindell, & Wood, 2002). Given the prevalence of female participants in our sample, our results may be representative of this fact. Future research should therefore balance participant sex in wefies. In addition, because we needed to minimise carry-over effects from selfies to wefies, our design confounded selfie type (solo vs. duet) with phone orientation (portrait vs. landscape) as all solo selfies were taken in portrait orientation and all duet selfies were taken in landscape. Thus, we cannot, on the sole basis of the current results, rule out that differences in posing biases between solo and duet selfies were due to the different orientations. However, we stress that the difference between portrait and landscape was carefully controlled in our earlier selfie work (Bruno & Bertamini, 2013). In that study we observed similar left-cheek biases for solo selfies in portrait and landscape orientations. It would seem reasonable, therefore, to assume that if we could have included a landscape condition for solo selfies, it would have shown the same pattern as the current portrait condition. This remains an empirical question that could be tested in future studies.
Chapter 4. The effect of left-right reversal on film

*This study has been published as: Bertamini, M., Bode, C., & Bruno, N. (2011). The effect of left-right reversal on film: Watching Kurosawa reversed. i-Perception, 2, 528–540.

Till now I have never shot a scene without taking account of what stands behind the actors because the relationship between the people and their surroundings is of prime importance.

Michaelangelo Antonioni, 1969.
4.1. Abstract

The mirror reversal of an image is subtly different from the original. Often such change goes unnoticed in pictures, although it can affect preference. For the first time we studied the effect of mirror reversal of feature films. People watched Yojimbo or Sanjuro in a cinema, both classic films by Akira Kurosawa. They knew that this was a study and filled out a questionnaire. On one day Yojimbo was shown in its original orientation, and on another day the film was mirror reversed. Sanjuro was shown reversed on one day and non-reversed on another day. Viewers did not notice the reversal, even when they had seen the film before and considered themselves fans of Kurosawa. We compared this with estimates from a survey. In addition, the question about the use of space (scenography) revealed that although people who had seen the film before gave higher ratings compared with those who had not, this was only true when the film was not reversed.
4.2. Introduction

In the opening scene of Yojimbo (1961), a samurai arrives at a fork in the road and throws a stick in the air. The stick points to the right, and the samurai follows the road to a village. Here the story begins. We will never know where he would have arrived if the stick had sent him to the left. But what we can test is how different the film would have been if keeping everything else the same, the stick had pointed to the left and the samurai had walked to the left to a similar but mirror-reversed village. In other words, an entire film can be shown with a left-right reversal of the images. This is what we did in our study, and afterwards asked viewers a series of questions on their experience. By doing this we tested (i) how often people reported that the film was reversed and also (ii) whether the judgments on the quality of the film, acting, and scenography were different for the participants that saw the original or the reversed versions.

4.2.1. Composition and scenography

In the study of the visual arts, composition and balance are important themes (recent studies of balance include McManus et al. 2011 and Gershon & Hochstein, 2011). For instance, Oppé (1944) claimed that Raphael's cartoons changed in meaning as the drawings were turned into tapestries (and mirror reversed in the process). One possibility is that people have a specific way of scanning a picture, and as a consequence, they prefer images in which movement proceeds from left to right (Gaffron, 1950). Empirical research on aesthetic judgments of pictures has identified some asymmetrical biases: there is a preference for having more salient content on the right side (Levy, 1976; Beaumont, 1985), for directional cues pointing from left to right (Mead & McLaughlin, 1992), for light coming from the left (Mamassian 2008), for portraits (especially of females) to show the left cheek rather than the right cheek (McManus & Humphrey, 1973; Schirillo, 2000), and for more space present in front (anterior) as opposed to behind when objects have a facing direction (Palmer et al. 2008; Bertamini et al. 2011). All but the last of these aspects of an image are affected by a left-right reversal.

The aesthetic criteria for a film may differ from those used to assess a painting (Cutting, 2002; Cutting et al., 2011). In Arnheim's words: "Film almost never deals with non-moving pictures as do painting and photography, and thus we
cannot speak here strictly of the composition of a static image" (1997, p.86). However, Arnheim goes on to argue that composition is part of a broader set of spatial aspects of a film. For dynamic images, composition in this broad sense is likely to be even more important than in paintings, and we will use the term scenography to refer to spatial composition as well as the set, costume, and lighting. Although usage of this term differs amongst authors, our use is in line with the following definitions of scenography: "the manipulation and orchestration of the performance environment. The means by which this is pursued are typically through architectonic structures, light, projected images, sound, costume and performance objects or props" (McKinney & Butterworth 2009, p.4) and "the creation of the stage space" (Howard, 2002, p. xix).

The left-right reversal manipulation changes some aspects of spatial layout while leaving others intact. Persons and objects relocate to the opposite side of the image, and any horizontal motion is in the opposite direction. The way that clothes are folded and swords are carried also changes. A kimono, for example, is always worn with the left side overlapping the right side (the reverse is used to dress a corpse for burial). Light that used to come from one side is now coming from the other. Any right-handed actor becomes left-handed and vice versa. Finally, many emotions are expressed by actors during a film, and facial expressions are also known to be asymmetrical (Sackheim & Gur, 1978), and more so for deliberate facial actions (Ekman et al., 1981). Any of these factors could be noticed by an observer, but even when they are not noticed, they could also contribute to a change in the evaluation of a film overall, or more specifically in relation to an evaluation of scenography (defined in our question as the use of space, set, costume, and lighting).

4.2.2. The films

Akira Kurosawa (1910–98) is frequently cited as one of the greatest directors of all time. He is also widely acknowledged as an influence on other directors, from Sergio Leone to George Lucas (both of who mused themes from Kurosawa's films in their own productions (Galbraith, 2002; Richie, 1999). A perfectionist, he worked passionately on every aspect of the filmmaking process. He used multiple cameras and was particularly admired for his skills as an editor (Richie, 1999). Images from Kurosawa's films are powerful and memorable. Yojimbo (1961) is set in 1860’s
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Japan. The main character is a “ronin” (a masterless samurai) played by the actor Toshirō Mifune. Some themes, such as the taciturn samurai, inspired later western films (e.g., the nameless hero). Sanjuro (1962) is a sequel to Yojimbo in which we meet again the same protagonist, although the film is lighter in tone (see Fig.14). Both were filmed in black and white and have never been dubbed into English. In our study they were screened in the original Japanese with English subtitles. A few seconds (less than a minute) at the beginning of each film and at the end were omitted to avoid any words using the Roman alphabet (but titles and credits in Japanese were preserved). The running times for Yojimbo and Sanjuro are 110 minutes and 96 minutes, respectively. We chose Kurosawa not only because he is highly admired as a director but also because in these films there are no cars and no Roman alphabet writing. We wanted to avoid the special case of detection of inversion for text and focus instead on the change in handedness and in composition of the visual images.

Figure 17. The original posters for the films Yojimbo (left) and Sanjuro (right). In the Sanjuro poster Mifune is holding his sword with his left hand. Possibly the image was reversed to fit the composition of the poster, but we could find no information on this (and therefore it may be that this has gone unnoticed before).
4.2.3. **Familiarity**

It is well known that having been exposed to a stimulus may affect responses to it at a later time. There is a large literature on implicit learning or learning without awareness (e.g., Seger, 1994). Importantly for aesthetics, prior exposure also affects preference and affective responses, a phenomenon known as "mere exposure" (Zajonc, 1968; 1980). Mere exposure has been studied in relation to actual works of art (e.g., Berlyne, 1970). Cutting (2003; 2007) discussed the application of the idea of mere exposure to the formation and maintenance of artistic canons and provided evidence to support this view in the case of French Impressionism. If exposure is critical for the evaluation of a film, then viewers that have seen the film before may behave differently from viewers that have not seen the film. Unlike a laboratory study, we cannot randomly assign people to the two groups. Moreover, what people may be unaware of is not which film they have seen in the past but the specific details of the film. If so, it is possible that people who remember having seen the film before may not notice that the film is now different (mirror reversed) and yet evaluate the film differently than those who see the film in the original orientation (because only the latter are being exposed to the same film again).

4.3. **Study 1: Expectations about how easy it is to notice a left-handed world**

4.4. **Methods**

4.4.1. **Participants**

The 105 participants were students from several classes at the University of Liverpool, including some with mature students. The majority were females (86), and the mean age was 24 years.

4.4.2. **Hypothesis**

In addition to the study of the experience of watching a left-right reversed film, we wanted to know what intuitive beliefs people have about how easy it is to detect a left-right reversal. To do this, we used a simple questionnaire with three different scenarios. One group of participants (N = 35) was asked whether it would be easy or difficult to notice that the world has been left-right reversed. Another
scenario described a museum in which all paintings have been mirror reversed (N = 35), and a third described a film (N = 35). The wordings of the questions are presented inside the graphs of Figure 18. For instance the question about the film was: "Imagine that you went to see a new film, and in the film the entire world has been changed into its mirror-reversed version. Most things would be the same except that most people in the film would now use their left-hand to eat, shake hands, point, and so on. How long do you think it would take for you to notice?"¹ Participants circled one of three answers: "Immediately", "Some time", "Never". If they answered "Some time," they were then asked how long. This first question was followed by a second question: "Now, please answer the same question but this time the film is a film that you had seen before in the non-reversed version. How long do you think it would take for you to notice?" This follow-up question was included only for the film and the museum scenarios, as the world cannot be unfamiliar. Figure 18 shows the percentage of responses in each category. The "some time" category has been split into "less than an hour" and "more than an hour" on the basis of the specific predictions made by the participants.

4.4.3. Results

In all cases a majority of respondents predicted that they would notice the reversal immediately or that it would take them less than an hour to notice it (world, 63%; museum, 63%; film, 63%). This majority increased when they were asked to assume that the paintings in the museum or the film were familiar to them (museum, 100%; film, 74%). We are not going to speculate about the differences between the three scenarios, as they may require further research. Our purpose was simply to see whether people's intuition was that this task was easy or hard. We can conclude from the data that the task is judged to be non-trivial (overall "immediately" responses were 27%) and that a few minutes may be necessary to notice the change, but this task is not impossible (overall "never" responses were 16%).

¹ The question mentioned the change of handedness for clarity, but we also replicated this pattern of expectations from an additional sample of 35 people for whom the question was shorter and did not mention handedness.
Figure 18. Distribution of people's expectations about how long it would take to notice a left-right reversal. There are three scenarios: (a) world, (b) museum, and (c) film. The wording of the question is included in the panels. For the museum and the film a follow-up question asked to repeat the prediction assuming that the paintings or the film were familiar. Error bars are 95% confidence intervals for percentages.
4.5. Study 2: Detection of left-right reversal of feature films

This study is the first investigation of the experience of watching a film after a manipulation that reverses the left-right orientation of the image. The first empirical question to answer is whether the spectators will notice the mainly left-handed world of the story, and whether having seen the film before, would increase the detection of the change. If the outcome were to match the expectations, based on the data presented above, a majority of people will detect the reversal, and this majority will be larger in the case of people who had seen the film before.

The sample in our study was made up of people who came to a free screening in a cinema located in the centre of Liverpool, UK. This sample was completely different from the sample that answered questions about how long it would take to notice a reversal (see section on expectations). Participants knew that in exchange for free entrance they had to fill out a questionnaire at the end, and they knew that this was part of a study. The questionnaire was designed to collect information about how much they liked the film overall and specifically about the acting and the scenography. It also asked the level of engagement with the story, and space was provided for people to make comments on anything they had noticed about the film. We collected information about sex, age, level of education, where they were sitting in the theatre, whether and when they had seen the film before, and whether they considered themselves fans of Kurosawa. Given the importance of previous exposure for aesthetics (e.g., Cutting, 2003), the difference between people who had seen the film before and those who did not is particularly important.

4.5.1. Hypothesis

We predicted that many people would not notice the reversal manipulation. This prediction was based on the fact that mirror images of objects have similar perceptual effects (e.g., Biederman & Cooper, 1991) and that people do not easily distinguish an original painting from its reversed image (Gordon & Gardner, 1974; Bennett, Latto, Bertamini, Bianchi, & Minshull, 2010), although they do better when the paintings are highly familiar (Blount, Holmes, Rodger, Coulthart, & McManus, 1975). However, our study was different from anything done before, and it is essential to measure the actual frequency of detection. In addition, judgments about the film’s quality may depend on the reversal despite the lack of awareness of the
manipulation. In particular, we were interested in the question about scenography.

4.6. Method

4.6.1. Design

There were four screenings for four groups of observers. On Monday Yojimbo was shown in the original orientation (N= 43) and Sanjuro was shown reversed (N= 36), and on Wednesday Yojimbo was shown reversed (N= 50) and Sanjuro was shown in the original orientation (N= 43). Yojimbo was always screened at 3:00 PM and Sanjuro at 6:30 PM. This choice meant that time of day was confounded with film, but orientation and film as well as orientation and time of day were balanced.

4.6.2. Participants

Ninety-three people watched Yojimbo, and seventy-nine watched Sanjuro. The majority were males (66%), and age ranged from 16 to 74 with a mode of 20. Highest level of education was varied, but a large proportion had a university degree (46%) or a doctorate (26%). A minority (19%) had seen the film before, but almost half of the participants (47%) answered “yes” to a question about whether they considered themselves a fan of Kurosawa.

4.6.3. Stimuli and procedure

The cinema was located within the Foundation for Art and Creative Technology, a complex that includes three cinema screens as well as art galleries. The theatre was small (10mx 10m) and had a capacity of 50 people. The screen was 8m wide. The image was of DVD quality, and the projector was a Christy Digital CP2000. Participants were permitted to choose a seat and were asked to complete the questionnaire after the film was shown. Participants had to choose a value between 1 (terrible) and 9 (wonderful) on the following four items: "Overall the movie was", "The quality of the acting was", "The quality of the scenography (use of space, set, costume, lighting, etc.) was", and "The performance of Toshiro Mifune (main character) was". The fifth question was about level of engagement, and the scale went from 1 (indifferent) to 9 (engaged). There was also an open question at the bottom of the page: "A final open question: Is there anything else in particular you
Carole Bode

would like to tell us about the movie that you have just seen?"

4.7. Results

4.7.1. Detection of reversal

Approximately half of the viewers (49%) wrote comments on the questionnaire in addition to answering the questions, and many others talked with the experimenter after the screening. Only two individuals wrote in their comments that they had noticed that the film was mirror reversed. One of them could speak Japanese and therefore reported that the Japanese characters were reversed. This puzzled her, but her comments were only relative to the text, not the film itself. Only one person therefore genuinely detected the manipulation in the film. This person was a fan of Kurosawa who had not only seen the film, but seen it repeatedly. She was also in contact with the family of Toshirō Mifune and carried with her a signed photograph and a small container with some of his ashes. We excluded both individuals from the subsequent analyses.

The almost total lack of detection of the reversal is remarkable. Except for the one individual mentioned above, none of the people who had seen the film before or that classified themselves as fans of Kurosawa detected that they were watching a film that was different from what they had seen before; nor did they detect the fact that they were watching a world populated mainly by left-handed people.

Next we consider the four separate aspects of the film that viewers judged. Given that we had only four screenings in total, reversal, film, and day of the week could not be completely crossed in the design. In all the analyses reported we included reversal (original or reversed) and film (Yojimbo or Sanjuro) as factors, but analyses performed with reversal and day of the week as factors produced exactly the same pattern of significant results. Mean scores are shown in Figure 19.
4.7.2. Overall impression of the film

The first question was about the overall rating of the film. Perhaps unsurprisingly ratings were, in general, high. The mean was 7.32 on a 9-point Likert scale. We performed an ANOVA with the following factors: Film (Yojimbo or Sanjuro), Reversal (original or reversed), Exposure (the group who had seen the film before and the group who had not), and Sex. The only significant effect was exposure: people who had seen the film before gave higher scores \[ F(1,148) = 10.63, p = .001 \]. This effect is likely to be a selection phenomenon: all but one of those who had seen the film before claimed also to be fans of Kurosawa. It is also possible that in addition to the selection issue, there was an effect of previous exposure. To test that possibility, we selected the subset of people who were fans (N = 80). Within this group only 30 (37%) had seen the film, and we compared the fans that had seen the film before with the fans that had not. We reasoned that for a fan of Kurosawa seeing a film that they had not yet seen should be a treat and therefore they should give higher scores (and nobody in either group was disappointed given the high scores). Conversely, if seeing a film that one has seen before is the important factor,
then the previously exposed group should have the higher score. The latter was the case \[ t(77.66) = 4.51, \ p < .001 \], supporting the idea that previous exposure is a contributing factor.

4.7.3. Acting

There were two questions about acting, one about the whole film ("The quality of the acting") and one about Mifune ("The performance of Toshirō Mifune"); the means were 7.04 and 8.02, respectively. The latter value is the highest mean for all questions and is close to ceiling on the 9-point scale. We performed a mixed ANOVA with the following factors: Question (overall or Mifune), Film (Yojimbo or Sanjuro), Reversal (original or reversed), Exposure (the group who had seen the film before and the group who had not), and Sex. There was a difference between the two questions \[ F(1,148) = 28.18, \ p < .001 \], an effect of Exposure \[ F(1,148) = 6.90, \ p = .010 \], and an interaction between the two \[ F(1,148) = 9.52, \ p = .002 \]. Despite the interaction, the trend for exposure was in the same direction for both questions (higher values from people who had seen the film before). Therefore, the results relative to acting show something similar to the results on overall impression of the film.

4.7.4. Scenography

As discussed in the introduction, because of the existing literature on effects of spatial composition for paintings, this was the question we were most interested in. We performed an ANOVA with the following factors: Film (Yojimbo or Sanjuro), Reversal (original or reversed), Exposure (the group who had seen the film before and the group who had not), and Sex. There were no significant main effects, but there was an interaction between Reversal and Exposure \[ F(1,148) = 4.27, \ p = .040 \]. This interaction is illustrated in Figure 17. As we have seen in the analysis of the overall quality of the film and the acting, viewers who have seen the film before tend to rate the film higher. However, in the case of scenography those who had seen the film before gave a higher rating only to the original version, the effect of previous exposure was absent for the reversed version (Fig. 20).

To find further support for a role of previous exposure, we reasoned that any effect of exposure should weaken over a long period of time. We used the
information about when the film had been seen and used the median to split the previously exposed group into two new groups: those who had seen the film within the last 5 years and those who had seen the film more than 5 years ago. Overall, the means for the two groups did not differ \( t(20.94) = -1.83, \text{ ns} \). Interestingly, the effect of exposure was present for the first group \( t(13.87) = 2.45, p = .028 \) but not the second \( t(12.61) = 0.19, \text{ ns} \), supporting the idea that (recent) previous exposure is linked with higher ratings for the original version, even though none of these viewers detected the reversal.

Figure 20. Mean rating values for the question relative to the scenography as a function of whether viewers had seen the film before and separately for the original and the reversed versions. Error bars are 1 SEM.

4.7.5. Engagement

We performed an ANOVA with the following factors: Film (Yojimbo or Sanjuro), Reversal (original or reversed), Exposure (the group who had seen the film before and the group who did not), and Sex. There were no significant main effects or interactions.

4.7.6. Seating

It is interesting to analyse briefly the information about where in the cinema people were sitting. One may expect that higher ratings would be associated with
sitting near the centre, and therefore more in line with the projector. We coded the five aisles from A2 on the right (near the entrance) to 2 on the left and plotted mean scores as a function of aisles. These plots displayed a symmetrical distribution with a peak near the centre. We performed an ANOVA for each of the questions and looked for evidence of a quadratic trend. For the questions about acting and scenography the quadratic term was significant ([\(F(1,163) = 6.69, p = .022\)], [\(F(1,163) = 15.18, p = .004\)], respectively) and there was a similar trend for the question on the overall impression of the film [\(F(1,163) = 4.41, p = .059\)]. Because people could choose their seats in the theatre, there are two possible explanations for the higher scores near the centre. The first is that people who are more interested in the film sit in the middle, and the second is that people who sit in the middle have a better experience.

We cannot separate these two in our study, but what is important is to check that location in the theatre was not confounded with previous exposure. If it were the case that people who had seen the film before tend to sit in the centre of the theatre, then the fact that they give higher scores may not necessarily depend on previous exposure but simply on where they were sitting. Therefore, we compared the location (as coded in terms of aisles) for the two groups (those who had seen the film before and those who had not).

There was no significant difference between the two groups in terms of location to the left or the right [\(t(166) = -0.34, \text{ns}\)] or in terms of eccentricity (aisles were recoded for eccentricity by removing the sign) [\(t(166)= -0.61, \text{ns}\)]. Therefore, the higher ratings from people who had seen the film before, which was discussed earlier, are unlikely to be an indirect consequence of where the viewers were sitting.

4.8. Study 3: Replication with short clips

We conducted a study in Italy to replicate and extend the basic finding. We selected two 5 min clips from Yojimbo (A and B) that were similar in content (they both begun with an interior scene, relatively rich in dialogue, and ended with a combat scene, rich in action). We recruited four groups of 120 students each from four undergraduate courses at the University of Parma. One group saw clip A (original orientation), then clip B (reversed); one saw clip A (reversed), then clip B (original); one saw clip B (original), then clip A (reversed); and one saw clip B (reversed), then clip A (original). Afterwards, participants were required to compare the two clips. Specifically, a questionnaire asked them to rate how much they
preferred the scenography of the second clip over the first using a nine point scale. They were also given an open question as in the Liverpool study. One interesting aspect of this study was the absence of subtitles. In the Liverpool study participants may have paid less attention to the images if they concentrated on reading them. In this control study we used the Japanese soundtrack with no subtitles. Consistent with the earlier study, none of the participants reported noticing that one clip was reversed. With respect to the role of familiarity, out of 480 participants, only 2 reported having seen the film before. For this reason, a comparison with the main study is impossible, although, interestingly, these two students reported preferring the scenography of the original version over that of the reversed one. An ANOVA with factors Clip (A or B), Version (original or reversed), and Sex revealed an overall preference for clip A over B \[F(1,433) =11.25, p=.001\], but no effect of version. It is interesting that even when two clips were compared directly against each other's, the reversal was not noticed.

4.8.1. Discussion

Our study revealed unequivocally that it is possible to watch a film mirror reversed without noticing the reversal, and with similar levels of engagement. One person noticed the reversal of the Japanese characters, and one noticed the reversal in the images, but everybody else failed to report the reversal. On the one hand, it is true that we did not ask explicitly whether the images were reversed, and therefore cannot claim that people would have been at chance once asked. On the other hand, participants knew that they were part of a study and knew that the event was organised by researchers from the University of Liverpool, and they were on average highly educated. Both Yojimbo and Sanjuro lasted more than 1.5 hours, and during this time viewers watched a world of left-handed people without detecting that this was unusual. In addition to the change in handedness, a few other aspects of the modified images might have looked wrong, specifically the asymmetry in facial expressions, the folding of the clothes, how swords were carried, and the direction of lighting and movement, as discussed in the introduction. These are all subtle changes but together they add to a considerable amount of information. In a similar study in Italy two clips were directly compared (one of them reversed), and even this direct comparison did not lead to detection of the reversal.
This lack of detection may be related to the fact that when viewing a film, the viewer is engaged with a story, and that such a story is unaffected by mirror reversal. A separate group of people judged how quickly they would notice a left-right reversal of the world, pictures in a museum, or a film. A majority predicted that it would take less than an hour to notice the reversal in each of the three scenarios. In the case of a film this expectation was not matched by people's actual performance in our study. Almost one participant in five had seen the film before, and almost half (47%) declared themselves fans of Kurosawa. Nevertheless, with the exception of one individual, having seen the film before or being familiar with the work of Kurosawa did not make it easier for the viewer to notice that the film was different. For instance, even though Mifune is a famous actor and many viewers would have been familiar with his roles in many of Kurosawa's films, it did not matter whether he was right handed (original version) or left handed (reversed version).

The choice of films by Kurosawa allowed us to test films from a famous and highly admired director, but it also had the advantage that the setting in 19th-century Japan meant that there were no cars and no Roman alphabet writing in the images. Detection of inversion for words is a special case, and we consciously designed our study to avoid this aspect. Instead we were interested in reversal of the image, and therefore the change in composition. This aspect was targeted specifically by the question on scenography. The ratings of the quality of the scenography (defined as the use of space, set, costume, and lighting) for the original version or reversed version differed as a function of previous experience; only the viewers who had seen the film before rated the original more highly than they did the reversed. The phenomenon of mere exposure (Zajonc, 1968) can help to interpret this finding. It is known that observers prefer stimuli that they have seen before even though they do not remember them (e.g., Seamon et al 1995; Johnson, Kim, & Risse, 1985). However, our situation is different and unique. Participants did remember having seen the film; what they did not remember was the orientation of the images. We found that people who had seen the film before reported liking the scenography more than people who had not seen the film before, but only when the film was shown in the original orientation (even though they did not consciously recognise that the reversed version was different). We interpret this finding as evidence of a composition-specific exposure effect. This interpretation is supported by the fact that the preference for the original version in people who had seen the film before was
specific to people who had seen the film relatively recently (in the past 5 years). However, given the limited sample size of the subgroup of observers who had seen the film before, this issue does need further research.

Studying the experience of watching a film in a cinema is challenging but rewarding. People who come to a cinema are a sample from a population of people with an interest in films (and specifically with an interest in the works of Kurosawa in our case) and therefore more diverse than participants recruited within the university community. Finally, questions about the role of asymmetric biases in visual art as well as questions about the role of previous exposure can be tackled, and our study is hopefully the first of many.
Chapter 5. Left–Right Positions in Moving Images*


There are deeper strata of truth in cinema, and there is such a thing as poetic, ecstatic truth. It is mysterious and elusive, and can be reached only through fabrication and imagination and stylization.

Werner Herzog, Minnesota Declaration, 1999.
5.1. Abstract

There are compositional biases in works of art that have been documented in static images. This study extends the analysis to moving pictures. We examined eight films by four different directors (Ford, Leone, Kurosawa, Chahine), each with a male actor in the major role. These directors are also from different countries (USA, Italy, Japan, Egypt). The analysis focused on three compositional aspects: a) the orientation of the face of the actor (which cheek was visible), b) the position of the face within the image (positioned either to the left of the screen showing the left or right cheek or to the right of the screen showing the left or right cheek), and c) the movement of the actor within the scene (moving to the left or to the right). Unlike in paintings there is no evidence that the left cheek was visible more often than the right. However, we confirmed that position and facing direction are related, i.e. the actor tends to face toward the centre of the screen. With respect to the analyses of movement, there was a greater frequency of movements from left to right, and this may explain the lower than expected frequency of the left cheek. Interestingly, we found a cultural trend in that the pattern of results from Western directors did not extend to the films by Chahine, which may be influenced by reading direction.
5.2. Introduction

An important aspect in any movie is the composition of the scene, i.e. the placing of objects within a space. Though watching a film provides a different experience to that experienced when viewing a painting, directors, like painters, compose images within the limitations of a frame (i.e., the camera shot) selecting the most important elements for inclusion in the image (Anderson, 2013; Arnheim, 1983; Marsh and Wright, 2000). We know that directors make explicit decisions (through the storyboards and scripts created for films) about where the main actor in their movies is positioned in the frame of the scene and whether they should, for example, face left or right. Yet it is unclear if these decisions are intuitive, directorial conventions, or due to the limitations of equipment and technology, particularly in relation to the capture of movement (DeLong et al., 2014). Indeed, the aesthetic criteria used to judge a film may differ from those used to assess a painting, and composition may well be a more important consideration in dynamic images than in paintings (Arnheim, 1974/1997; Cutting, 2002). The following section reviews the literature on composition and asymmetrical biases in visual art, especially paintings. After that we will introduce the methods used to examine these issues within a set of films.

5.2.1. Compositional Asymmetries in Visual Images

Empirical research has explored how both asymmetric biases and directional cues can affect the dynamics and balance of an image, and in turn its aesthetic evaluation (Arnheim, 1951; Palmer, 1991). Levy (1976) found that right-handed observers have a preference for images in which the more salient object is placed to the right. She explained this on the basis of a known attentional bias to the left. Furthermore, the left visual field bias may be linked to a tendency to scan from left to right, causing paintings to appear heavier when objects are placed to the right (Arnheim, 1974/1997; Gaffron, 1950). In relation to directional cues in static images, implicit motion is more often from left to right and this may reflect a preference to scan an image from left to right in dextrals (Freimuth & Wapner, 1979; Mead & McLaughlin, 1992). When arranging objects within a rectangular frame, objects positioned to the left or right of the frame were preferred when they faced inward
towards the centre (‘Inward bias’: Palmer et al., 2008). An additional positional bias places more space present in front (anterior) of objects as opposed to behind them when the object faces along the horizontal axis (‘Anterior bias’, Bertamini et al., 2011a, b). This same phenomenon has been referred to as ‘lead room’ in cinematography.

Empirical studies provide various explanations for facial orientation biases. The right hemisphere’s role in the regulation of emotion accounts for more emotive expressions on the left rather than the right side of the face (Sackeim & Gur, 1978; Sackeim, Gur, & Saucy, 1978). In Western European portraits, the left cheek rather than the right cheek is more likely to be presented to the viewer, though the effect is weaker for males (the stronger bias in females representing a greater inclination to express emotion, McManus & Humphrey, 1973; Nicholls, 2000; Schirillo, 2000). Additionally, Humphrey and McManus (1973) suggested that the left or right facial bias of the sitter might depend on the similarity or dissimilarity in gender or status between the artist and model (i.e. left cheek bias: similar status/gender; right cheek bias: dissimilar status/gender). Alternately, Nicholls et al. (1999) argue that people posing for a portrait instinctively know which side of the face most effectively expresses emotion, suggesting that a tendency to present the left cheek when expressing an emotion and the right cheek to conceal emotion has a phylogenetic explanation.

The effect of interactions between cultural factors, cognitive functions and brain asymmetries on aesthetic preference is not well understood (Chokron et al., 2009). One of the compelling arguments for cultural differences in compositional biases is the significance of the relationship between reading direction and aesthetic preference. For example, Pérez González (2012) compared samples of 19th century studio portraits from Spanish and Iranian photographers (left to right and right to left readers respectively). Whilst the Spanish sample displayed a preference pattern for left to right direction, the Iranian photographs showed the converse pattern, strongly suggesting that writing direction is linked to compositional organization in visual art. Additionally, whilst people preferred images when the salient object was placed on the right rather than on the left, regardless of their reading direction (Chokron & De Agostini, 2000), reading direction had no effect on the leftward bias in a grey scale task (Nicholls & Roberts, 2002). Dissociations such as these, and the interactions of reading and writing direction on visual laterality in compositional biases provide a
strong case for further investigation (Beaumont, Young, & McManus, 1984; Pérez González, 2012).

5.2.2. Stimuli: The Films

Films provide a rich visual experience, but present more challenges in the analysis of compositional aspects than those found in a static image (moving figures, changes of camera angle, lighting, etc., Hochberg & Brooks, 1996). Therefore, we limited the examination of composition to a group of directors and films from eastern and western cultures. We then focused on the specific positional, facial and directional orientations of the main male actor. The section that follows summarises the films that were chosen and the reasons they were selected.

We chose films made by four critically acclaimed directors from different regions of the world: Akira Kurosawa (Japan, 1910–1998), Youssef Chahine (Egypt, 1926–2008), Sergio Leone, (Italy, 1929–1989) and John Ford (USA, 1894–1973). These directors and their films are associated with their countries and cultures, although there are undoubtedly intercultural influences between them.

Table 6. Technical and biographical information about the directors, the films (release date and length) and the actors, including the actor’s time spent on screen.

<table>
<thead>
<tr>
<th>Director</th>
<th>Film</th>
<th>Release date</th>
<th>Film length</th>
<th>Actor</th>
<th>Actor’s screen time (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>John Ford¹</td>
<td>The Searchers</td>
<td>1956</td>
<td>119 min</td>
<td>John Wayne</td>
<td>50.5</td>
</tr>
<tr>
<td></td>
<td>The Man Who Shot Liberty</td>
<td>1962</td>
<td>123 min</td>
<td>John Wayne</td>
<td>27.2</td>
</tr>
<tr>
<td></td>
<td>Valance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sergio Leone²</td>
<td>A Fistful of Dollars</td>
<td>1964</td>
<td>100 min</td>
<td>Clint Eastwood</td>
<td>50.4</td>
</tr>
<tr>
<td></td>
<td>The Good, the Bad and the</td>
<td>1966</td>
<td>177 min</td>
<td>Clint Eastwood</td>
<td>28.2</td>
</tr>
<tr>
<td></td>
<td>Ugly</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Akira Kurosawa³</td>
<td>Yojimbo</td>
<td>1961</td>
<td>110 min</td>
<td>Toshiro Mifune</td>
<td>60.8</td>
</tr>
<tr>
<td></td>
<td>Sanjuro</td>
<td>1962</td>
<td>96 min</td>
<td>Toshiro Mifune</td>
<td>58.3</td>
</tr>
<tr>
<td>Youssef Chahine⁴</td>
<td>Struggle in the Valley</td>
<td>1954</td>
<td>125 min</td>
<td>Omar Sharif</td>
<td>30.8</td>
</tr>
<tr>
<td></td>
<td>(Sira' Fi al-Wadi)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Struggle in the Pier</td>
<td>1956</td>
<td>98 min</td>
<td>Omar Sharif</td>
<td>50.6</td>
</tr>
<tr>
<td></td>
<td>(Sira' Fi al-Minaai)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹Born in Cape Elizabeth, 1894 – died in Palm Springs, 1973
²Born in Rome, 1929 – died in Rome, 1989
³Born in Tokyo, 1910 – died in Tokyo, 1998
⁴Born in Alexandria, 1926 – died in Cairo, 2008
For example, Leone referenced Kurosawa when making the “Man with No Name” trilogy, Kurosawa cited John Ford as one of his favourite directors (Ritchie, 1999), and Chahine spent time in California working as an actor (Fawal, 2008). From these four directors we selected a set of films which fit within the action genre, and which were all released between 1954 and 1966 (see Table 6 and Fig. 21).

Though there are differences in narrative, the general themes involve a fight against injustice. All have an internationally recognized male actor in the central role.

_Yojimbo_ (1961) and its sequel _Sanjūrō_ (1962) tell the stories of a _ronin_ (a masterless samurai) exacting revenge and meting out punishment on corrupt officials.

Figure 21. Posters for the films used in the analyses. Each column is for a different Director/Actor pair. From left to right: Leone/ Eastwood (Fistful of Dollars; The Good, The Bad and the Ugly), Ford/ Wayne (The Searchers; The Man Who Shot Liberty Valance), Chahine/ Sharif (Struggle in the Valley; Struggle in the Pier), Kurosawa/ Mifune (Sanjūrō; Yojimbo).
and criminals on behalf of their victims. Toshirō Mifune plays the role of the samurai. In *A Fistful of Dollars* (Leone, 1964, an unofficial remake of *Yojimbo*) a stranger is caught between two feuding clans and schemes to play the two sides off each other, whilst *The Good, the Bad, and the Ugly* (Leone, 1966) continues the adventures of the “Man with No Name” as he searches for buried Confederate Army gold. This role is strongly associated with the actor Clint Eastwood. *The Searchers* (Ford, 1956) follows an American Civil War veteran as he hunts for his abducted niece. In *The Man Who Shot Liberty Valance* (Ford, 1962) a Senator returns home for the funeral of an old friend, revealing the true events behind the debt he owes his friend. John Wayne plays the protagonist in both films. In Chahine’s *Struggle in the Valley* (*Sira` Fi al-Wadi*; 1954) a dispute between business rivals results in murder and revenge. *Struggle in the Pier* (*Sira` Fi al-Mina*; Chahine, 1956) takes place in the port of Alexandria and focuses on the theme of unjust exile and fate. The leading actor is a young Omar Sharif, prior to appearing in English language productions.

The main reason to include a director from Egypt, apart from the fact that this allowed us to have films from four different continents, was that in this case the director and the actors are Arabic speakers (right to left readers) and therefore the reading and writing direction for their language is opposite to that of the American and Italian directors (left to right readers).

5.3. *Methods of Analyses*

We performed three analyses on the films, from which we obtained three datasets. We call these (a) Orientation of the face, (b) Position of the face and (c) Movement. We report results from each of them in turn. The creation of the dataset involved watching the film and coding the current image of the lead actor (i.e. Wayne, Eastwood, Mifune, Sharif) as belonging to a set of fixed categories. The categories are listed in Table 7. A simple key press marked the transition from one category to a different one. Each key press was recorded with a timestamp and we were then able to compute the duration of each category. Because the process is time consuming not all films were coded by a single person. After completing a first analysis, we decided to add a second wave of coding, with a new set of coders. We refer to these two datasets as ‘waves’. We include the two coding groups (waves) as a factor in the analysis. Note also that a category has no direct relation to other possible ways to segment a film, such as screen shots. For instance if the face and
position of the actor was the same between two screen shots that counts as a single event in our analysis.

Table 7. All categories of the three datasets in the analyses of the film: (a) Orientation of the face (b) Position of the face, and (c) Movement.

<table>
<thead>
<tr>
<th>Orientation</th>
<th>Position</th>
<th>Movement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presents left cheek</td>
<td>Left side/cheek</td>
<td>Moving to the left</td>
</tr>
<tr>
<td>Presents right cheek</td>
<td>Left side/cheek</td>
<td>Moving to the right</td>
</tr>
<tr>
<td>Front facing</td>
<td>Right side/cheek</td>
<td>Moving to the front</td>
</tr>
<tr>
<td>Back of the head</td>
<td>Right side/cheek</td>
<td>Moving to the back</td>
</tr>
<tr>
<td>Absent</td>
<td>None of the above</td>
<td>Absent</td>
</tr>
</tbody>
</table>

For each of the three datasets we analysed two aspects of the data. The first was the frequency of each type of event, that is, the number of events that fell into each of the categories. We focused on the comparison between left and right (dichotomous variable) and conducted logistic regressions. The second aspect of the results that we looked at was the average length in time of each type of event. This is a measure in seconds and, unlike the frequency, can be analysed using ANOVA. It is important to note that the two indices could be measuring different aspects. For example, it is possible that a given category does not occur very frequently, but when it is present it is longer in duration than other categories. On the other hand, a strong preference for one type of composition, for instance showing the left cheek of the face, could result in higher frequency as well as longer duration of this type of event.

5.4. Study 1: Orientation of the Face

In this analysis we categorised the orientation of the face of the leading actor. In every scene a decision was taken to sort the events into one of five types: (a) showing the left side/cheek, (b) showing the right side/cheek, (c) frontal view of the face, (d) back view of the head, (e) face absent (Fig. 22). Therefore every period of time during the film could be coded as belonging to one of these five categories.

5.4.1. Results

The orientation categories front, back and absent are not theoretically interesting. Therefore, we will focus the analysis on the comparison of left and right
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orientation. The relative frequency of these categories is shown in Fig. 23. We ran a logistic regression on the categorical variable Orientation of the face, i.e., whether the left cheek or right cheek was displayed on screen. The predictors were Film (eight levels) and the Coder waves (two levels). We report the overall Hosmer and Lemeshow goodness of fit test for the model $\chi^2(7) = 3.92, p = 0.789$. There was a significant effect of Film, $\text{Wald} = \chi^2(7) = 31.09, p < 0.001$, but no effect of Coder wave, $\text{Wald} = \chi^2(1) = 0.18, p = 0.669$.

Figure 22. Examples of face orientation and body position (from Yojimbo, 1961). The red line represents the midline of the screen used to demarcate left and right. The first image shows Mifune on the left of the screen (Position), showing the right side of the face (Orientation). The second image shows Mifune on the right of the screen, showing the left side of the face.

Given the significant effect of Film, we followed this up with specific tests of orthogonal hypotheses organized by Director. By design the Directors are supersets of the Films, so a contrast between directors is also a contrast between films. We compared the Western directors (Leone & Ford) to Chahine (excluding Kurosawa).
We did this to establish whether there was a pattern of opposing orientation between the Western directors and the Eastern director (Chahine). There was a significant effect of Director, \( \chi^2(1) = 7.88, p = 0.005 \). We then compared Ford with Leone. There was no difference, \( \chi^2(1) = 2.46, p = 0.117 \). Lastly, to complete the set, we compared Kurosawa with Ford, Leone and Chahine, and found no difference, \( \chi^2(1) = 1.84, p = 0.175 \). In addition to frequency, we also analysed the average duration of each event. The data was binned along the time duration, and we analysed Film (eight levels) Coder wave (two levels) as between factors, and Category (L, R, front, back) as within factors. The time windows of the analyses were arbitrarily chosen to be 10% of the duration of the film. The ANOVA did not confirm any significant main effect or interaction \([Film, F(7,128) = 0.19, \text{n.s.}], \) \([Coder\ Wave, F(1,128) = 0.09, \text{n.s.}] \). The same result was true when comparing just Left and Right orientation. We followed this with the same tests as in the previous analysis. There was no significant effect when comparing Chahine (Eastern) to the two Western Directors, when comparing Leone and Ford, and when comparing Kurosawa to all other directors.

Figure 23. Analysis of Orientation of the face. The left panel shows the count of the number of events of each type (left cheek visible or right cheek visible). The right panel shows the average duration of the two events. Error bars are 95% CI.
5.4.2. Discussion

Overall, there was no systematic orientation bias. Figure 23 shows that overall the frequency of events showing the left and right sides of the actor’s face were similar. This was true both in terms of frequency of the events and in terms of average duration of the events. The association between frequency and director, however, suggests that differences exist between the four directors.

In particular, Figure 23 shows that for the Egyptian director, Chahine, there is a bias opposite to the bias for the other directors, particularly those of Ford and Leone. This was confirmed by a direct comparison of frequencies between Chahine on one side and Ford and Leone on the other (excluding Kurosawa). Although small and not significant, the duration data shows the same pattern (Fig. 23). It is therefore possible that we are seeing a difference between Eastern and Western directors, with opposite biases.

5.5. Study 2: Position and Orientation of the Face

In the second analysis we categorised the face of the leading actor both in terms of orientation and in terms of position in the image: (a) showing the left cheek and located on the left side of the image (LL), (b) showing the right cheek and located on the left side of the image (LR), (c) showing the left cheek and located on the right side of the image (RL), (d) showing the right cheek and located on the right side of the image (RR), (e) none of the above. Therefore every event during the film could be coded as belonging to one of these five categories.

5.5.1. Frequency Results (Position)

The relative frequency and duration of the five categories is shown in Fig. 24. We will focus the analysis on the comparison of the first four (LL, LR, RL, RR). Moreover, we will start by comparing Position on the screen (collapsing the four categories into two). We carried out a logistic regression to see whether the face was more often on the left (LL + LR) or the right side of the screen (RL + RR). This position on the screen was the categorical variable. As before we included Film and Coder wave as predictors. We report the overall Hosmer and Lemeshow goodness of fit test for the model \[\chi^2(8) = 37.64, \ p < 0.001\]. There was a significant effect of
Film, \([\text{Wald } = \chi^2(7) = 81.19, p < 0.001]\), but no effect of Coder wave, \([\text{Wald } = \chi^2(1) = 0.95, \text{n.s.}]\).

Given the significant effect of Film, we followed this up with specific tests of orthogonal hypotheses organized by Director. By design the Directors are supersets of the Films, so a contrast between directors is also a contrast between films. We used the same contrasts as for the previous dataset. We compared the Western directors (Leone & Ford) to Chahine (excluding Kurosawa). We did this to establish whether there was a pattern of opposing orientation between the Western directors and Chahine. There was a significant effect of Director, \([\text{Wald } \chi^2(1) = 7.62, p = 0.006}]\). We then compared Ford with Leone, and confirmed a significant difference, \([\text{Wald } \chi^2(1) = 30.22, p < 0.001}]\). Lastly we compared Kurosawa with Ford, Leone and Chahine, and found a difference, \([\text{Wald } \chi^2(1) = 10.02, p = 0.002}]\).

Figure 24. Analysis of Position and Orientation of the actor’s face. The left panel shows the count of the number of events of each type (LL, LR, RL, RR and none of the above). The right panel shows the average duration of the events. Error bars are 95% CI.
5.5.2. Frequency Results (Orientation)

A second set of analyses tested whether the actor displayed more frequently his left (LL + RL), or right cheek (RR + LR). We refer to this as Orientation (left cheek versus right cheek). The first analysis included Film (eight levels) and Coder wave (two levels). We report the overall Hosmer and Lemeshow goodness of fit test for the model $[\chi^2(8) = 3.72, p = 0.882]$. There was a significant effect of Film, $[\text{Wald} = \chi^2(7) = 33.14, p < 0.001]$, but not of Coder wave, $[\text{Wald} = \chi^2(1) = 1.52, p = 0.218, \text{n.s.}]$.

As in the previous data set we conducted a series of orthogonal contrasts comparing the differences between the Eastern and Western directors, this time in relation to Orientation of the face. Firstly, we compared Ford and Leone with Chahine, but excluded Kurosawa. There was a significant effect of Director, $[\text{Wald} = \chi^2(1) = 10.94, p = 0.001]$. We then compared Leone to Ford. There was no significant difference between the two, $[\text{Wald} = \chi^2(1) = 0.13, \text{n.s.}]$. Finally, we combined the data from the two Western directors and Chahine and compared them to Kurosawa. There was no effect, $[\text{Wald} = \chi^2(1) = 1.06, \text{n.s.}]$.

5.5.3. Frequency Results (Inward Bias)

Figure 24 shows all categories; there seem to be higher frequencies for RL and LR compared to LL and RR (thus generating a bell shaped pattern). This was expected as a result of a tendency for actors to face towards the centre of the scene, meaning that when located on the right of the screen a person is more likely to face left (and vice versa). In static images this bias has been reported as inward bias (Palmer et al., 2008) or anterior bias (Bertamini et al., 2011a). Excluding “the None” of the above category, the overall frequency was 59.3% for inward cases, compared to 40.7% for outward cases. We decided to check whether this bias was different for different Directors using the same three tests used in the previous analyses. None of the three was significant $[\text{Wald} = \chi^2(1) \text{ were 2.06, 3.80 and 0.76, respectively, all n.s.}]$.

5.5.4. Duration Results

In addition to frequency, we also analysed the average duration of each event. The data was binned along the time duration, and we analysed Film (eight levels)
Coder wave (two levels) as between factors, and Orientation (L or R) and Position (L or R) as within factors. The time windows of the analyses were arbitrarily chosen to be 10% of the duration of the film.

The ANOVA confirmed a main effect of Film \([F(7,120) = 2.53, p = 0.018, \eta^2 p = 0.129]\) and a marginal interaction between Film and Coder Wave \([F(7,120) = 2.44, p = 0.023, \eta^2 p = 0.125]\). Importantly, Coder Wave did not interact with any other factor. There was also an interaction between Position and Orientation \([F(1,120) = 96.38, p < 0.001, \eta^2 p = 0.445]\). This interaction is due to the inward bias visible in Fig. 21. We followed this analysis with specific tests for the Directors as in previous analyses, starting with Position (Fig. 25). When comparing Chahine (Eastern) to the two Western Directors, there was a main effect of Country \([F(1,108) = 5.10, p = 0.026, \eta^2 p = 0.045]\) and an interaction between Country and Position \([F(1,108) = 5.18, p = 0.025, \eta^2 p = 0.046]\). There was no effect of Position (L versus R) when comparing Leone and Ford, and no difference between the two Directors. Finally, we compared Kurosawa to all other directors. There was an effect of Position \([F(1,108) = 5.88, p = 0.017, \eta^2 p = 0.039]\), and an interaction between Position and Director \([F(1,108) = 5.67, p = 0.019, \eta^2 p = 0.037]\).

The same analysis was done for Orientation (Fig. 26). When comparing Chahine (Eastern) to the two Western Directors, there was a trend for Country \([F(1,107) = 3.61, p = 0.060, \eta^2 p = 0.033]\) and an interaction between Country and Orientation \([F(1,107) = 11.95, p = 0.001, \eta^2 p = 0.100]\). There was an effect of Orientation (left versus right) when comparing Leone and Ford \([F(1,70) = 5.68, p = 0.020, \eta^2 p = 0.075]\), but no effect of Director. There were no significant effects when compared Kurosawa to all other directors. Finally, we analysed again the average duration of the inward and outward events. This ANOVA included the factors Inward bias (consistent and inconsistent) and Director (Ford, Leone, Kurosawa, Chahine). There was no effect of Director, and an effect of Inward bias \([F(1, 144) = 81.02, p < 0.001, \eta^2 p = 0.36]\). This supports that the inward bias was present also in terms of durations, with longer events in which the actor is facing towards the centre of the of the image.
Figure 25. Analysis of Position and Orientation of the actor’s face, collapsed to show just the Position. The left panel shows the count of the number of events of each type (left is the combination of LL, LR, right is the combination of RL, RR). The right panel shows the average duration of the events. Error bars are 95% CI.

Figure 26. Orientation of the face (presenting the left cheek, or presenting the right cheek). The left panel shows the count of the number of events of each type (left is the combination of LL, RL, right is the combination of LR, RR). The right panel shows the average duration of the events. Error bars are 95%.
5.5.5. *Discussion*

The analysis of the position of the face revealed a strong inward bias: the leading actor tends to face towards the centre of the image. This is consistent with the picture perception literature (Bertamini et al., 2011; Palmer et al., 2008). Another finding was that the overall pattern for the face orientation (visible cheek) was the same as that of the first dataset. This analysis overlaps in part (but not completely) with the first dataset, and it is interesting to note the similarity with the previous results: For Western directors/actors there is a slight tendency to show the right cheek, but this reverses for the Egyptian director/actor. We will return to this in the final discussion.

5.6. *Study 3: Movement*

In this analysis we categorised the movement of the leading actor. We used the following categories: (a) the person is performing a movement (walking, running, riding) towards the left (from the viewpoint of the camera), (b) the person is performing a movement (walking, running, riding) towards the right (from the viewpoint of the camera), (c) the person is present but static, (d) none of the above. Therefore every event during the film could be coded as belonging to one of these four categories.

5.6.1. *Results*

The relative frequency of the four categories is shown in Figure 27. Because the last two are not theoretically interesting we will focus the analysis on the comparison movement to the left and movement to the right. We conducted a logistic regression on Movement (movement to the left or to the right) with Film (eight levels) and Coder wave (two levels) as predictor. A Hosmer and Lemeshow goodness of fit test \( \chi^2(8) = 3.13, p = 0.926 \). There was a statistically significant effect of Film, \( \text{Wald} = \chi^2(7) = 14.33, p = 0.046 \), but no effect of Coder wave, \( \text{Wald} = \chi^2(1) = 0.15, p = 0.699, \text{n.s} \). As in the previous data sets we conducted a series of orthogonal contrasts comparing the differences between the Eastern and Western directors.
We compared the Eastern and Western directors, but excluded Kurosawa to test whether there were differences in the actor’s movements to left or to the right. Firstly, we compared Western directors (Ford and Leone) to Chahine, and confirmed a difference, $\text{Wald} = \chi^2(1) = 5.76, p = 0.016$. We also found a marginal difference between Ford and Leone, $[\text{Wald} = \chi^2(1) = 4.05, p = 0.044]$. Lastly, there was no effect also when comparing Kurosawa to the other directors (Ford, Leone, Chahine), $[\text{Wald} = \chi^2(1) = 0.175, \text{n.s.}]$.

In addition to frequency, we also analysed the average duration of each event. The data was binned along the time duration, and we analysed Film (eight levels) Coder wave (two levels) as between factors, and Category (movement to the left, movement to the right, neither) as within factor. The time windows of the analyses were arbitrarily chosen to be 10% of the duration of the film. The ANOVA did not confirm any significant main effect or interaction $[\text{Film}, F(7,117) = 0.48, \text{n.s.}; \text{Coder Wave}, F(1,1117) = 0.33, \text{n.s.}]$. The same result was true when comparing just Left and Right movement. We followed this with the same tests as in previous analysis. There was no significant effect when comparing Chahine (Eastern) to the
two Western Directors, when comparing Leone and Ford, and when comparing Kurosawa to all other directors.

5.6.2. Discussion

The action in the films that we analysed was biased to take place from left to right in the Western directors. It should be noted that the analysis only coded the action of the main character, and secondary characters could provide movement in the complementary direction. However, a bias for movement to the right is consistent with the picture perception literature (Freimuth & Wapner, 1979; Gaffron, 1950; Mead & McLaughlin, 1992). Our results therefore extend the finding to action films. Another very interesting aspect of the data is the fact that the bias for movement to the right was absent when considering Chahine. Given that the bias is absent in the Egyptian director the implication is that the bias is related to culture and possibly to reading direction. In addition, the movement bias may be related to the orientation of the face. A bias to move from left to right implies a bias to show more of the right side of the face. Comparison of Figure 27 with Figure 26 supports this interpretation.

5.7. Discussion

In this study we analysed eight films by four directors: Ford, Leone, Kurosawa, Chahine. We compared three compositional aspects: the orientation of the leading actor’s face (which of the actor’s cheeks was visible to the viewer), the position of the leading actor on the screen (left or right side of the frame), and lastly, the leading actor’s movement (from left to right or from right to left). It is interesting to compare the results based on images in films with what has been found for images in paintings. In paintings, the left cheek rather than the right cheek is more likely to be presented to the viewer, though the effect is weaker for males (McManus & Humphrey, 1973; Nicholls & Roberts, 2002; Schirillo, 2000). This effect has been confirmed using photographs (Bruno & Bertamini, 2013; Bruno et al., 2014).

In the analysis of the leading actor’s facial orientation, there was no evidence of a clear cheek orientation bias: overall left and right sides of the actor’s face were equally visible. This was true both in terms of frequency of the events and in terms of average duration. However, this lack of overall bias may have originated from two
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opposite biases in Western and Eastern directors. We found a link between the pattern of frequencies and directors. For Leone and Ford there was a tendency to show the right cheek, for Chahine there was a tendency to show the left cheek. This interaction may reflect cultural difference between directors, traditions, or perhaps a role of writing direction between Arabic and European languages. Japan in many ways is a special case, both in terms of its complex writing pattern, and in terms of the large Western influences in the 20th century. This could explain the intermediary position in the analysis of the films by Kurosawa (see Figs. 23 and 24).

Although in paintings there is an overall left cheek bias, McManus (1979) has also suggested that a right cheek bias for self-portraits may emerge in relation to a perceived kinship between the artist and model. Thus, in the case of a male painter, the painter himself, male relations, and males in general were painted so that the right side of the face was presented to the viewer. With four male directors and four male leading protagonists in our films, one could make a parallel interpretation with the results of our study. However, the differing pattern in the individual directors was not consistent with this interpretation.

In terms of scene composition, previous research suggests that observers have preferences for pictures where the focus of interest is on the right-hand side (Levy, 1976; McLaughlin et al., 1983). In relation to this, it is suggested that other than conveying a story, directors (working within the constraints of a frame) will use artistic conventions and visual cues to focus the viewer’s attention on salient objects (Carroll & Seeley, 2013). Thus, in the second analysis, we tested whether the leading actor’s face was more often on the left or the right side of the screen. Overall there was no evidence of a positional bias in terms of frequency of where the face was positioned or duration of those events, but with a strong bias in Leone. The data for Chahine did not show a pattern opposite to the other directors as in the first analysis. Our second analysis focused on the combination of position (left or right side of screen) and facial orientation (left or right cheek visible). It is known that people, and also objects with an anterior and posterior structure, tend to be represented with the anterior part facing towards the centre of the image, or more generally so that the anterior has more space from the margin than the posterior (Bertamini et al., 2011a; Palmer et al., 2008). The data from the films supported the presence of this bias: when the face was on the left the right cheek was more often visible, and when it was on the right the left cheek was more often visible. This finding of a bias for the
actors to face inwards towards the centre of the screen extends the effect reported in relation to static images to films (Bertamini et al., 2011b; Palmer et al., 2008).

Some aspects of the results were similar for the first and second analysis. There are cheek orientation differences between the Western actors and the Egyptian actor, who tends to present his left cheek more often. If we focus on the Western directors, given a strong inward bias, and a tendency to show the right cheek more often than the left cheek (Fig. 26), one would expect the face to appear more often on the left (showing the right cheek to face inward). This was not the case and the tendency was instead for the face to be on the right side. This is not impossible because, as shown in Fig. 24, when orientation and position were inconsistent with the inward bias (face looking out of the frame) there were more faces on the right side. As noted before, the pattern for Chahine is reversed.

The presence of an inward bias makes sense, as actors in conversation will frequently face each other. But there may be other factors and considerations that affect composition. Cinematic cues, such as the actor glancing into off-screen space to imply additional space or action taking place beyond the limitations of the frame may be a consideration (Marsh & Wright, 2000).

The third and final analysis focused on the frequency and duration of the actor’s movements on screen (i.e., moving from left to right, and right to left with respect to the camera). We found a bias for movement from left to right consistent with the literature on implied motion in pictures (Freimuth & Wapner, 1979; Gaffron, 1950; Mead & McLaughlin, 1992). However, there was a notable absence of the left to right movement bias in the Egyptian films. This difference could be the consequence of a cultural influence, linked to reading direction. The influence of cultural factors on spatial cognition such as reading direction has been offered as an explanation in our understanding of movement in the visual field. In European paintings, motion is implied from left to right (Freimuth & Wapner 1979; Mead & McLaughlin, 1992).

Reading direction may influence lateral positioning preferences across cultures (Nachshon, 1981; Nachshon et al., 1999; Pérez González, 2012). Reading direction may influence how the eye scans each frame of a film, affecting viewer perception of the compositional order of the film as a whole. In relation to the films of Chahine and Kurosawa, this may well have implications for the way that film is read. In European cultures, people read from left to right, and in Arabic countries
people read from right to left. Japanese people primarily read from top to bottom and right to left (Morikawa & McBeath, 1992; Suitner & McManus, 2011). The influence of reading direction and its inherent complications merit more investigation with regard to perception of compositional asymmetries, particularly in relation to Japanese and Arabic films.

The results from the third analysis showing a preferred direction of movement from left to right can be linked to the results about face orientation. The left to right bias of movements may cause the right cheek to be shown more often than the left cheek. This would explain the difference with respect to the more frequently observed left cheek bias in portraits (Schirillo, 2000) in which no movement is present or even implied.

In this study we have explored compositional properties from eight action films. The films were selected from a classic period of cinematography for action films, and represented four countries, each with a different cultural heritage. Whilst we acknowledge that cultural influence will undoubtedly have determined aspects of the film production and staging, the compositional differences between the Western and Eastern films is interesting. We found differences with respect to known biases in portraiture, namely the lack of a left cheek bias. However, this may be explained by a bias to present motion from left to right in Western cultures. This first analysis of a small sample of films has raised questions in relation to aesthetic preference and compositional biases in this medium. Whether the differences in compositional preferences in the Egyptian films and Japanese films can be further understood in terms of cultural influences such as writing and reading direction on aesthetics warrants further investigation.
Chapter 6. Conclusion & future research

The central topic of the research presented in this thesis concerns involved in preferences for compositional lateral symmetries and asymmetries in both static and moving visual images. Chapter 1 provided context for the research by examining key writers and models in the field of empirical aesthetics. The relationship between art and science is at times productive and rewarding, at other times it is, at best, ambivalent. With regard to this, a fundamental question relates to how these models define “art” and whether original art can be studied meaningfully within an empirical framework, or whether studies should employ only laboratory based art (see Leder et al., 2004; Leder, 2013; Marković, 2012; Nadal et al., 2010). Recently, a re-evaluation of methodologies and paradigms used to measure aesthetic preference of visual art has suggested a multilevel, holistic approach (Jacobsen, 2006, 2010; Leder et al, 2004, 2006; Pierce et al., 2016) and is a promising advance in examining the aesthetic experience of both viewer and artist. To some extent we approached and conducted the experimental studies contained in this thesis from this perspective.

Chapter 2 addressed a fundamental issue regarding principles of composition, namely universal preferences for symmetry and complexity, discussed in the introduction (Chapter 1). Cross-cultural comparisons are challenging but important because similarities would support (in this case) universality in response to symmetry, yet few such studies have been carried out. Soueif and Eysenck’s (1971, 1972) comparisons of British and Egyptian experts and non-experts found no strong evidence for a cultural difference in a preference for symmetry, but there were differences in preferences for complexity and simplicity. With regard to our approach, two methodological issues needed to be addressed in our investigation. In the first instance, the stimuli used by Soueif and Eysenck (1971, 1972) raised some questions regarding the influence of familiarity and semantic associations on participant preferences. Secondly, Soueif and Eysenck studies analysed non-artists and artists. Whilst it is interesting and important to look at experts, an untrained population could highlight more inherent sensitivities to symmetry, because it is possible that an artist would be more aware of the aesthetic importance of symmetry and asymmetry in design (Augustin & Leder, 2009; Belke, Leder, & Augustin, 2006). Importantly, in my study I used three different measurements of complexity.
that were unavailable at that time to Souief and Eysenck in their studies: Gif ratio, Edge length and the average cell size (average blob size, ABS) all of which correlate with different aspects of complexity. The results confirmed some degree of universal agreement in preferences for simple abstract symmetry. My current findings show a preference for moderately complex patterns in the British group, a preference observed in earlier research (see Berlyne, 1971; Friedenberg & Liby, 2016) but we found the opposite for the Egyptian group for certain patterns. Egyptians appear more to be more sensitive to these particular patterns than the British group. This is particularly interesting and merits further investigation. The interaction between symmetry, preference and orientation is also very interesting. This requires further examination in relation to preferences for specific types of symmetry between the two groups and factors such as orientation, familiarity and novelty and reading direction. Soueif and Eysenck (1971, 1972) and Eysenck and Castle (1970) suggested a possibility that there are sex differences in preference for specific symmetries. In my study British males liked asymmetry better than females. British males also gave overall higher ratings than British females to all symmetries, particularly to vertical symmetry except 90° rotational symmetry, which British females rated higher. Like Souief and Eysenck (1972), I found no overall differences between the Egyptian and male and female groups. On average, Egyptian males rated horizontal symmetry slightly higher than Egyptian females but overall both male and female Egyptians gave similar ratings for the different classes of symmetry. As both groups in the current study contained more females than males (Souief & Eysenck, 1971, included more males than females), a more detailed analysis of sex as a factor poses a question for further research. Unlike Soueif and Eysenck (1972) I found no difference in age-related preference for symmetries despite a greater variance in ages among the British group. Further exploration of this would be of potential interest in understanding the development of preference for symmetry.

Previous analyses suggest that artists prefer poses showing the left side of the subject’s face when composing a portrait but showing the right side when composing their own self-portrait in relation to a perceived kinship between the artist and model (Humphrey & McManus, 1973; Latto, 1996; McManus, 1979). There is also some evidence that artists may prefer compositions with key features on the right of the picture. I was interested whether these findings generalize to self-portraits by non-
experts. In solo selfies, I found a strong preference for poses showing the left cheek, similar to previously reported left side biases in both painted and photographic portraiture and self-portraiture, as well as previously reported right side biases (in self-portraits painted with the aid of mirrors). In wefies (duet selfies), we found a strong preference by selfie-takers to place the friend to their left and themselves on the right, and a bias for showing the left cheek of the friend and the right cheek of the taker. This is consistent with previous reports that artists tend to place key content on the right side of the image (Levy, 1976; Gaffron, 1950; Wölfflin, 1928), and a preference for objects facing into rather than out of the picture frame (Palmer et al., 2008).

These findings support an account of posing preferences in terms of biologically determined asymmetries over an account based on culturally induced conventions. However, there are some limitations regarding the data. We collected our data opportunistically at a public event. While we were able to collect data from our target age range, our participant sample was strongly unbalanced with regard to participant sex and handedness. It has been reported that left-cheek posing biases are stronger in portraits of females (Lindell, 2013; Nicholls, Clode, Lindell, & Wood, 2002), and this bias may be reflected in our results. Future research should therefore balance participant sex in wefies. In addition, because we needed to minimise carry-over effects from selfies to wefies, our design confounded selfie type (solo vs. duet) with phone orientation (portrait vs. landscape) as all solo selfies were taken in portrait orientation and all duet selfies were taken in landscape. Thus, we cannot, on the sole basis of the current results, rule out that differences in posing biases between solo and duet selfies were due to the different orientations. Earlier work (Bruno & Bertamini, 2013) controlled for these solo selfies in portrait and landscape orientations and similar left-cheek biases were observed. It is reasonable, therefore, to assume that if I had included a landscape condition for solo selfies, it would have shown the same pattern as the current portrait condition. This remains an empirical question that will be tested in future studies.

Of all the visual arts, cinematic film is the most recent and is a relatively unexplored artistic genre in empirical aesthetics. The research conducted in Chapters 4 and 5 extend the knowledge of specific aspects of the effects of compositional asymmetries in the context of motion pictures. For the first time we studied the effect of left-right mirror reversal on preference for feature films. We asked one group of
people to estimate how long it would take them to notice if the world, pictures in a museum, or a film had been left-right mirror reversed. The majority said they would take less than an hour. Nonetheless, the study revealed that it is possible to enjoy watching a film without noticing the mirror reversal. In a similar study conducted in Italy (using film clips) the reversal also went undetected. I found that people who had seen the film before (within the last 5 years) reported liking the scenography more than people who had not seen the film before, but only when the film was shown in the original orientation (even though they did not consciously recognise that the reversed version was different). This can be interpreted as evidence of a composition-specific exposure effect. However, given the limited sample size of the subgroup of observers who had seen the film before, this issue does need further research.

The final study extended the research to from films by four directors from different countries (USA, Italy, Japan, Egypt). The analysis focused on three compositional aspects involving the facial position, orientation, and lateral movements of the actor on the screen. Unlike in analyses of portraits, we found no evidence of a left cheek bias. This may be explained by a left to right directional bias for motion in Western cultures (where the right cheek would be visible). However, it was confirmed that position and facing direction are related, i.e. the actor tends to face toward the centre of the screen. A greater frequency of movements from left to right may explain the lower than expected frequency of the left cheek. Interestingly, a cultural trend found in the pattern of results from Western directors did not extend to the films by Chahine, which may be influenced by reading direction and needs further exploration.

Overall these findings confirm a preference for left-right asymmetries in both static and moving pictures, and provide new evidence in support of a biological basis for side biases independent of expertise. Importantly, they highlight some cultural differences in preferences for compositional symmetries that may be linked to reading direction, and a difference in preference for complexity. Defining what factors relating to composition determine preference is key to understanding human aesthetic preference and decisions in the appreciation and production of visual art. This thesis provides a significant contribution towards that goal. Although the current research has addressed some issues relating to asymmetrical biases, particularly confirmation of the Inward bias and left-right biases, it should be seen as
a first step in understanding the phenomena from a cross-cultural perspective. Whether the differences in compositional preferences in the Egyptian films and Japanese films can be further understood in terms of cultural influences such as writing and reading direction on aesthetics warrants further investigation.

Additional research is essential to begin to address some of the questions generated by the current studies. For instance, future work entails addressing some of the limitations highlighted in Chapter 3 and Chapter 5, in relation to cultural influences on directionality in posing orientation. I am already currently addressing the limitations encountered in Chapter 3 in a study of Egyptian photographic self-portraits. Importantly, Maass and Russo (2004) pointed out the dangers of generalizing scientific knowledge beyond the context of the culture in which it was investigated. However, cross-cultural comparisons are important and may continue to provide more exciting and interesting results such as those for symmetry preferences found in Chapter 2, and also in asymmetries in side biases such as those in Chapter 5.
References


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Carole Bode


Carole Bode


Carole Bode


Carole Bode


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Carole Bode


Carole Bode


Appendices
Appendix 1. Questionnaire and Symmetry Pattern sets (A,AA,B,BB).

Date: ………………… Sex: Male [ ] Female [ ] (please circle the appropriate box)
Age: ……… Nationality: ………………………
Which hand do you write with? Left hand [ ] Right hand [ ] (please circle the appropriate box)
Your native language: ……………………………………
If you have been studying English, for how many years: …………………………………………………
What other languages have you studied and for how many years? ………………………………………………………
…………………………………………………………………………
…………………………………………………………………………
Subject(s) studied at University: ……………………………………

On the following page you will see a series of geometrical patterns similar to the one in the example below. Please evaluate each of them in turn in terms of how much you like the pattern. In the score box underneath each pattern please write a number between 0 and 10. This is a score from something that you do not like at all (zero) to something that you find extremely beautiful (ten).

This is an example with a box in which to write the answer.

You can take your time to respond, and you are allowed to go back and change your response by crossing over the first response. Please make sure you complete ALL of the score boxes for the patterns.
Thank you for taking part in this study. You can contact the experimenter by email if you have any questions.

By compiling this questionnaire you consent to the statistical analysis of the data. If you would like a summary of the results of our study, please leave your email address here ________________________
Or alternatively contact us directly at m.bertamini@liv.ac.uk or e.bode@liverpool.ac.uk or 0151 7942954. Thank you.
Appendix 2. Selfies Questionnaire

Committee on Research Ethics
Questionnaire

Please tell us some information about yourself.

1. Age.................   2. Please circle a box: 

          BOY    GIRL

3. Which hand do you write with? Please circle a box:

          YES    NO

4. Do you have/use a camera?

5. If you have a camera, how often do you use it? Tick one box:
   a. Every day ........................................
   b. 2 or 3 times per week............................
   c. 1 per week........................................
   d. 2 or 3 times a month..............................
   e. Never..............................................

5. If you have a smartphone, how often do you use the camera app to take a ‘selfie’? Tick one box:
   a. Every day ........................................
   b. 2 or 3 times per week............................
   c. 1 per week........................................
   d. 2 or 3 times a month..............................
   e. Never..............................................

7. When you take a selfie, which do you think is your most important feature on your face? Put a number from 1 to 6 in the boxes, do not use the same number twice. For example: put 1 for your most important feature and 6 for your least important
   a. Eyes ..............................................
   b. Nose................................................
   c. Mouth.............................................
   d. Chin...............................................
### Appendix 3. Watching Kurosawa Reversed questionnaires

Date ________  Sex  M  F  Age ________  Are you left-handed?  Y  N

Please circle your highest level of education:
- GCSE
- A level
- FE
- Undergraduate Degree
- Postgraduate degree

Subject(s) studied: ____________________________  Profession: ____________________________

Imagine that the entire world were to change into its mirror-reversed version. Most things would be the same except that most people around you would now use their left-hand to eat, shake hands, point, and so on. How long do you think it would take for you to notice?

- Immediately  [ ]
- Some time  [ ]
- Never  [ ]

If your answer was "some time" please tell how much long (eg seconds, minutes, hours):

_________________

What do you think would be the first thing that you would notice?

_________________

---

By compiling this questionnaire you consent to the statistical analysis of the data.

Contact: m.bertamini@liv.ac.uk or 0151 7942954

Thank you.
Imagine that you went to see a new film, and in the film the entire world has been changed into its mirror-reversed version. Most things would be the same except that most people in the film would now use their left-hand to eat, shake hands, point, and so on. How long do you think it would take for you to notice?

Immediately [ ] Some time [ ] Never [ ]

If your answer was "some time" please tell how much long (eg seconds, minutes, hours):

______________

What do you think would be the first thing that you would notice?

______________

Now, please answer the same question but this time the film is a film that you had seen before in the non-reversed version. How long do you think it would take for you to notice?

Immediately [ ] Some time [ ] Never [ ]

If your answer was "some time" please tell how much long (eg seconds, minutes, hours):

______________

What do you think would be the first thing that you would notice?

______________

By compiling this questionnaire you consent to the statistical analysis of the data.
Contact: m.bertamini@liv.ac.uk or 0151 7942954
Thank you.
Imagine that you visit a museum of fine art with lots of paintings. You are not familiar with these paintings. All the images have been mirror-reversed. How long do you think it would take for you to notice?

Immediately [ ]  Some time [ ]  Never [ ]

If your answer was "some time" please tell how long (eg seconds, minutes, hours):

______________

What do you think would be the first thing that you would notice?

______________

Now, please answer the same question but this time assume that you are familiar with the paintings and you have seen them before in the non-reversed version. How long do you think it would take for you to notice?

Immediately [ ]  Some time [ ]  Never [ ]

If your answer was "some time" please tell how much long (eg seconds, minutes, hours):

______________

What do you think would be the first thing that you would notice?

______________

By compiling this questionnaire you consent to the statistical analysis of the data.
Contact: m.bertammi@liv.ac.uk or 0151 7942954
Thank you.
Date:        Time:        Film:        Seat No.        Sex: M or F

Age:        Nationality:        Your native language:

Have you ever seen this film before?  Yes or No  If yes, when did you see it?

Do you consider yourself a fan of Kurosawa?  Yes or No

Overall the film was

(terrible)  (wonderful)
1  2  3  4  5  6  7

The quality of the acting was

(terrible)  (wonderful)
1  2  3  4  5  6  7

The quality of the scenography (use of space, sets, costume, lighting, etc.) was

(terrible)  (wonderful)
1  2  3  4  5  6  7

The performance of Toshiro Mifune (main character) was

(terrible)  (wonderful)
1  2  3  4  5  6  7

Your engagement with the story was

(indifferent)  (engaged)
1  2  3  4  5  6  7

If you had seen the movie before, your enjoyment this time was

(better)  (worse)
1  2  3  4  5  6  7

Please tell us the highest level of education you have achieved:

GCSE/A level  Further Education  Undergraduate Degree  Postgraduate degree

Subject(s) studied at degree /postgraduate level

A final open question: Is there anything else you would like to tell us about your experience of the film you have just seen?

By completing this questionnaire you consent to the statistical analysis of the data. If you would like to receive a summary of the results of our study, please leave your email address here. Alternatively, contact us directly at mbertamini@liv.ac.uk or 0151 794 2954 (please also see information sheets at the desk). Thank you for your participation.
Notes

Publications


Conferences


Bertamini, M. Berselli, N., Bode, C., Lawson, R. & Wong L. (June 2010). The rubber hand illusion in a mirror. The Rubber Hand Illusion in a Mirror, IMRF conference, University of Liverpool.
Carole Bode

Education

PhD Psychology (part-time), Left right asymmetries can affect aesthetic judgments of expressiveness in visual images, (2010-present)

B.Sc. Psychology, University of Liverpool, 2010.

Staedelschule, Frankfurt am Main, studentship, 1993-4.

Further Adult Education Teaching Certificate, Liverpool, 1988-89.


Employment

Lecturer (Psychology), Go Higher Access, Faculty of Humanities & Social Sciences, University of Liverpool, 2012-present.


Freelance Illustrator and painter.

Student Mentor, Go Higher Access, University of Liverpool, 2007-2009.

Curator, Artsbase Gallery & Studios, Liverpool, 1995-98.

Costume Designer, Ballet Kusumi, Frankfurt am Main, Germany, 1993-94.

Studentship with Jorg Immendorf, Staedelschule, Frankfurt am Main/Düsseldorf, 1993-4.


Gallery Assistant, Bluecoat Gallery, 1987-88.

Teaching

Modules I have developed and delivered:


GOHI004 Societies & Individuals, Lead Module Co-ordinator (2012-2016).

GOHI005 Psychology, Lead Module Co-ordinator (2012-2016).


Go Higher SES (2006-12):

I designed and delivered the following Level 3 Foundation modules:


Undergraduate Teaching:

Modules I have delivered, assessed, and moderated:

Psy117 Real World Psychology, Department of Psychology, Edge Hill University (2016-present).

Psy2117 Applying Psychology, Department of Psychology, Edge Hill University (2016-present).

Psy2114 Cognitive Psychology, Department of Psychology, Edge Hill University (2016-present).

Psy 2115 Biological Psychology, Department of Psychology, Edge Hill University (2016-present).

Psy3129 Personality & Individual Differences, Department of Psychology, Edge Hill University (2016-present).

Psy3122 Substance Abuse, Department of Psychology, Edge Hill University (2016-present).

Psyc 229 Psychology of Mind & Brain, School of Psychology, University of Liverpool (2016).

Psyc 106/ Psyc 227 Animal Cognition, School of Psychology, University of Liverpool (2010-13).

Psyc 106/ Psyc 227 Memory & Sleep, School of Psychology, University of Liverpool (2010-13).

Psyc 309, Visual Intelligence, School of Psychology, University of Liverpool (2010-13).

Psyc 205, Perception & Memory, School of Psychology, University of Liverpool (2010-13).