Examining the visual preferences of art experts and non-experts

Doctoral dissertation

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Abstract

Empirical aesthetics has long been concerned with the question of what factors determine our visual preferences. Through various theoretical and methodological frameworks, the field has gradually moved closer to understanding the aesthetic experience. Based on our current knowledge, we can be confident that our preferences are influenced by the properties of the visual stimuli, our mental content, and the interaction between the two. This thesis aims to examine the factors affecting preferences on three levels: stimulus properties, meaning, and expertise. It is clear that certain stimulus properties, such as symmetry, balance, or optimal complexity, influence the aesthetic experience. These low-level features have a perceptual advantage, which is a result of the way the human mind operates, explaining our preference for them. The effect of meaning preference, which is related to the interpretation of stimuli, is also well-known in empirical aesthetics. The recognition and interpretation of elements in our visual environment is evidently a key function of perception, thus carrying evolutionary significance. The third level is the top-down influence of expertise in the process. To investigate differences in visual preferences between art experts and non-experts, we conducted a series of interrelated empirical studies. First, we designed a composition production task (N=114) to identify the key distinctions in how experts and non-experts approach the creation of 'beautiful' versus 'ugly' compositions. The results showed that symmetry, balance and meaning are the main factors in the distinction between beautiful and ugly. We also found evidence about the effect of art expertise on the preference for stimuli features and meaningfulness. Based on these findings, we developed a stimulus set for a forced-choice preference task (N=77 – prestudy, N=196 – main study. This online questionnaire was designed to map the preferences of experts and non-experts. According the results, art expertise sets a limit to the preferences of symmetry and meaningfulness. This does not mean that experts show opposite preferences compared to those of non-experts.

Instead, in both dimensions, the non-expert like biases in the preference choices disappear and a more balanced pattern emerges. Interestingly, the preference for prototypicality does not disappear like that due to art expertise – when being exposed to meaningful stimuli. Thus, whereas art expertise modulates the preference for stimuli features and meaningfulness, in case of simple, obvious meaningful images, art experts are driven by the same factor as non-experts. Finally, we conducted an eye-tracking study (N=75) to examine both the implicit and explicit preferences of these groups. Results revealed that there is indeed a difference between art experts' and non-experts implicit preferences. Namely, we found signs of implicit symmetry preference among non-experts but not among experts, as well as implicit preferences for meaningless images among experts, but not non-experts. Thus, the effect of art expertise does not only exhibit on the explicit level, but also on the implicit level. By employing a diverse range of methods we present a comprehensive assessment of visual preferences, which contributes to the understanding of the role of art expertise in the aesthetic experience.

1. Introduction

Lilies are my favourite flowers, and I love having them on our balcony. When they bloom, I often enjoy my morning tea outside, as their presence makes the experience that much better. As a psychology student, I first became interested in how our visual environment affects our emotions and behaviour, which led me to start researching aesthetic experience. Over time, I've become fascinated by the complexity and uniqueness of this everyday experience: how it offers a glimpse into the thousands of years of evolution that have shaped the human mind, allowing us to experience and appreciate beauty; and how this elemental feeling of visual pleasure is influenced by not only the objects themselves but also the unique constellation of the perceiver's interests, experiences and expectations.

Originally, the study of aesthetic experience, known as empirical aesthetics, was a significant component of art psychology. Today, as aesthetics and the arts do not always overlap, empirical aesthetics is better understood as an interdisciplinary field. It draws on topics from philosophical aesthetics and art psychology, concepts from cognitive and general psychology, and methods from experimental psychology and neuroscience (Shimamura and Palmer, 2012; Nadal and Vartanian, 2022). The field is also undergoing a conceptual redefinition, laying the foundations for what is now referred to as 'psychological aesthetics' (Skov, 2024). This thesis tackles a topic within this intersection, addressing questions from philosophical aesthetics (What do we find beautiful? What drives our visual preferences?), relying on theoretical frameworks from cognitive and art psychology, and employing various methods from experimental psychology, including production tasks, preference tasks, questionnaires, and eye-tracking.

Empirical aesthetics has long been concerned with the question of what factors determine our visual preferences. Through various theoretical and methodological frameworks, the field has gradually moved closer to understanding the aesthetic experience. Based on our current knowledge, we can say that our preferences are influenced by the properties of the visual stimuli, our mental content, and the interaction between these two factors (Ramachandran and Hirstein, 1999; Palmer et al., 2013; Leder et al, 2014). This thesis aims to examine the factors affecting preferences on three levels: stimulus properties, meaning, and expertise. It is clear that certain stimulus properties, such as symmetry, balance, or optimal complexity, influence the aesthetic experience (Marković, 2002; Arndt and Révész, 2018). These low-level features have a perceptual advantage, which is a result of the way the human mind evolved and operates, explaining our preference for them (Reber et al., 2004). The effect of meaning preference is also well-known in empirical aesthetics. It is associated with the recognition and interpretation of elements in our visual environment, which is evidently a key function of perception, thus carrying evolutionary significance (Ramachandran et al., 1998; Ramachandran and Hirstein, 1999). The third level is the top-down influence of expertise in the process, which has been showed to be modulating the perceptual processing (Kozbelt, 2001). Perhaps this is the most challenging factor to study, given the terminological and methodological inconsistencies in the literature (which we will discuss in details below). The results of this thesis highlight that the effects of individual factors cannot be interpreted in isolation but only in relation to each other. For example, the contradictory findings in the literature on the effect of expertise on symmetry preference (see Weichselbaum et al., 2018; Leder et al, 2019 and Gartus et al., 2020) suggest considering meaningfulness as an important factor in symmetry preference. Similarly, while we have substantial knowledge about preferences for symmetry and meaning when examined separately, studying these preferences in relation to each other allows us to better understand the hierarchy and the interplay of these features. This tendency of measuring the combined effect of factors by using multidimensional stimuli is one of the main methodological focus of today’s empirical aesthetics (see for example Van Geert et al., 2022; Redies et al., 2024). However, due to the lack of assessment tools, this has not been done until now regarding symmetry and meaningfulness.

By employing a diverse range of research methods from free composition creation to strict forced-choice preference task with eye-tracking, the studies in this thesis explore the underlying features in the visual preferences of art experts and non-experts in a way it has not been investigated or presented before. Thanks to this variety of assessment tools, preferences could be comprehensively explored on multiple levels, including the self-defined distinctions between ‘beautiful’ and ‘ugly’, the comparison of the effect of lower- and higher-level features as well as implicit preferences. Furthermore, the unique stimuli created for these studies introduce a method of measuring the effect of image features with different nature comparably – which was hardly possible until now.

The theoretical and empirical research presented in this thesis yield a deeper understanding of the visual preferences of art experts and non-experts, but also raises new questions and suggests conceptual and methodological improvements that could benefit both myself as a researcher and the field as a whole. Therefore, I believe that completing this thesis was not only a significant milestone in my professional development but also a valuable contribution to the discipline of empirical aesthetics.

1.1. Purpose and overview of the thesis

First, our aim is to establish a comprehensive theoretical framework for empirical aesthetics, covering its historical milestones, key concepts, and methods. We place particular emphasis on the role of stimulus features and meaningfulness in shaping aesthetic experiences. Given the central question of this thesis — exploring the differences in visual preferences between art experts and non-experts — we also review relevant theoretical and empirical literature on the topic.

Second, to investigate these differences in visual preferences, we conducted a series of interconnected empirical studies. We began with a composition production task to identify the key distinctions in how experts and non-experts create 'beautiful' versus 'ugly' compositions. In presenting this study, we also discuss empirical findings related to the effects of stimulus features and meaningfulness on the preferences of both groups. Based on the findings from this initial study, which highlighted symmetry and meaning as the primary predictors of beauty, we developed a stimulus set for a forced-choice preference task. This online questionnaire was designed to map the preferences of experts and non-experts. Alongside this study, we present a theoretical discussion covering the limits of symmetry preference, as well as how art expertise modulates the preferences towards meaningfulness and typicality. Finally, we conducted an eye-tracking study to examine both the implicit and explicit preferences of these groups. In this section, we review literature on eye movements as indicators of implicit aesthetic preferences, with a specific focus on the differences between expert and non-expert viewers. Through this diverse methodological approach, our goal is to achieve a deeper and more comprehensive understanding of visual preferences across different levels of expertise.

2. Empirical aesthetics

We all have experiences in our everyday lives that are shaped by visual pleasure. This influence extends beyond simply choosing a painting for our living room or finding the perfect angle for a photo of our puppy. Our visual preferences guide us in countless ways within our physical environment. They affect how we relate to objects, clothes, landscapes, faces, and much more. Whether we are aware of it or not, these preferences influence our emotional state, our daily choices, our mate selection, our relationship with our own appearance, and more.

Therefore, when we discuss visual preferences, we are not limited to art appreciation. Instead, we seek to understand the human mind’s connection to the complex visual environment. The scientific field that explores how our preferences shape our thoughts, emotions, and behaviours is known as empirical aesthetics. While it encompasses the study of experiences across all perceptual modalities, the primary focus of both empirical and theoretical research remains on visual preferences, the very topic that established this field. By now, empirical aesthetics has a rich and extensive history with a wide range of methods and conceptual approaches to assess the object of the perception, the individual that is perceiving it, as well as the influence of the context. By now, with the improvement of the technology we are not only able to access the phenomenal or behavioural level, but also physiological measurements (such as brain activity or eye-tracking) help us draw consequences about the cognitive processes, individual differences and evolutionary explanations. In the next chapter we cover the main milestones of empirical aesthetics focusing on the models and methods in the research of visual preferences. In this thesis, we will mainly discuss the research of the perceived object instead of the individual and the context, as it is the most relevant to our studies. For a detailed review of this discipline including its subject, detailed history, key questions and concepts as well as its methodological development see The Oxford Handbook of Empirical Aesthetics (2022) edited by Marcos Nadal and Oshin Vartanian.

2.1. Efforts to understand visual preferences

Even ancient civilisations had concepts about what people perceive as beautiful, and they tended to apply these features on their visual environment, such as buildings, clothes or body artefacts, because they just *seemed to work* in increasing preference. But how can we actually measure beauty? The birth of empirical aesthetic dates to 1876 when Gustav Theodor Fechner published his work titled "Vorschule der Ästhetik", in which he first attempted to quantify the aesthetic experience. His main idea was to measure how people react to different physical properties of visual stimuli. As such, he studied the appreciation of various object features like symmetry, the golden ratio or balance. His approach was to find a correlation between visual properties and the experienced beauty. Therefore, he introduced various remarkable methods. In the method of choice participants must choose of various stimuli according to their preferences. In preference ratings, they must quantify their own preference toward a stimulus, while in the method of production they create or modify the stimuli according to their preferences. He also argued for using a mixture of different methods for assessing the experience the most effectively. Relying on these correlations, he aimed to describe objective laws of aesthetics.His findings and methods inspired many researchers. For instance, his results on the preference for a certain level of complexity and order provided the key concept in the next 100 years of empirical aesthetics. One of his most impactful concepts was to look at the aesthetic experience as a function of the interaction between the object and the beholder's mind, rather than solely the property of one or the other. These ideas among with his original research objects and methods are still providing a solid and fruitful foundation for empirical aesthetics (see Séra and Kakas, 1991). The various approaches not only aimed to measure the basic visual preference, but also gradually expanded the concept of *aesthetic preference* by integrating emotional, cognitive, and cultural factors, apart from the visual properties.

2.1.1. Aesthetic formulae

Fechner's intention to quantify the aesthetic experience and describe objective laws of beauty inspired various scientific approaches. American mathematician, George D. Birkhoff

(1933) aimed to create an aesthetic formula based on objective properties like order and complexity. According to his theory, the higher the ratio of order to complexity, the higher the aesthetic “measure”, the pleasantness (M=O/C). He applied to his formula not only on visual stimuli like polygons and vases, but also on music and poetry.

Hans J. Eysenk, who is best known for his work on personality psychology (see: Eysenck & Eysenck, 1993), also contributed to the field of empirical aesthetics with structured quantitative measurements, and a similar formula based on image features like order and complexity (1941). Eysenck’s work involved empirical testing with various objects, such as polygons, to validate this formula. His studies found varying degrees of correlation between the predicted aesthetic value and the actual pleasure reported by observers (1942). He also aimed to map the individual differences in aesthetic appreciation based on personality measurements (1972).

Although their approach might seem rather elementarist, as he broke down the mental process of the aesthetic appreciation into simple components, the systematisation and the research of such low-level features is still a key concept in empirical aesthetics. However, the concept of aesthetic preference has over time surpassed basic visual preferences.

2.1.2. Good Gestalts

In the early 20th century, an impactful theory emerged from Germany on how the human mind perceives the world. Wertheimer (1925) introduced the main idea of Gestalt psychology was the recognition of the holistic way of perception, or with other words, the whole is greater than the sum of its parts. He suggests that our mind is wired to perceive whole objects or forms (e.g. ‘Gestalts’) instead of individual components of an object or isolated elements. Therefore, our visual system is looking for clues of such objects. He described these perceptual clues in his 1938 study titled ‘*Laws of organization in perceptual* *forms*'. These are also referred to as the 'principles of Gestalt' or the 'principles of figural goodness' (see the illustrations on Figure 1). Such features are for example closure, proximity, similarity, continuity and the law of 'prägnanz' or simplicity of organisation, which means that we perceive all stimuli in the simplest configuration possible. For instance, visual elements that are close to each other and have joint continuing shapes are more likely to appear to us as the parts of one coherent figure or one group. If those figure-organizing clues can be found, they evoke appreciation and recognition, whereas the lack of them evokes uncertainty. Wertheimer laid the groundwork on how the human visual system perceives figures and patterns.

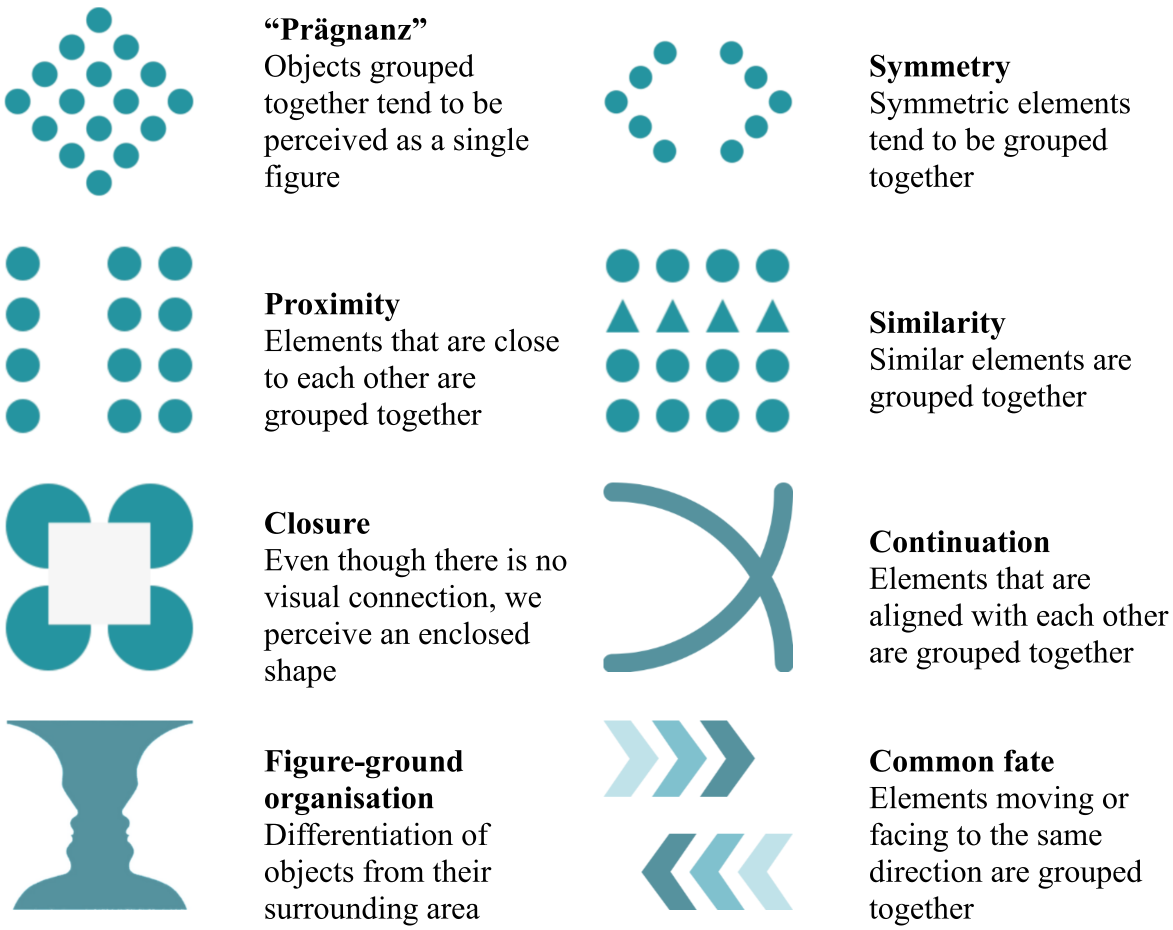


Figure 1: Illustration and brief description of the Gestalt principles (Created by the author)

Another notable contributor of Gestalt psychology is Köhler, who extended Wertheimer's ideas not only with introducing figure-ground organisation as another principle of the good Gestalt (1929), but also with describing his learning by insight theory (1925/2018). Koffka also widened the application of the Gestalt theory by interpreting it into developmental psychology (see for a summary Ash, 1985), and by describing more perceptual principles like symmetry and common fate (Koffka, 1935). The robust effect of Gestalt principles has been consistently demonstrated throughout the development of empirical aesthetics (see for example Palmer, 1991; Marković, 2002; Arndt and Révész, 2018). For a thorough comprehensive summary of the heritage of Gestalt theory, see Wagemans and his colleague's two-part review (2012a, 2012b).

In the mid-20th century, inspired by Gestalt psychology, Rudolf Arnheim extended the Gestalt principles to visual aesthetics and artistic expression (1954). He explored how visual structures and organization contribute to aesthetic experience. He emphasized the importance of balance, symmetry, and other compositional elements in visual preference. He attributed great importance to the positioning of the figure on the background, as the two can only be perceived in relation to each other, and their relationship is fundamental to the assessment of the perceptual quality of the image. In his book "Art and Visual Perception" (1954), he describes how the background and the shapes on it interact with each other and how their positioning implies "perceptual forces." For example, a regular circle placed in the centre of a regular square background is the most visually pleasing when the geometric centres of the square and the circle coincide (see Figure 2). As the circle is slightly moved from this position, it will seem as though it has been displaced from the centre and wants to return to it, or as if it is moving away from the centre. Every composition implies such psychological forces of attraction and repulsion. Thus, the visual experience is dynamic, and the interaction of these directed forces significantly contributes to our perception. At certain points, these forces cancel each other out, the shapes stand firmly on the background, and no forces are associated with them, surrounded by calm. This is what we call a state of balance, what is the main predictor of the aesthetic experience according to this theory.

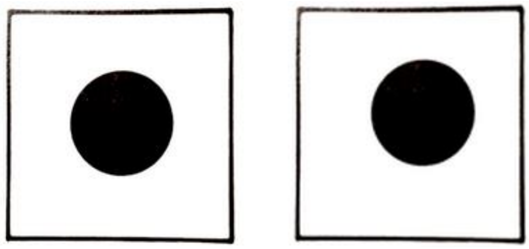


Figure 2: Examples of balanced (left) and imbalanced (right) compositions (Arnheim, 1954)

Arnheim's concept of balance inspired many researchers approaching the phenomenon from different perspectives. The research by Kovács and Julesz (1994) also supports this theory, where participants were asked to judge the "best position" of a small circle within a square frame. The highest preference score was given to the circle placed in the centre of the square, indicating a balanced composition. The results of Palmer, Gardner, and Wickens (2008) are similar: subjects preferred compositions where the figure is located in the centre of a rectangular background.

Gestalt psychology laid the foundations for approaching the aesthetic appreciation of visual features as the function of the cognitive processes of the human mind. Since then, this idea empowered various approaches, such as arousal theory, fluency theory, but it also provided the main concept behind the evolutionary explanations of the aesthetic experience. Its key concepts are still driving researchers as important guidelines in understanding the nature of perception and preferences (see a review by Wagemans et al, 2012a and 2012b on the Gestalt theory; or the thesis by Van Geert, 2023 on Prägnanz).

2.1.3. Psychobiological approach

In the second half of the 20th century, Daniel Berlyne, considered one of the founders of modern experimental aesthetics, introduced his psychobiological theory of aesthetics (Berlyne, 1971). He argued that all visual stimuli evoke a certain level of arousal (activation level) in the beholder's nervous system, which is directly related to perceived pleasantness. Specifically, he hypothesized a preference for an intermediate arousal level, achieved through the right amount of certain image features. In other words, he proposed a reversed U-shaped relationship between preference and arousal level. According to his concept, the most important features to influence arousal-activation are novelty, incongruity, and, most importantly, different types of complexity (see figure 3). Berlyne termed these features *'collative variables'*. It is important to note, that he also considered psychophysiological features (e.g. intensity) as well as 'ecological features' (e.g. meaning and associations) to play a role in preferences.

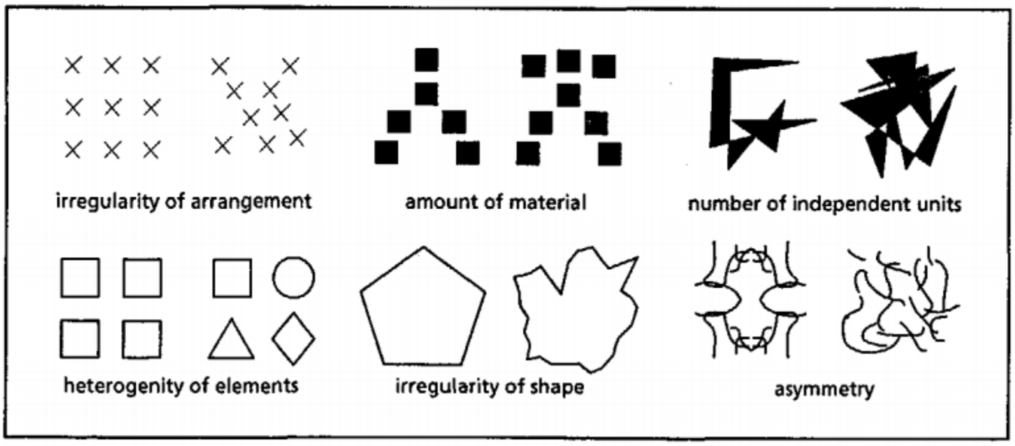


Figure 3: Different types of complexity in visual stimuli (Berlyne, 1971, p. 199)

Berlyne also introduced a motivation-theory-like approach to aesthetic experience, suggesting that this range of arousal level during perception is rewarding. According to his concept, stimuli that evoke activation above the optimal level are associated with tension, while evoking arousal below this level induces a lack of interest. To achieve the optimal range of arousal, stimuli must be complex enough to avoid boredom but not too complex to avoid confusion and overload. Thus, the arousal theory suggests that people prefer stimuli that balance familiarity and novelty, complexity and simplicity, therefore Berlyne aimed to investigate them systematically through empirical measurements. His methods included not only preference ratings and preference choices but also physiological measurements like heart rate and galvanic skin response. Although he primarily used non-art stimuli in his experiments, he extended his theories and empirical work to artworks as well.

While his theory about the optimal level of arousal could not be conclusively proven by studies, Berlyne's contributions to empirical aesthetics have had a lasting impact on the field. He successfully operationalized abstract concepts of aesthetics (e.g., complexity, novelty) into measurable variables, which he then manipulated to measure preferences and individual differences. This approach helped establish aesthetics as a legitimate field of scientific inquiry, moving beyond subjective opinion to a more systematic and testable framework (see: Bornstein, 1975).

Another psychobiological theory of preferences was described by Kreitler and Kreitler (1972). They hypothesized a direct relation between arousal level and aesthetic preference but proposed a different relationship than Berlyne. They considered arousal reduction to an optimal level rewarding and comforting, making it a key determinant of preferences. Thus, they viewed art appreciation and aesthetic experiences as tools to regulate one’s arousal level. To support their theory, they assessed people’s preferences using subjective ratings and physiological measurements and manipulated objective stimuli features like complexity and familiarity, which were considered to influence the evoked arousal level. Thanks to their extensive empirical work, they significantly contributed to the development of empirical aesthetics, not only with a remarkable theory of preferences but also with a robust set of measurements based on operationalized methods.

2.1.4. The Martindale model

In the 1980s, the tools and concepts of cognitive psychology provided a new approach to the experimental study of aesthetics, focusing on the human mind's information-processing nature. Preferences and perception itself became a function of these processes. Therefore, the psychobiological theories of arousal-optimalisation and arousal-reduction gave the way to the emerging cognitive processing models.

A notable contributor of empirical aesthetics through cognitive hedonics who integrated theories and methods of psychology, neuroscience, and evolutionary biology and applied them to the aesthetic experience and artistic creativity was Colin Martindale. Although his theories are not specific for visual preferences, his processing-based approach inspired novel ideas of aesthetic processing, as well as some of the present thesis' research questions. His aim was to find the ultimative reasons behind the preferences. As such, he looked at aesthetics and art from an evolutionary perspective, seeking to understand why the human mind is sensitive for specific features or styles. His findings suggested that certain aesthetic preferences are hardwired into the brain, shaped by millions of years of evolution (Martindale and Moore, 1988). His work aligns to some level with Berlyne's by providing evidence on the preference for intermediate complexity, as well as on the importance of balancing novelty and familiarity in art appreciation. However, he also refutes Berlyne's concepts (see Martindale, Moore and Borkum, 1990). While Berlyne considered the collative variables (e.g. complexity, novelty) as most important in preferences, in Martindale's concept the most dominant feature in preferences is meaning (which Berlyne included in his ecological features). In his structural-cognitive theory Martindale suggests that semantic processing as a higher-order process overwrites the effects of objective image-features in the aesthetic experience. As such, the key to preferences must be in the semantic processing instead of the sensory-perceptual impressions.

Based on this idea, he described a semantic mental network (1991), in which the activity of the elements defines the preferences. As such, he hypothesized that the more a stimulus activates a semantic concept or its associations in the network, the higher the preference. According to his theory, the network is structured based on similarities. The most representative element of a semantic category is called the (hypothetical) prototype, which can also be considered as a central point in the network. In relation to the prototype, the more typical elements are closer, while the less typical concepts are more distant in the network. Furthermore, the activation threshold decreases with typicality, which means, that the more typical the element, the easier it is to activate. When a stimulus is presented, the semantic processing should analyse its meaning and activate the corresponding elements of the cognitive network. Therefore, the more typical a stimulus, the higher the network activation, and the higher the preference. He tested this idea mostly using semantic categories and colours, but he also intended to extend its validity to artworks. Based on this theory, his cognitive network model is also known as Martindale's prototype preference model (see Farkas, 2003).

Martindale also intended to prove the direct relation between meaning and preferences and found that meaning is more dominant over complexity in the appreciation of artworks (Martindale, Moore and Borkum, 1990) and melodies (Martindale and Moore, 1989). Later, Farkas (1997) criticized and refuted this idea based on his cross-cultural comprehensive findings. He nuanced the influence of meaning by manipulating stimuli features like the positive or negative valence of the meaning (Martindale and coworkers only used positive valence meaningful stimuli). His work was also strictly criticised by Boselie (see for example Boselie, 1991).

Though there has been an intense and highly interesting scientific debate on the validity of Martindale's cognitive model (see a detailed summary in Farkas, 2003), which seems to have come to an end with the disproval of the model, it still is considered as a remarkable milestone in the history of empirical aesthetics. Martindale contributed to a more comprehensive understanding of how and why certain visual stimuli are preferred, emphasizing the importance of cognitive processes in aesthetic appreciation. His work demonstrates that the principles of cognitive psychology can provide valuable insights into the field of empirical aesthetics. As such, it inspired several information-processing based preference theories.

2.1.5. The processing fluency theory

Martindale's idea of the direct relationship between typicality and preference can be compared to the mere exposure effect described by Zajonc (1968), referring to the direct relation between the time of exposure and the preference, as well as to Mandler's work on familiarity's influence on aesthetic preference (1982). He suggested that we process all stimuli we meet according to our pre-existing mental schemas. A stimulus that is easy to identify with a schema (e.g. is already familiar) evokes positive affective response, whereas a less typical, less familiar stimulus is harder to assimilate into a schema, therefore its processing needs more cognitive effort. However, a less familiar stimulus can also evoke positive preference, if the effort that we put in the processing leads to a successful understanding. Mandler's theory has also been applied to aesthetic preferences by Lasher, Carroll and Bever (1983) known as the conflict integration model. Mandler's idea of the ease of processing determining the hedonic value aligns with Simon's concept of cognitive economy (1979) and the processing fluency principle (Schwarz et al., 1991).

The principle of cognitive economy describes that the human mind has limited cognitive capacity, therefore it aims to process information with as little invested effort as possible, with the most effective outcome. This involves simplifying complex problems and using heuristics or mental shortcuts (Simon, 1979). Thus, stimuli that is easy to process (both sensory and semantically) are optimal for our perceptual systems. Aligning with this, the processing fluency principle (Schwarz et al., 1991) suggests that the ease (or fluency) of the cognitive processing is associated with positive affective states. The more fluent the processing, the higher the hedonic value.

Based on these ideas, Reber, Schwarz and Winkielman (2004) developed the perceptual fluency theory of aesthetic preference. They applied the principle of processing fluency on perceptual preferences, suggesting that stimuli that is easier to process are appearing aesthetically more pleasing to us. They defined easy stimulus processing by objective features like the high speed and accuracy (Reber, Wurtz, & Zimmermann, 2004). They also described various stimulus features that contribute to the easy processing, like symmetry, familiarity, prototypicality or figure-ground organisation providing a wide range of empirical findings supporting their role (Reber et al., 2004a). Symmetry mathematically refers to a repeating pattern of information (Armstrong, 1988), most commonly in a bilateral/mirrored or rotational organisation. As such, the total amount of information to process is less compared to asymmetric stimuli. As prototypicality is associated with more typical, therefore more familiar stimuli, it evokes fluent processing by the easy accessibility of the information to process. While primarily focused on visual aesthetics, the principles of processing fluency can be applied to other sensory modalities and cognitive processes, such as music, language, and decision-making.

The processing fluency theory of aesthetics explains why we find some things more beautiful than others, highlighting how easily we can process them. Reber, Schwarz, and Winkielman (2004) showed that when something is easy to understand or perceive, it tends to be more pleasing to us. Their work has made a big impact on the study of aesthetics by providing a clear and testable way to measure what makes something aesthetically pleasing.

More recently, the processing fluency theory has been extended by integrating the insights from predictive processing frameworks and the epistemic motivation model (Yoo, Jasko and Winkielman, 2023). This comprehensive approach suggests that the congruency or incongruency of the perceivers' predictions and expectations influence the fluency of processing. Furthermore, the directional and indirectional epistemic goals – such as preferring specific conclusions or valuing disluency in a specific situation – also play a role in the ease of processing.

2.1.6. Emotional responses in the aesthetic experience

Feeling pleased or rewarded are clearly closely related to emotional responses. For a long time, the philosophical and experimental approaches of the aesthetic experience and art appreciation did not meet. Kant (1790 in Burnham, 2000) described art appreciation as a pleasure without interest. As such, he laid the foundations for a connection between aesthetics and emotions. John Dewey (1934/2005) described art appreciation as a complex experience, which has a primarily emotional nature, therefore considering the emotional involvement of the observer is essential in order to understand the process.

On the other hand, experimental approaches focused on the measurable variables, aiming to quantify preference based on subjective ratings and choices, but beyond that, could not assess the emotional components of the experience. With the psychobiological approaches, researchers like Berlyne tried to link physiological responses to the aesthetic response (see for example Berlyne et al, 1963), based on the idea that arousal level has an emotional effect. This was a step towards merging emotional factors into the theoretical concepts and methods.

Significant researchers to widen the perspective of empirical aesthetics with the detailed assessment of aesthetic emotions are Smith and Ellsworth. Their main inspiration is the idea, that pleasantness and arousal do not fully cover the emotional factor of aesthetic experiences (Smith and Ellsworth, 1985). They suggest that the aesthetic experience inevitably consists of a much more complex emotional response. Their aim was to identify the various emotions that contribute to it, as well as to understand how they appear in art appreciation. Another remarkable researcher to contribute to this approach is Silvia, who aimed to map not only the components of interest and different emotions in the aesthetic experience, but also the interplay between the result of the cognitive aesthetic processing (e.g. interpretation and judgement) and the elicited emotional response (Silvia, 2005). A variety of methods has been applied to assess these wide range of aesthetic emotions including self-reporting tasks, experimental manipulations and physiological measures (Silvia, 2006). In his studies, Silvia also intended to relate personality traits to aesthetic experiences, explaining individual differences. A notable methodological milestone on this field is the AesthEmos questionnaire developed by Schindler and his colleagues (2017), which aims to provide a comparable, reliable, multidimensional assessment tool on various aesthetic emotions, that can be applied on many forms and modalities of the aesthetic experiences.

These contributions were essential for the further development of empirical aesthetics by widening the range of testable phenomena with the complex emotions related to the experience. This led to a more comprehensive approach of the phenomena, therefore to theoretical and methodological improvements in the discipline.

2.1.7. A comprehensive approach of the aesthetic experience: The Leder model

in the early 2000s, as a response to the increasing number of factors considered as influencing in the aesthetic processing (e.g. sensory features, cognitive processes, emotions, interest, environmental and contextual factors), Leder, Belke, Oeberst and Augustin (2004) developed and published a comprehensive model of the aesthetic experience, more specifically they focused on the perception of artworks (see Figure 4). They aimed to systematically structure the cognitive processes contributing to the aesthetic experience into a multilevel model, that incorporates all features that influence not only the aesthetic preferences but also the aesthetic emotions. Therefore, they included all kind of components that have previously been proven to play a role in the experience by reviewing the history and the current concepts of empirical aesthetics. The development of the Leder model involved the review of a wide range of empirical studies, as well as thorough empirical testing. By now, it is supported by numerous empirical studies. However, as all scientific concepts, it also has been a target of critique, which give opportunity for continuous improvement.

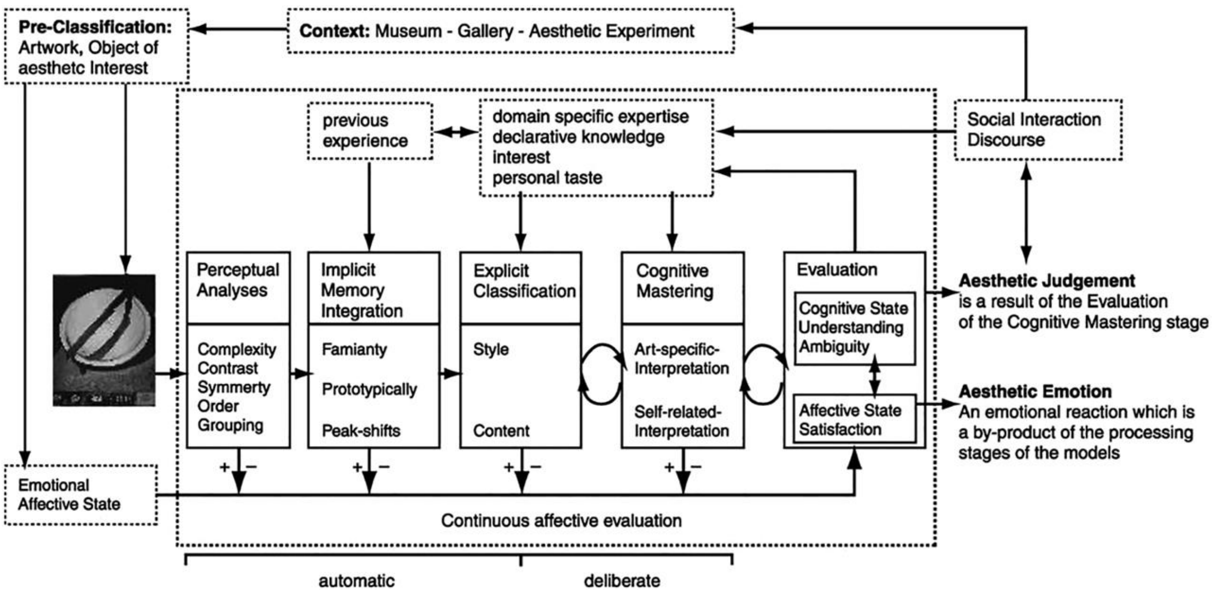


Figure 4: The model of aesthetic experience (Leder et al., 2004, p. 492)

The model does not only cover the stages of the cognitive processing, but also the interpersonal and intrapersonal factors, as well as the complex interplay between the various components. As such, they do not refer to their model as the model of aesthetic preferences or judgements. The fact that we use the term ‘aesthetic experience’ widens the range of the input, processes and their output.

According to the Leder model, the starting point of the aesthetic experience is not solely the stimulus itself, but contextual and intrapersonal conditions, such as the perceiver's current emotional state and the pre-classification of the stimuli. While the former factor is quite self-explanatory, the latter refers to the interpretation of the perceptual situation itself, including the perceiver's knowledge or beliefs about the stimuli (e.g. wether it is an artwork or not) and the conscientiousness of the experience (e.g. whether it is motivated behaviour driven by interest or not). Furthermore, the current emotional state and the pre-classification is influenced by contextual and environmental factors. For example, one can either encounter stimuli that evokes aesthetic response intentionally (e.g. going to a museum to appreciate artworks or plating the dinner beautifully to make it more desirable for our guests) or unintentionally (e.g. finding a beautiful lake during an excursion). The different conditions will influence the aesthetic experience.

When presenting the stimuli, which is the sensory input of the experience, the first step of the hierarchic cognitive processing begins, which is perceptual analysis. It covers the perception of the stimulus features, including their effect on the figural organisation, attention and preference. Thus, this is a bottom-up process driven by the physical properties of the stimulus, which happens quickly and automatically. These stimulus properties can be symmetry, balance, curvature, stability, complexity, closure, order etc. (see for a summary Palmer et al., 2013).

The next step of the Leder model (2004) is implicit memory integration, which is also an automatic process of perception. As recognition is the main function of the human visual system (see Goldstein, 1989), the continuous testing whether the new stimulus matches with the existing perceptual and semantic categories is an essential stage. As this process involves the perceiver's existing schemas and categories, previous experiences highly influence it. Related to this implicit classification, this is the stage where the effect of familiarity, prototypicality and peak-shift[1] can occur. The output of this stage also contains associations and memories evoked by the stimulus.

The next stage is explicit classification, which refers to a conscientious evaluation of style and content. Style refers to the unique (artistic) style, in which the information is presented, while content is the information itself. The output of this stage is usually a verbalizable impression of the stimulus. According to the hierarchy of the stages, Leder and his colleagues emphasize that these features (particularly style) are higher order compared to the sensory properties and implicit categorisation outputs. Although it is important to note that when describing the model, they mainly focused on art appreciation.

In a continuous interplay with explicit classification, cognitive mastering is the next step in the process, which refers to the comprehensive interpretation of the perceived stimulus. It does not only widen the recognition, but also refers to decoding the layers of symbolic associations and meanings. As the latter two stages contain explicit evaluation, it is sensitive to top-down influences originating from the cognitive constellations of the beholder, such as domain specific expertise, personal interest and taste. This factor is also included in the Leder model, being in interaction with our previous experiences.

The last step is the cognitive-affective evaluation itself, which involving the evoked cognitive and affective state results in an aesthetic judgement and aesthetic emotion, the phenomenological components of the experience. The cognitive state includes the successfulness of the mastering, or with other words, the level of understanding. The less ambiguous the stimulus, the easier to reach a deeper understanding. The higher the level of

[1] The peak-shift effect, described by Hanson (1959) is the phenomenon occurring when participants (or in Hanson's original study pidgeons) are taught to give positive and negative responses to specific stimuli, but then when presenting them wider variations of the stimuli, they peak of the most positive responses will not be at the positively conditioned variation, but slightly shifted away so that it differs even more from the negatively conditioned variation. With other words, it describes how discrimination training can lead to a preference for stimuli that are exaggerated versions of the rewarded stimulus.

understanding, the more positive the cognitive state. The affective state occurs as a result of the continuous affective evaluation influenced by the processing stages. It can be described as a feel of satisfaction, which by the end of the evaluation contributes to a feel of pleasantness. Leder and his colleagues describe the emotional evaluation and the aesthetic emotion itself as byproducts of the cognitive processing. Despite this, they still consider it an essential part of the overall experience.

According to the model, the experience does not 'stop' after the two (cognitive and emotional) outputs occur. Instead, the aesthetic judgement and the experienced emotions provide contextual feedback through social interaction and discourse.

The Leder model of the aesthetic experience is a significant milestone in the field of empirical aesthetics, providing a detailed multidimensional framework for understanding the cognitive and affective processes as well as the contextual and intrapersonal factors involved in aesthetic experiences. It has provided a valuable basis for empirical research (see the authors' revision of their model after 10 years in Leder and Nadal, 2014) and has advanced our understanding of how people perceive, interpret, and evaluate artworks and aesthetic objects. By its multifactorial nature, the model also helped in creating of the stimulus in the present thesis' second study, so that it only measures the target variables.

While the model emphasizes cognitive processes, it has been critiqued for not fully accounting for the role of emotions in art perception. Firstly, it underemphasizes the emotional impact, therefore, overlooks the significant role emotions play in aesthetic experiences (Leder and Nadal, 2014). Secondly, according to the model, emotions are often considered outcomes of cognitive processing rather than integral components of the aesthetic experience (Leder et al., 2012). Instead, Moslemi (2018) suggests that emotions are active and central throughout the engagement with art. Its further critiques mainly address the lack of correspondence between the conceptually described cognitive-emotional processes and the neuroscientific findings. To bridge the gap, Chatterjee and Vartanian (2014) suggested a new framework, 'the aesthetic triad' that aligns with the revealed brain activity during aesthetic experiences. According to their theory, the aesthetic experiences emerges as the result of the interplay between three fundamental neural systems, namely the sensory-motor, emotion-valuation, and knowledge-meaning (or semantics-meaning) systems, with the latter being the most dominant among them (Chatterjee and Vartanian, 2021).

2.1.8. On the way to the new psychological aesthetics

Twenty years have passed since the publication of the Leder model by now, in which it has been a fruitful anchor in empirical aesthetic studies. However, in the near past, some remarkable criticism came to light, fuelling highly interesting scientific discourse. On the XXVIII Congress of the International Association of Empirical Aesthetics in Palma, 2024, I had the opportunity to attend at a symposium titled '*The place of aesthetic experience in psychological aesthetics and neuroaesthetics*' with the talks of Marcos Nadal, Martin Skov, Anjan Chatterjee and Helmut Leder. During the session, Skov and Nadal presented their critique on the model of aesthetic experience as well as their new approach to psychological aesthetics. On the other hand, Chatterjee and Leder also presented their arguments and considerations about the new approach.

The four above mentioned researchers added remarkable contributions to the discipline of neuroaesthetics, which applies the concepts and methodology of neuroscience on the domains of empirical aesthetics. They even co-authored (among others) comprehensive studies about the key concepts and questions of neuroaesthetics (see for instance Pearce et al., 2016). This interdisciplinary field emerged with the accessibility of neuroscientific methods (first of all EEG, ERP and fMRI) in the early 2000s (see Nadal et al., 2008; Skov et al, 2009;). Initially, it has been defined as the approach to understand 'the biological bases of aesthetic experiences' (Chatterjee & Vartanian, 2014, p. 370). However, Skov and Nadal recently suggested that the traditional concept of 'aesthetic experience' itself is a controversial and severely underdefined concept, therefore should not be considered as the key concept in the research of the psychology of aesthetics anymore.

The lack of consensus about the definition of the aesthetic experience has already been addressed in the literature. It has also been stated to be 'one of the most poorly defined concepts in psychology and neuroscience' (Brattico, Bogert & Jacobsen, 2013, p. 1). Therefore, it is a particularly challenging task to reliably compare it to other experiences in order to define its unique psychological and neurological features compared to other types of experiences. Therefore, Nadal and Skov suggests discarding the traditional, philosophically rooted concept of the aesthetic experience and shift the focus to a new, evidence-based approach (Nadal, 2024). According to Skov, this new theory of aesthetic experience 'views aesthetic evaluations as computational events involving the application of affective tags of pleasure and displeasure to sensory representations in a way that is substantially influenced by contextual and personal factors such as prior experience, knowledge, expectations, predictions, and task conditions' (Skov, 2024, p. 16).

One aspect of convergence in the research of the arts and aesthetics seems to come from the cognitive science, namely the Predictive Processing (PP) framework. Frascaroli, Leder, Brattico and Van de Cruys (Royal Society, 2024) recently published the edited theme issue *'Art, aesthetics and predictive processing: theoretical and empirical perspectives'* in the journal '*Philosophical Transactions B'* about the application of PP in the study of aesthetics. The articles of the issue introduce the idea of active inferences in the processing as well as their role in the aesthetic experience. They argue that artworks intentionally play with our mind's predictions, therefore they are more engaging and exciting (Frascaroli et al., 2024). Also, the authors consider the process of beholding art as an *'epistemic arc'* driven by curiosity, evoking epistemic action (trying to make sense of the perception) and followed by the '*aha-experience*', a.k.a. the moment of insight, which makes an artwork meaningful (Van de Cruys et al., 2024).

In the past 150 years of empirical aesthetics, various theories and approaches emerged, have been reshaped and surpassed, but the valuable and rich history of this discipline still inspires researchers, providing recurring key concepts in the focus of their interest. The continuous development of the ideas and methods contribute to a more and more nuanced, comprehensive understanding of the psychology of the aesthetic preferences.

3. Identifying the key features determining preferences

Even though there have been numerous conceptual and methodological shifts in the history of empirical aesthetics, there have always been some key concepts in the spotlight of the interest. Among those, the most important and relevant for this thesis are the research of visual stimulus features, meaning and categorisation, as well as the effect of expertise.

3.1. Stimulus features

The first contributions of empirical aesthetics – and to experimental psychology itself – were based on the preference of stimulus features like symmetry or the golden ratio (Fechner, 1871). The reason behind this is that, among the factors influencing preference, objective stimulus properties were the most evident to methodologically control, manipulate, and correlate with preference judgments. Thus, as the earliest accessible variables, their research has a long history with a robust amount of empirical literature. Throughout the various conceptual approaches regarding the aesthetic experience, stimulus features have been categorized in numerous systems, as well as their preference has been aimed to explained by different theories.

Researchers have long been looking for the ultimate objective properties of the 'good form'. As the 'goodness' of the form is not as easily operationalized as for example its colour or brightness, studies applied various methods using a wide range of visual stimuli to investigate it. Moreover, the objective properties are hardly objective in definition across the different approaches. The diverse terminology alongside with the use of multidimensional features, like complexity makes the task even more complex:

The Gestalt principles of *figural goodness* highlighted the importance of symmetry, closure, continuation, proximity, similarity and figure-ground organisation. These features have ever since been considered and found to be (more or less) aesthetically pleasing (see a review by Wagemans et al, 2012a and 2012b). Berlyne's (1971) psychobiological approach emphasized the importance of *collative variables* like complexity and novelty. His explanation behind the preference was based on the evoked optimal arousal level, which he related to an intermediate level of these key features. Among these variables, he determined complexity as a multidimensional stimulus property (see figure XX). Thus, it refers to various stimulus features, such as the number of units, the regularity of arrangement, the amount of material, the heterogeneity of the elements, the regularity of shape and symmetry. The complex interplay of these determines the perceived level of overall complexity. Similarly, Birkhoff (1933) and Eysenck (1941) also considered *complexity and order* as multidimensional features, as well as both included for instance the dimension of symmetry – asymmetry as a main contributor to them, thus, a dominant determinant of preference. Garner (1974) explained the preference of stimulus features by the *amount of information* they contain. He suggested that stimuli that contains less, more structured or redundant information is easier to process. Therefore, isometric transformations like different types of symmetries are preferred. His theory aligns with the fluency theory of perception (Reber et al., 2004a), which considers the ease of processing as the explanation of preferences. Van Geert and

Wagemans (2020) also define stimulus complexity as ‘the quantity and variety of information in a stimulus’ (p. 3). In their comprehensive review on the role of complexity and order in aesthetic preferences they point out the lack of consistency regarding the measures of complexity and order in the empirical literature. For instance, the importance of symmetry has been present in the different approaches, but in some studies, it appears as a dimension of complexity (see for instance Nadal et al., 2010), whereas in others it is listed among the factors of order (see for example Van Geert and Wagemans, 2020). As we can see, there is hardly any consistency in the grouping and weighting of the measured stimulus features.

3.1.1. Complexity, integrity and symmetry

Marković (2002) suggests a reduction of the assessed stimulus features according to the conceptual overlaps. Thus, he describes uniformity/complexity, compactness/integrity and symmetry as the main models of the objective constrains of figural goodness. Uniformity/complexity (aligning with the Geatalt law of similarity) refers to the number of different elements in a pattern, thus the informational complexity of visual stimuli (see Leeuwenberg, 1971). Being a key concept in experimental aesthetics, complexity has long been associated with visual preferences. However, due to its multidimensional nature and inconsistent terminology it is difficult to find any consensus in the literature about *how* it modulates preferences. More recently Van Geert, Bossens and Wagemans (2022) published a systematic assessment tool, the OCTA (Order and Complexity Toolbox for Aesthetics) to deepen our understanding on the role of order and complexity in aesthetic preferences, as well as to improve the conceptual and methodological issues of this topic. Compactness or integrity is associated with the Gestalt laws of proximity and continuation and refers to the degree of the random figure dispersion (Attneave & Arnoult, 1956). It is a measure of the spatial cohesiveness of a pattern, the integration of a pattern into a coherent form. Therefore, as a cue to easy perceptual organisation, the higher level of integrity is associated with a higher level of preference. Marković (2002) lists symmetry as the third objective measure of visual preferences and identifies it as the strongest predictor of the aesthetic preference. According to Garner's model of figural goodness (Garner and Clement, 1966) a symmetric form is perceptually better due to its redundant information content and fluent processing. According to this conceptual approach, we aim to measure complexity, integrity and symmetry to assess the role of stimulus features in the visual preferences.

3.1.2. Stability

Stability, which refers to the position and the direction of a figure and is believed to play an important role in our preferences. Révész and Séra (2008) addressed this feature's preference in their study using an adjustment task and found that a stable picture is perceived as more beautiful compared to an instable one, even if the shape itself is just the same. The explanation of this preference is thought to be the compliance of the seen visual stimuli to our fundamental everyday experience, the gravity (Palmer et al. 2013).

3.1.3. Balance

According to Arnheim (1954), the above-mentioned stimulus features are subordinated to balance, which results of the interaction between the elements of the composition. Aligning with Arnheim, Locher (1996) suggests that balance serves to unite the structural elements of a composition into a cohesive state. Thus, in a balanced composition the pictorial elements are grouped or arranged in such a way that their perceptual forces compensate each other. This balanced state usually involves some type and some level of symmetry and is associated with aesthetic preferences.

3.2. Symmetry over all?

As we can see, symmetry has been a key concept regarding – not only visual – preferences since the dawn of empirical aesthetics. It has been considered as an essential contributor of the main concepts of preferred stimuli features, such as figural goodness, balance, complexity and order. Moreover, as we will see below, symmetry has also been considered the main principle in predicting visual preferences. To gather a deeper understanding on its preference, let us discuss its appearance first. From a mathematical point of view, there are several types of symmetries, which refer to repetitive groups of information using different isometric transformations (Armstrong, 1988). Therefore, symmetry can manifest in various forms, as illustrated on Figure 5.

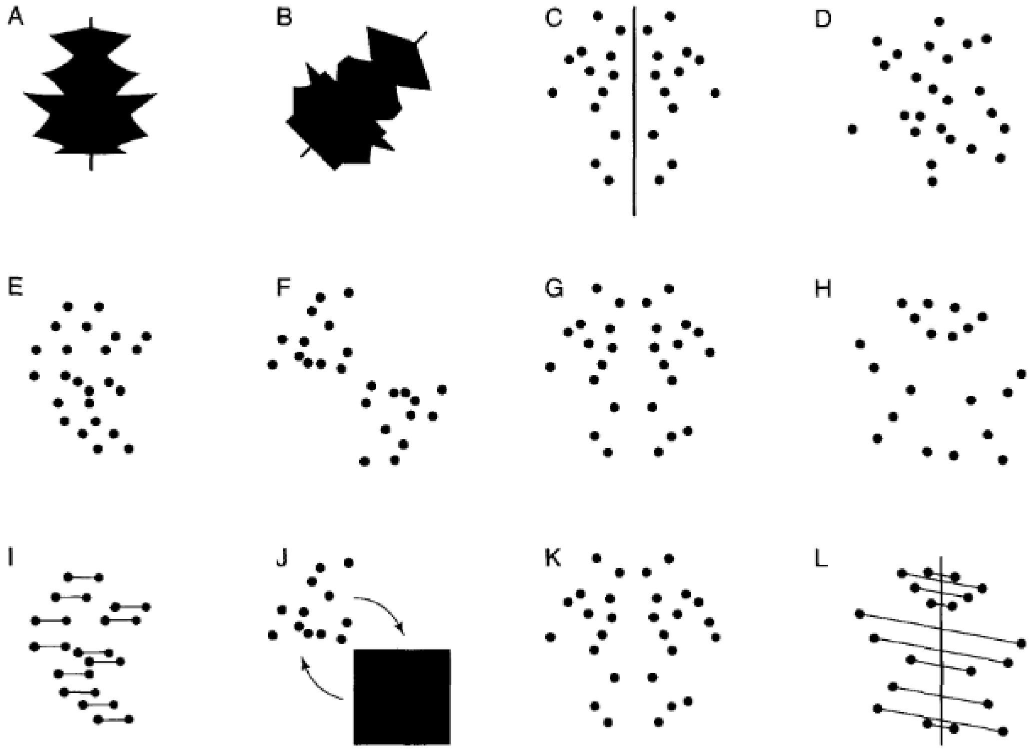


Figure 5: Examples for the different forms of symmetry (Wagemans, 1997, p. 347.) '(A) A polygon with mirror symmetry about a vertical axis (indicated by solid line). (B) A polygon with mirror symmetry about a diagonal axis (indicated by solid line). (C) A random-dot

pattern with mirror symmetry about a vertical axis (indicated by solid line), (D) A completely random dot pattern. (E) A random-dot pattern with translational symmetry. The translation vector is indicated in (I) underneath. (F) A random-dot pattern with a rotational symmetry, The 180° rotation is indicated in (J) underneath. (G) A random-dot pattern with perturbed mirror symmetry. The perturbations are indicated in (K) underneath. (H) A random-dot pattern with skewed mirror symmetry. The skewing is indicated in (L) underneath.'

However, according to the empirical findings, vertical bilateral or "mirror" symmetry has been found to be the far most salient type for the human visual system. Our brain is wired to detect mirror symmetry more rapidly and effortlessly (Julesz, 1971). According to Bertamini (2010) mirror symmetry is more salient in the perception of objects and coherent shapes compared to translational symmetry. Additionally, our brain is most sensitive to bilateral symmetry when the axis is vertical compared to other orientations (Wagemans et al., 1992; Treder, 2010). Even 4-month-old infants process vertical bilateral symmetry more efficiently than asymmetry or horizontal symmetry (Bornstein et al., 1981). Not only does vertical bilateral symmetry seem to be more easily detected, but it is also generally preferred over asymmetry or other forms of symmetry (Barlow & Reeves, 1979; Arndt & Révész, 2018).

As bilateral symmetry means the transformation (e.g. mirroring) of a pattern, it results in repetitive information. Therefore, aligning with the processing fluency theory (Reber et al., 2004), it is easier to process. The findings of Locher and Nodine (1973) also support this idea. According to their results, during the visual exploration of symmetric figures participants tend to only scan one side thoroughly, whereas in case of asymmetric figures their gaze was more distributed on both sides.

There are more explanations of the saliency of symmetry for the human visual system in the literature. There are ultimate explanations by evolutionary psychologists behind the easy and outstanding processing of this feature. Firstly, most biologically important objects, such as predators, prey or mate are symmetric stimuli. This can be an evolutionary approach in the explanation of the rapid attention catching effect of symmetry (Ramachandran, 1999). According to this theory, this reaction could be an early warning-system to facilitate further procession, until the object is fully recognized.

The theory of Dutton (2010) suggests another interesting explanation. According to Dutton, symmetry created by an individual (e.g. a symmetric human artefact) is a huge effort of the mind and the body. For creating a symmetric object (e. g. an Acheulean hand axe) one needs to find the right materials and place, have an accurate mental representation of the aimed form, have a plan of achieving that form, be able to execute the precise but definite movements and to constantly collect feedback about the difference between the achieved and the desired form. This means, that symmetric objects could be a fitness indicator of their creator, which led to a preference for symmetric objects. Evidence for this theory can be that despite the fact that hand axes were made to be used as a tool for hunting, almost perfectly symmetric Acheulean hand axes were found without any clue of usage. Dutton assumes that their creators kept them as a signal of their abilities which helped them in mating.

For instance, humans and animals both have a strong preference for symmetry over asymmetry in mate choice. We find people with more symmetrical face or body more attractive. This preference is deeply evolutionary based, as asymmetric appearance is a reliable indicator of parasitic infestation and developmental anomalies, whereas symmetric appearance indicates health and fitness (see Bereczkei, 1999). Empirical aesthetics research has also shown that despite their cultural habituation, the preference for symmetry is also present in cultures with a traditional preference for asymmetry in art and design (Leder et al, 2024).

The preference for symmetry has widely been investigated on various types of stimuli and populations. Regarding simple abstract patterns, Marković (2002) found, that among the objective features, symmetry is the most important one in the aesthetic judgement during a visual preference task. Jacobsen and Höfel (2002) also found, that symmetry is the strongest predictor of visual preferences for abstract patterns. Locher and Nodine (1989, p. 483) describe the outstanding and universal role of symmetry in the visual preferences as "the human eye-brain system seems to virtually resonate with symmetry. The rapid and accurate detection of static symmetry by the perceptual system is most likely a fundamental unlearned response. The perceptual value of symmetry was discovered by ancient artists and incorporated into the design of both their art and architecture".

3.3. Meaning and representativeness

The main function of human vision is to make us able to discover and recognize objects in our environment (Ramachandran, 1990). This has evolutionary relevance, such as finding food or water, recognizing mates and harmful objects in order to survive (Olivia and Torraba, 2006). According to our current understanding, automatic perceptual grouping helps us to identify and distinguish coherent objects even in noisy visual environments (Marr, 1981). Ramachandran and colleagues (1998) describe that object-like stimuli segments are highly salient for our visual attention and neural processing. Ramachandran and Hirstein (1999) suggest that features that carry the unique characteristics of an object (or person) have perceptual advantages due to providing relevant information for fluent and effortless recognition and are therefore preferred. Numerous empirical studies have confirmed this effect of preferring representative over non-representative stimuli (most of the studies used artworks). See for example Komar and Melamid (1999), Illés (2008a), Pihko and colleagues (2011). Illés (2008b) asked non-expert beholders to choose from a variety of artworks the ones that are most and least 'close to the self' and found that representative artworks were chosen as the closest, whereas abstract paintings as the most distant. These results emphasize the importance of representative meaning in the aesthetic experience. Similarly, Ramachandran and Hirstein (1999) also describe the positive effect of easy categorizability. They argue from an evolutionary perspective that distinguishing edible from inedible, prey from predator or harmless from harmful has been crucial in the evolution of our visual system. As we categorize objects according to differences and similarities, the - hypothetical or existing - category prototype will always carry the most unambiguous and straightforward cues of being a member of the category, therefore it will be preferred (Martindale, 1984, 1988). Research confirmed such visual preferences in various stimulus types such as furniture (Whitfield & Slatter, 1979), music (Smith & Melara, 1990), faces (Rhodes & Tremewan, 1996), paintings (Farkas, 2002), fish, birds and automobiles (Halberstadt & Rhodes, 2003). Although there are inconsistencies in the terminology, some relating concepts can be mapped according to the literature. The level of typicality refers to the closeness to the category prototype (Ceballos et al., 2019). As it correlates with the amount and/or intensity of the category specific features, it is also associated with preferences. There are also empirical findings of such typicality preferences (Ceballos et al., 2019; Suhaimi et al., 2023). Furthermore, familiarity refers to the previous experiences according to which we form our perceptual categories (the more familiar an object, the more it contributes with its features to our concept about its category) and has also been shown to be preferred very similarly to typicality (Cho et al., 2024). Therefore, typicality and familiarity are closely related to each other as well as to the concept of prototypicality and seem to be important factors in the mapping of visual preferences.

However, not all beholders prefer easily accessible and effortlessly categorizable meanings. Studies have shown that art experts enjoy when the meaning is not that obvious (Pihko et al., 2011), as well as prefer abstract over representational art (Bimler et al., 2019).

Ramachandran and Hirstein (1999, p. 16) explain this with the unique metaphoric nature of art: “The purpose of art, surely, is not merely to depict or represent reality — for that can be accomplished very easily with a camera — but to enhance, transcend, or indeed even to distort reality.” To gain a deeper understanding on how this unique artistic perspective affects the aesthetic experience, let us discuss the effects of domain-specific expertise in general as well as art expertise specifically.

3.4. The effect of expertise

According to Ericsson “when someone has gained special skills or knowledge representing mastery of a particular subject through experience and instruction, we call this person an expert” (2014, p. 508). The Leder model of aesthetic experience (Leder et al., 2004) a domain-specific knowledge can affect the aesthetic experience. This refers to the bias in visual experiences resulting from learning and practicing. Such visually led professions and tasks are for example medical imaging, driving racing cars or airplanes, playing professional soccer or chess and of course working in the field of visual arts and design. The expertise-evoked differences in the visual perception have various reasons. Firstly, experts of these fields are *highly exposed to a specific type of visual stimulation* compared to non-experts. Thus, they are more familiar with particular visual features which deviate from non-experts’ visual experiences. Secondly, they are *sensitive to specific visual cues* that are salient regarding their expertise, which means that they have been trained to recognize and react to these cues, as well as they are practicing it on an everyday basis. Thirdly, beholding visual stimuli has a *specific function* in their professions, compared to non-experts. Therefore, when presenting them domain-specific visual information, we cannot expect experts to scan and perceive it task-irrelevantly, such as non-experts. And lastly, these salient cues of these domain-specific visual stimuli in these profession-related tasks *carry a meaning or a valence*. This additional meaning is often only available for experts, which makes it also one of the indicators of the level of expertise. For instance, the classical study of Chase and Simon (1973) presented how chess masters can perfectly reproduce a real chess position with over 20 pieces, and how they are unable to do it when the pieces are random positioned. Non-experts could only recall the position of 4-6 pieces, regardless of the reality of the chess position. This illustrates how the task-relevant meaning affects the cognitive processing of a domain-relevant stimulus.

3.4.1. Art experts as a special population in empirical aesthetics

In empirical aesthetics, the group of art experts receive special attention as their training and professional work usually involves factors that affect their aesthetic experience. Kozbelt (2001, p. 705) summarizes this in his comprehensive study on the effect of art expertise on visual perception as following: "Artists spend large amounts of time engaged in drawing, painting, or manipulating other media to produce visual representations. Consequently, no one would be surprised to learn that artists can render scenes or objects better than other people. [...] Artists live in a visual world in which the visual qualities of images, objects, scenes, patterns, colours, and spatial relations play an important role. Artists routinely analyse these elements with the goal of rendering them." Research shows, that art experts indeed exhibit better performance in visual memory (Winner and Casey, 1992) and detecting visual alteration tasks (Casey et al., 1990). Ostrofsky and his colleagues (2013) describes that art training (with a special focus on observational drawing) develops perceptual advantages in object form processing. Kozbelt (2001) reports that art experts are more efficient in recognizing objects in out-of-focus photographs and in Gestalt completion tasks, show memory performance for pictures and object arrangements, report a more intense use of mental imagery during sentence understanding, and outperform at generating and transforming mental images of figures. Kozbelt and colleagues (2010) also found that art experts are better in choosing the most important information (e.g. focal points) to include in limited line tracings to make them meaningful. These findings confirm that art experts exhibit different perceptual processing when being exposed to visual stimuli, even if the stimulus is not an artwork.

This thesis aims to map the elemental effects of art expertise on visual preferences. Research so far has mainly focused on exploring the differences in the preferences for artworks among art experts and non-experts. However, as we could see above, art experts' visual processing deviates from non-experts also when being exposed to non-art stimuli. Therefore, we expect to find expertise evoked differences also in the preference for non-art stimuli. Our studies target this scarcely researched topic.

4. First study: Creating beautiful and ugly compositions

4.1. Summary of the study

Based on existing research in visual perception, certain objective features contribute to aesthetic preferences for visual stimuli, such as balance, symmetry, complexity, integrity, and stability. Additionally, previous findings suggest that meaning attribution can also influence the aesthetic experience. To test these effects, art experts (n=64) and non-experts (n=49) were asked to create two simple compositions from basic geometric elements: one beautiful and one ugly. They were also asked to assign titles to their compositions, which we categorized as either representative or abstract. By comparing the two tasks, we drew conclusions about the role of stimulus features; by comparing the two groups, we examined the effect of expertise; and by analyzing the assigned titles, we explored the role of representativeness.

Our main findings indicate that certain stimulus features clearly function as organizing principles of visual beauty. Specifically, a preference for balance and symmetry was dominant across both non-experts and experts. Stability showed a more moderate effect, and this preference even disappeared among experts. Representativeness emerged as a reliable predictor of preferences in both groups: non-experts demonstrated a stronger preference for representativeness, while experts favored more abstract compositions. These results highlight the distinctive roles of symmetry, balance, and representativeness in shaping aesthetic preferences for visual beauty and ugliness, particularly among non-experts, as well as provide a more nuanced understanding of how art expertise influences visual preferences.

4.2. Theoretical background

4.2.1. Art, aesthetics and beauty

According to Schneck (2019, Issues in aesthetics: How to judge art, para. 2), "within philosophy, aesthetics is the study of beauty." The nature of artworks traditionally includes being an aesthetic object. Nevertheless, Augustin, Wagemans and Carbon (2012, p. 187) point out that the two concepts are not always in overlap. They explain it as following: "With respect to the question what makes the mere sensory experience an aesthetic one in our current day understanding, Allesch (2006, p. 8) pointed to "… a certain striking feeling ('Betroffenheit') caused by the way in which an […] object becomes detached from an everyday context and breaks through the routine of our perceptions and actions" (transl. from German by MDA). This can undoubtedly be the case for experiences of art, but certainly also for other candidate experiences, ranging from impressions of the sublime, e.g., with natural phenomena such as sunsets, to more simple aesthetic impressions of everyday consumer products, such as telephones or tea kettles (e.g., Blijlevens et al., in press, Hekkert et al., 2003). The transferability to other domains was also pointed out by Leder et al. (2004), who defined an aesthetic experience as the entirety of cognitive and affective processes involved when examining an artwork, from mere sensory processes to aesthetic judgement and emotion." Thus, not all aesthetic experiences are related to art. On the other hand, the reception of art is not necessarily an aesthetic experience. While many artworks can be analysed and appreciated for their aesthetic qualities, such as beauty, form, and harmony, some philosophical frameworks suggest that not every artwork must be viewed primarily as an aesthetic object (see a comprehensive theoretical review by Hudson-Miles and Broadey, 2021). In a recent work (Illés and Palkó-Arndt, in press) we point out that one of the main challenges of today's empirical aesthetics is the research of contemporary art domains, such as conceptual, performative, participative or interactive artworks. According to the art theory concept of Babarczy (2023), the interpretation and examination of some artworks based on traditional aesthetic approaches is meaningless and can lead to ignoring the essential content of the work. Thus, the field of empirical aesthetics could benefit from theoretical and methodological improvements to fill these gaps.

A similar issue pointed out by Augustin and her colleagues (2012) is that both theory and research in empirical aesthetics shows a high inconsistency of terminology regarding the impressions of the aesthetic experience. Such expressions are for instance preference, beauty, pleasure, pleasingness, interest, interestingness and liking. Therefore, is difficult to interpret and compare the findings. They investigated the main vocabulary people use to describe their aesthetic impressions and found that – aligning with the results of Jacobsen and his colleagues (2004) – '*beautiful'* and '*ugly*' have the most general relevance. They also aim to develop a standardized '*language of aesthetics*' for supporting more comparable and reliable methodological approaches.

Révész, Séra and Deák (2012) point out that empirical aesthetics usually focuses on the positive aesthetic experience, with "beauty" emerging as the key concept in theory and research. Aligning with Silvia and Brown (2007) they emphasize the importance of widening the range of assessment with the negative impressions of the aesthetic experience, such as fear, anger and disgust.

Considering these concerns, we designed our first study to give an opportunity for negative impressions to emerge by using 'beautiful' and 'ugly' as the catchphrases in a composition creating task.

4.2.2. Visual preferences of art experts and non-experts

The domain specific visual stimuli for art experts are artworks. Visual artworks, such as paintings, drawings and photographs are also key stimuli in empirical aesthetics for several reasons. Firstly because – as we have seen above – they are usually considered as aesthetic objects by their nature. Therefore, they provide an obvious option for assessing the aesthetic experience. Secondly, they are easier to operationalize for measurements compared to 3-dimensional objects, multimedia stimuli or real-world scenes. This aspect also refers to the digitalizability of those 2-dimensional pictures, which makes them suitable for monitor-based data collection such as computer-based online and offline studies, desktop eye-tracking, fMRI presentation etc. Thirdly, when assessing the influence of art expertise on the aesthetic experience, researchers expect the main effects to emerge when being exposed to artworks, as the domain-specific stimuli.

Whereas other fields of expertness affect the processing of domain-specific stimuli, Kozbelt (2001) describes that the effect art expertise are much more general and apply even to nove patterns, as well as to non-art stimuli. He also supports his suggestion with various empirical results. As we aim to map the more fundamental aspects, such as preferences for stimulus features (with a primary focus on symmetry) and meaningfulness in our studies, we decided to move away from the artwork-based bias. To accurately assess the effect of the targeted features while minimizing potential confounding factors, we consistently refrained from framing the tasks in the following studies as art appreciation. However, to understand the differences in visual preferences between art experts and non-experts, we must rely on existing research that uses artworks, as it offers valuable guidelines for assessing and understanding preferences for non-art stimuli as well.

But what are the main differences between the preferences of art experts and non-experts, and what lies in their background? "Art no longer cares to serve the state and religion, it no longer wishes to illustrate the history of manners, it wants to have nothing further to do with the object, as such, and believes that it can exist, in and for itself, without *things*." This quote by Kazimir Malevich (1927/2003, p. 74) reflects to the change in the function and (self-)definition of art in the beginning of the past century, in which abstraction and the mediated feeling replaced the traditional principles of representativeness and depiction in visual arts (Gombrich, 1950/1995). As art has turned towards non-objectivity, art experts are necessarily exposed to non-representational visual stimuli. Given this familiarity and positive experiences with abstraction, we can expect them to have more positive responses to non-representational visual stimuli compared to non-experts. Malevich (1927/2003, p. 30) also writes in his essay that "the depicting of the events of daily life, […] falls to the lot of those who lack the capacity for *new* creation and are slaves to appearances." This tendency for creating something new is also a driving force in arts. Martindale (1990) described this as the pressure for novelty. According to this mindset, we can expect art experts to seek for novel patterns and meanings in their aesthetic experiences. The studies of Hekkert and Wieringen support this idea. They found that when evaluating the aesthetic quality of artworks, experts emphasized originality much more than nonexperts (1996a), while naive observers reported realism and colour to be more important to paintings (1996b).

This pressure for novelty along with the high exposure and positive experiences with various type of visual stimuli also suggests an influence of expertise on the preference for stimuli features. For instance, Weichselbaum and colleagues (2018) found that art experts tend to prefer asymmetric patterns more than non-experts. The study by Hu and colleagues (2020) as well as by Tamás and her colleagues (2022) also supported this finding. These results suggest that the role of such lower-level features in preference is overwritten by other principles in case of art experts.

It seems like the pressure for novelty, the openness for not-easily-accessible meaning, the wide range of visual experiences introduced by art training along with the professional practice of beholding, observing and creating results in a unique constellation of visual perceptual processes in art experts (Kozbelt, 2001). Notably, Illés (2008b) suggests the distinction between the expertise in art-interpretation and art-creation. She lists art historian, critics and curators in the former, while artists and designers in the latter group. This distinction would be essential in the research for gaining a deeper understanding of the effects of art expertise in visual preferences. However, - as we will see - most of the studies refer to both groups as art experts. We will discuss this conceptual and methodological issue along with the third study.

4.3. Hypotheses

According to the theoretical and empiric literature, we assume that the stimulus features will be significant principles for non-expert in the composition creating task. Namely, we hypothesize that their beautiful compositions will be more balanced (H1a), symmetric (H1b), cohesive (H1c), complex (H1d) and stable (H1e) compared to their ugly compositions. In terms of art experts, we expect expertise to overwrite the effects of these stimulus features, therefore, we hypothesize that the expert group will not show the non-expert like preferences for the above listed stimulus features (H2). Based on the assumptions regarding non-experts preference for representational stimuli, we hypothesize that non-experts will tend to depict something representative rather on their beautiful compositions than on their ugly ones (H3).

Finally, we expect that experts will rather create abstract compositions in the beautiful task than non-experts (H4).

4.4. Method

In the present study we aimed to investigate the aesthetic judgement in the field of experimental aesthetics with a composition creating task among art experts and non-experts, while focusing on the presence of the features of figural goodness and on the significance of the content: whether the created picture is depicting something or not.

4.4.1. Sample

To determine the required sample size for our study, a power analysis was performed using G*Power version 3.1.9.7 (Faul et al., 2007). As we used more statistical analyses, we relied to the one that needed the highest number of participants. Thus, with $w=0.4$, $\alpha=0.05$ and power=0.80 the minimum sample size needed for a Chi-Square test assumed a target sample size of 81 participants. Our sample consists of 114 university students from the University of Pécs and from the Hungarian University of Fine Arts (Budapest). The non-expert group consists of 49 participants, 30 females and 19 males, the mean age is 19.9 years, the standard deviation 3.42 years. There are 64 participants in the expert group, 44 of them are females, 19 males, 2 of them did not identify themselves with neither category. The mean duration of the time spent in higher education in the field of visual arts or design is 2.76 years, the standard deviation is 1.08 year.

4.4.2. Tools

We wanted to give an opportunity for participants to create something representative or abstract. Therefore, we designed our composition creating task so that the given forms can easily be composed into familiar figures, (for instance: square + triange = house, circle =

moon/sun) but at the same time, these simple geometric forms offer the possibility of endless number of abstract compositions.

Every participant got an A4 sized white paper sheet and for both tasks and three figures cut out of thick black paper. The forms were a square (4x4 cm), a triangle (h=4 cm) and a circle (d=4cm). Each of the forms were uniform and regular. For sticking the figures on the background, we needed glue. For analysing the data, we used the software IBM SPSS.

4.4.3. The task

The first step of our investigation was data collecting, in which participants in small groups and calm environment were instructed to do the two composition making tasks. Therefore, every participant got a paper sheet for background of the picture, the three forms and a tube of glue. The experiment consisted of two tasks. Firstly, participants were asked to locate the forms on the background "the way it looks beautiful". Next, they glued the figures on the paper. In the second task, participants got the same forms again and had to turn the paper sheet. Now they were instructed to locate the forms on the background "the way it looks ugly". When finished, they glued the figures of the composition. The sequence of the two tasks was randomized, so that half of the sample made the beautiful task followed by the ugly one, the other half inversely. After the two compositions were finished, participants were asked to give titles to both pictures, so that we could decide whether it is depicting something or not. Finally, participants had to write their age, gender, field of study on the paper. and to answer one additional question about expertise, so that we could filter the artist group for active, experienced students, and control group for artistically uneducated participants. The expert group got the following question: 'How long have you been studying on university level and/or working on professional level in the field of visual arts and design?'. Non-experts question was: 'Please let us know if you have any notable connection to the visual arts, art history or design (e.g. through family, hobby or studies). We filtered the control group by any mentioned close or (semi-)professional relation to visual arts or design (e.g. artist parent, university level art history studies).

The created pictures have been scored by three independent scorers (who were neither educated in the field of psychology nor in fine arts) on 5-staged Likert-items among the following stimuli features: balance, symmetry, integrity, complexity, stability. The higher the score, the more the given objective feature seems to appear on the composition. The titles of the pictures have been categorized as either abstract or representative. See examples of the created compositions in Figure 6.

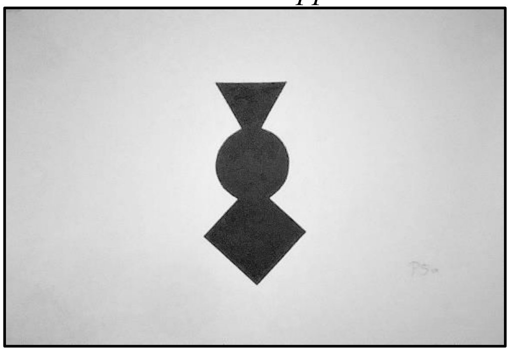
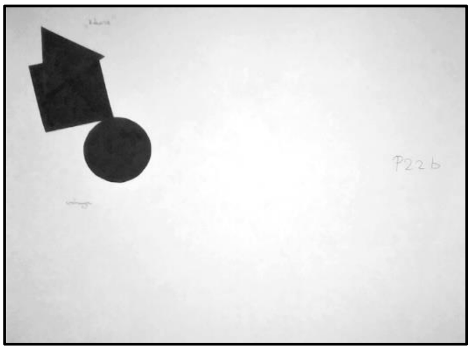
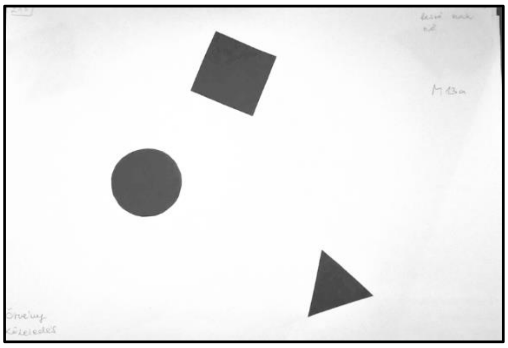
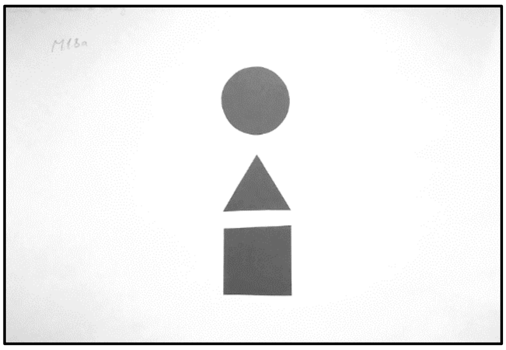
	Beautiful composition	Ugly composition
Non-expert	*'Bábu' / 'Puppet'* 	*'Káosz' / 'Chaos'* 
Expert	*'Közeledés' / 'Approach'* 	*'Minden a helyén' / 'Everything in Its Place'* 

Figure 6: Examples of the compositions of both tasks in both groups

4.5. Data analysis

Statistical analyses were performed using the JAMOVI Statistics Programme (Version 1.2.27.0 for Windows). Outliers (the number of preference choices with more than 3 SD absolute deviations from the median)– approximately 2 % of the collected data – were excluded. Firstly, we checked for interrater reliability between the three raters. As not all variables were normally distributed, we used Spearman rank-correlations to determine the agreement between the raters. According to the correlations, there are moderate to strong positive correlations in terms of each stimulus feature (balance, symmetry, integrity, complexity and stability) between each rater. See the correlation matrixes in appendix 1. After that, we calculated preference indexes (PIs) for each stimulus feature. Therefore, we calculated the means of the raters' scores for each feature in the beautiful compositions as well as in the ugly compositions and distracted the latter mean scores from the former. Thus, a positive preference index refers to the greater appearance of the feature on the beautiful compared to the ugly picture. We analysed the in-group and between group differences using these new variables: balance PI, symmetry PI, integrity PI, complexity PI, stability PI. The absolute values of Skewness and Kurtosis were below 2, thus the variables were normally distributed. See the means and standard deviations of the preference indexes in the two groups in Table 1.

	group	**Balance PI**	**Symmetry PI**	**Integrity PI**	**Complexity PI**	**Stability PI**
Mean	non-expert	0.889	0.918	-0.286	-0.551	0.563
	expert	0.923	0.897	0.0513	-0.144	0.226
Standard deviation	non-expert	1.26	1.22	1.59	1.51	1.28
	expert	1.29	1.21	1.84	1.51	1.50

Table 1: Means and standard deviations of the preference indexes in the two groups

To explore the differences between the groups we performed a repeated samples ANOVA with the preference indexes as dependent variables and the expertise groups as the between subject factor. The assumption for equal variances has been fulfilled by all dependent variables. Due to a violation of sphericity and an estimated epsilon (ε) greater than 0.75, we applied the Huynh-Feldt correction. To determine the preference for each stimulus feature, we performed one-sample t-tests to compare the preference indexes to the neutral preference index 0 in the two groups separately. In these analyses, picture pairs with 1, 2 or no title have been included. Regarding the hypotheses about meaningfulness, we assessed the titles of beautiful and ugly compositions as nominal variables (its two levels are: representative or abstract) and compared the frequencies within and between the groups using separate chi-square tests. In the analysis of the content, only the data of participants with two titled compositions were included in these, therefore 29 person were excluded due to missing titles.

4.6. Results

When comparing the two groups' the preference indexes, the main effect of stimulus features turned out to be significant ($F(3.09,428)=31.40$, $p<.001$, $\eta^2_p=0.227$) whereas neither the main effect of groups ($F(1,107)=0.243$, $p=.623$), nor the interaction between stimulus features and expertise ($F(3.09,428)=1.53$, $p=.205$) showed any significant effect. To gain a deeper understanding of the significant main effect of stimulus features (see the values visualized on Figure 7), we performed a post-hoc test using Tukey corrected pairwise comparisons. This revealed that apart from the similar preference balance and symmetry, each stimulus feature's preference differed significantly from each other.

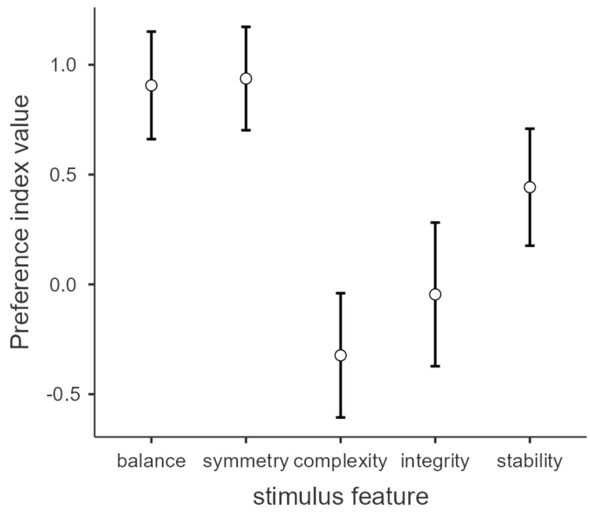


Figure 7: The PIs for the whole sample. Circles show the mean values, squares the median, vertical lines the confidence intervals.

To understand the preference for each feature, we compared each preference index to the neutral preference index value 0, and found that non-experts tended to create their beautiful compositions more balanced ($t(47)=4.88$, $p<.001$,$d=0.704$), symmetric ($t(48)=5.25$, $p<.001$, $d=0.750$), stable ($t(47)=3.06$, $p=.004$, $d=0.441$) and less complex ($t(48)=-2.56$, $p=.014$, $d=-0.366$) compared to their ugly compositions. Integrity did not show any significant effect. Notably, the effect sizes are low to moderate in case of complexity and stability and medium to large in case of balance and symmetry.

In case of experts, only two of the stimulus features seemed to play a significant role when creating the beautiful and ugly compositions, namely the beautiful compositions showed a higher level of balance ($t(60)=5.572$, $p<0.001$, $d=0.713$) and symmetry ($t(64)=5.999$, $p<.001$, $d=0.744$) with medium to large effect sizes. See the relevant preference indexes visualized for both groups on figure 8.

Non-experts Experts

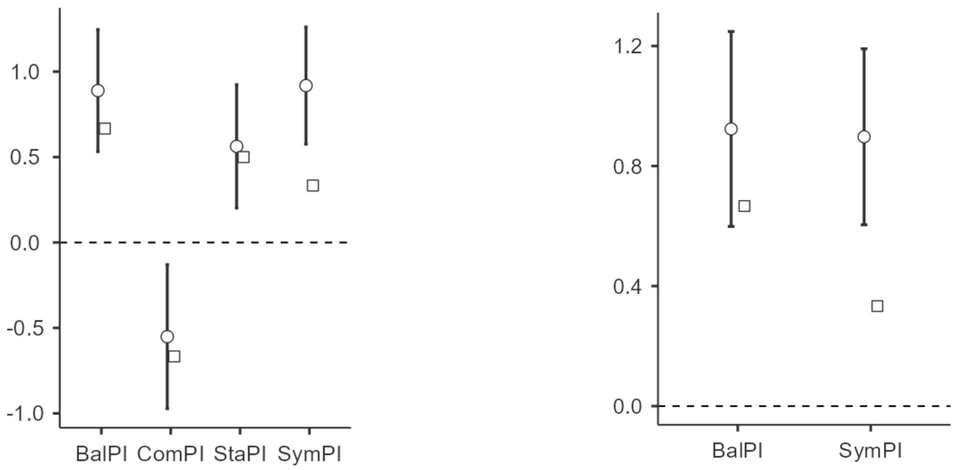


Figure 8: The visualized preference indexes of the non-expert (left) and expert (right) groups compared to the neutral preference index value 0. Circles show the means, squares the median values. The preference indexes refer to balance (BalPI), symmetry (SymPI), stability (StaPI) and complexity (ComPI).

In terms of representativeness, we compared the frequencies of title types between the beautiful and ugly compositions for each group separately. See the frequencies in Table 2.

Title category	Non-expert		Expert	
	Beautiful	Ugly	Beautiful	Ugly
Representative	29	11	12	9
Abstract	13	31	31	34

Table 2: Frequencies of the title categories among both groups. Note that the sizes of the groups changed due to excluding participants without two titled compositions, Thus, the total number of non-experts in these analyses is 42, whereas there are 43 experts.

Regarding non-experts, we found a significant difference in the frequencies ($\chi^2(1)=11.6$, $p<.001$), indicating a higher number of representative titles in their beautiful compositions, along with a higher number of abstract titles in their ugly compositions. We did not find such differences in the title frequencies between the beautiful and ugly compositions of art experts ($\chi^2(1)=0.529$, $p=.467$). When comparing the two groups among their title type frequencies, we found that the beautiful compositions tend to be more representative in the non-expert group than among experts ((χ^2 (1)=14.4, p<.001), while there was no such difference in case of ugly compositions (χ^2 (1)=0.327, p=.568).

4.7. Discussion

4.7.1. Stimulus properties: balance and symmetry as key principles

In our first two hypothesis we assumed that non-experts' beautiful compositions will be more balanced, symmetric (H1b), cohesive (H1c), complex (H1d) and stable (H1e) compared to their ugly compositions. According to our results, this expectation was met by balance (H1a), symmetry (H1b) and stability (H1e), but not by integrity (H1c) and complexity (H1d). Whereas the beautiful compositions of the non-expert group turned out to be significantly more balanced, symmetric and stabile than the ugly ones. These results align with the previous findings on non-experts' visual preferences (Marković, 2002; Palmer et al., 2013) as well as with the theoretical expectations regarding the effect of stimulus features in the aesthetic processing (Leder et al, 2004, Reber et al., 2004a; Leder et al, 2014). Among the investigated features, the effect of symmetry and balance turned out to be the most dominant when differentiating between pictorial beauty and ugliness in a production task.

Despite our expectation, we did not find such an effect in case of integrity. Thus, it turned out to be irrelevant in visual preferences in our experimental setting. However, we must note, that the effect of integrity is not necessarily invalid. Creating beautiful and ugly compositions without a significant distinction of integrity does not mean, that participants would not choose or rate higher the more cohesive alternative of a stimuli in a preference task (see for example Marković, 2002). Furthermore, the simplicity of the 3 given figures could also limit the possible rage of integrity participants applied.

Interestingly, in case of complexity we found an opposite effect. The beautiful compositions turned out to be *less* complex than the ugly ones. According to the theoretical concepts of complexity in the aesthetic experience (Berlyne, 1971; Van Geert and Wagemans, 2020), the relation between complexity and visual preference is not linear. Instead, an overly high level of complexity is considered as disturbing and overloading, whereas the too low level of complexity is associated with a lack of interest and boredom. We assumed that given the simplicity of the provided pictorial elements (white blank background, three of the simplest geometric shapes in black), the level of complexity will be limited to a low level, making it impossible to make a composition that is disturbingly complex for the eye. Thus, we awaited the optimal level of complexity to be low in the ugly, and higher (optimal) in the beautiful images. This assumption turned out to be false. According to the coding system described by Leeuwenberg (1971), the low level of complexity may be associated with increased preference due to its less informational load and therefore, easy processing. Another possible explanation of this result could be that while complexity is usually considered as a multidimensional feature including symmetry, integrity and meaningfulness/familiarity, we provided separate rating scales for these features. Therefore, the raters probably extracted these components when estimating the level of complexity, relying more on the number of distinct intersections and shape elements. Thus, complexity turned out to be conceptually different from the other measured stimulus features, therefore, hardly measurable and interpretable with our approach. The same could be true to balance, which showed highly similar results with symmetry, suggesting that it is a multidimensional feature with symmetry being the main component of it. To investigate the effect of distinct stimulus features in the aesthetic preferences, we aim to gain a higher level by control assessing ode-dimensional stimuli features in the future, to be able to draw more straightforward consequences.

In terms of art experts, we expected expertise to overwrite the effects of the measured stimulus features, therefore, we hypothesized that the expert group will not show the non-expert like preferences for the above listed stimulus features (H2). Interestingly, we did find similarities between the groups in the appearance of the measured features in the beautiful compared to the ugly compositions. Similarly to non-experts, art experts also exhibited a preference toward symmetry and balance by applying these features rather on their beautiful than on their ugly compositions. The other assessed stimulus features did not show such an effect of preferences. According to these results, symmetry and balance seem to be reliable predictors of aesthetic preferences regardless of art expertise. Just like in case of non-experts, the results of symmetry and balance are highly similar, therefore, we can assume an overlap between the two features, which also aligns with the theoretical concept od pictorial balance (Arnheim, 1954). In our future studies, we decided to only include symmetry, as it is more unambiguous to assess and interpret.

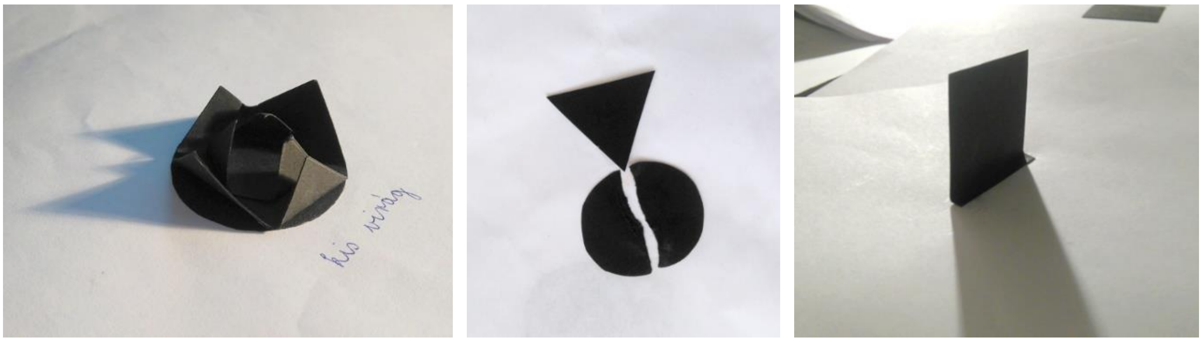
4.7.2. Meaning attribution

According to our results, our third hypothesis, assuming that non-experts will tend to depict something representative rather on their beautiful compositions than on their ugly ones (H3) has been fulfilled. We found a clear pattern in title types (representative/abstract), showing a significant bias towards representativeness in beautiful compositions. This aligns with the previous findings on non-experts' preference for representativeness and meaningfulness (Vogt and Magnussen, 2007; Illés, 2008; Pihko et al., 2011). Interestingly, we also found the complementary effect: the bias towards abstract titles in the ugly compositions. This emphasizes the clear distinctive function of representativeness between visual beauty and ugliness in the aesthetic preferences of non-experts.

Finally, we hypothesized that experts will rather create abstract compositions in the beautiful task than non-experts (H4). This expectation was fulfilled, our results clearly show that regarding their beautiful compositions, art experts tend to give abstract titles rather than representative, as well as they created significantly fewer representative compositions in this task than non-experts. These results align with the theoretical concepts of the effect of expertise on the preference of abstract stimuli (Leder et al., 2004; Illés, 2008).

4.7.3. Limitations of the production method

The methodology we used in this research comes with certain limitations. For example, the creative freedom granted in the instructions led to some compositions that are statistically uninterpretable. These works are so original and groundbreaking that attempting to score them within our variables would diminish their essence. Therefore, they are incomparable to the other compositions. Examples of these unique compositions can be seen in figure 9.



"Kis virág" / "Little flower" — "Behatolás" / "Penetration" — "Vízválasztó" / "Divider"

Figure 9: Examples of the artistic solutions

In our study we tried to get closer to the scientific explanation of the beauty of our visual environment. We have investigated on three different levels: among the objective features, the artistic/naive perspective, and the content. Our main findings are that there are stimuli features, that clearly manifest as organizing principles of visual beauty. Namely, the preference for balance and symmetry are dominant among the measured features, being present not only among non-experts, but also in the expert group. Stability showed a more moderate effect, which even disappeared in the expert group. Representativeness turned out to be a reliable predictor of preferences in both groups. Non-experts exhibited a higher preference for representativeness, whereas experts preferred abstract compositions more.

An interesting aspect of art experts' aesthetic experience could be their enjoyment of the 'epistemic arc' as well as the seeking of transformative experiences. According to the predictive processing framework, perceptions evoke active inferences in our mind (Van de Cruys et al., 2024). Art experts may not only be more motivated in the perception, but also find more enjoyment in the epistemic action itself, whereas non-experts may enjoy the moment of the aha-experience more. Furthermore, art experts may have more experiences with transformative experiences evoked by artworks. Therefore, they probably seek more meaningful creations with higher transformative power. According to Pizzolante and colleagues (2024), an experience has transformative power when it challenges prior beliefs or expectations, evokes new insight or has remarkable after-effects. As such, art experts may use more unexpected, incongruent or surprising elements.

4.8. The next step: Making the key concepts comparable

Our first study provided valuable insights into how art experts and non-experts differentiate between beautiful and ugly images. This composition-creation methodology allowed a wide range of features to emerge, helping us identify the most prominent ones. With this understanding of where the key differences lie, we can now take a step further and investigate preferences for these features in detail. Specifically, we aim to assess the interaction between preferences for symmetry and meaningfulness. While empirical aesthetics has documented preferences for these features, previous studies, as we will see below, typically rely on separate measurements using different stimuli. Uniquely, our goal was to create a stimulus set that incorporates both symmetry-asymmetry and meaningful-meaningless dimensions, allowing us to measure their interaction.

5. Second study: Comparison of preferences for symmetry, meaning, and prototypicality

5.1. Summary of the study

Empirical aesthetics focuses on understanding how perceptual features shape aesthetic preferences, with symmetry being a key aspect. However, recent studies show variation in symmetry preference across samples and stimuli. Our study aims to explore the boundaries of symmetry preference, particularly in relation to meaning, prototypicality and expertise in visual arts. With our stimuli we can test the comparative dominance of these features. In our forced-choice preference task (N=196), we manipulated images for symmetry, meaning, and prototypicality. Findings reveal that symmetry preference is only remarkable in meaningless images among non-experts. Instead, meaningfulness emerged as a significant factor influencing their aesthetic preferences. Experts show no distinct preference for symmetry or meaningfulness. However, prototypicality is favoured by both groups in meaningful stimuli, regardless of symmetry. These results highlight the dominance of meaning in aesthetic experience and underscore the complex interplay between symmetry, meaning, and art expertise.

5.2. Theoretical background

5.2.1. Limits of symmetry preference

Empirical aesthetics has long been interested in the exploration of the perceptual features that shape aesthetic preferences. Studies in this field often measure explicit preferences using artworks or visual stimuli that vary along specific perceptual dimensions, with symmetry emerging as a particularly intriguing feature (see for a summary: Wagemans, 1997; Palmer et al., 2013).

There are different explanations for the preference of symmetry. Firstly, evolutionary psychology suggests that it is associated with salient stimuli such as preys, predators and mates in the environment (Ramachandran & Hirstein, 1999). It can also signal health and fitness, as a symmetrical face and body probably implies a mutation-free physical development, therefore good genes (Miller, 2001; Rhodes, 2006, Chatterjee, 2013). Furthermore, it is associated with a skilled maker, because it needs a high cognitive effort to create a symmetric object or image (Dutton, 2009). Secondly, the preference for symmetry is also associated with effective and fluent processing in the human visual system (Reber et al, 2004a). In fact, one of the main characteristics of human symmetry detection is a biologically based preference for vertical mirror symmetry in the visual system (see Wagemans, 1997). As we aim to investigate the preference for figural images, we use of the term 'symmetry' referring to vertical mirror symmetry and 'asymmetry' indicating a lack of vertical mirror symmetry, unless otherwise stated. Although the latter terminology deviates from the literature, we chose it for better text clarity.

Thus, symmetry preference has been a fruitful topic in empirical aesthetics, considering more and more methodological and conceptual approaches (see for a summary: Treder, 2010 and Bertamini & Rampone, 2020). While symmetry has been considered a crucial predictor of aesthetic evaluation across various image types, including faces (Rhodes, 2006; Bertamini et al., 2019), patterns (Gartus & Leder, 2013, Leder et al, 2019), shapes, flowers, and landscapes (Bertamini et al., 2019), several studies have shown that the preference for symmetry might prevail differently in some cases. For instance, it is among others influenced by the stimulus type. Its role is especially important in the case of abstract images or faces (Pecchinenda et al., 2014; Bertamini & Makin, 2014). Little (2014) found a higher preference for symmetry when using faces compared to artworks. According to McManus (2005), symmetry does not always contribute to aesthetic preference, as it is sometimes considered sterile and rigid. This hard-wired preference has its limits, and researchers are now working to understand these boundaries. This is also the goal of the present study.

5.2.2. The influence of expertise on symmetry preference

There are controversial findings regarding art experts' preferences for symmetry in non-art objects. While some studies suggest a preference for asymmetric geometric images (Leder et al., 2019) and a lack of symmetry preference for abstract and face-like geometric patterns (Gartus et al., 2020), others found that art experts too have a non-expert-like implicit preference with a more moderate explicit preference for symmetry (Weichselbaum et al., 2018). Researchers suggest that art experts have a different set of preference guiding criteria during the aesthetic evaluation of an image, which can also overwrite the preference for symmetry (Leder et al. 2019). According to Reber et al. (2004a) in the case of artworks, experts are more likely to consider aesthetic value, the ideas behind the work and the norms of "good" and "bad" (aesthetic) taste. Leder et al. (2004) emphasize the artistic style as a more dominant feature. However, these factors are mostly understandable for artworks. In this study, we aim to investigate the difference in non-experts' and art experts' preference guiding criteria in the case of non-art objects.

5.2.3. Meaning and prototypicality

Meaningfulness emerges as another influential factor in aesthetic judgment. One of the main functions of perception is identification (Goldstein, 1989), and it is neurologically rewarded (Ishizu & Zeki, 2011). Evolution shaped our brain to rapidly recognize salient objects in our environment (Olivia & Torraba, 2006), which could be a reason for the preference of representational images. Therefore, representational images are usually preferred over abstract images. There is evidence in the literature on this effect in case of artworks. Most preferred paintings in general are representational images, namely landscapes with visual elements that help our survival (Komar & Melamid, 1999; Casti & Karlqvist, 2003). Non-experts prefer representational art to abstract (Illés, 2008; Pihko et al., 2011), whereas art experts prefer abstract to representational artworks (Bimler et al., 2019).

According to Leder et al. (2004), the main difference between the aesthetic processing of art experts and non-experts lies in the stage of explicit or verbalizable classification of the visual stimuli, as it relies heavily on previous experiences. Without any specific art knowledge, the output of this stage is most likely a description of what is depicted, which is much easier to verbalize in case of a representational image. Thus, we would like to test how the interaction of meaning and expertise sets boundaries to symmetry preference when being exposed to non-art stimuli.

The more familiar and unambiguous the stimuli, the easier the processing, which might also be related to visual preferences (Reber et al., 2004a; Winkielman et al., 2006). In a recent fMRI study, Cho et al. (2024) found that the typical and familiar look contributes to the product design preferences through fluent processing. The more typical an object or an image, the closer it is to the prototype, which is the best representation of a class of objects. The idea of prototypicality preference is a concept by Martindale (1984, 1988). Such preference has been found regarding colour patches (Martindale & Moore, 1988), furniture (Whitfield & Slatter, 1979), music (Smith & Melara, 1990), faces (Rhodes & Tremewan, 1996), paintings (Farkas, 2002), fish, birds and automobiles (Halberstadt & Rhodes, 2003). Typicality versus novelty or atypicality is an important concept in product design studies as well. Typicality seems to be the main predictor of preferences regarding pants and jackets (Ceballos et al., 2019). A moderate preference for typicality was recently found by Suhaimi et al. (2023) in the product design of industrial boilers, while lower typicality was found to be related to low visual appeal and low prestige. Which feature will contribute more to the meaningful non-art images' visual preference, symmetry or typicality? Our study also targets this aspect of the boundaries of symmetry preference. It is important to note, that in this study we consider prototypicality the most typical representation of a given category.

5.3. Hypotheses

According to the cognitive models of the aesthetic experience, there is a hierarchy in the processing. As such, lower-level early processing covers the perceptual features, whereas categorization and content processing are higher-order stages (Leder et al, 2004, Locher, 2014). Therefore, we assume that the effect of low-level feature symmetry will be in general less dominant compared to the higher-order effects of meaningfulness and prototypicality. Given this context, we aim to find out more about the comparative dominance of symmetry or meaningfulness in aesthetic judgment as well as the modulation of these features by expertise in visual arts. In the present study, we test these effects using non-art stimuli manipulated among the features symmetric/asymmetric, abstract/representative, and prototypical/non-prototypical. We posit the following hypotheses: H1 - Symmetry is more dominant in the preference choices of non-experts compared to experts. H2 - There is a preference for asymmetry over symmetry in simple non-art images among art experts. H3 - Higher-order feature meaning is more dominant over perceptual feature symmetry in the preference choices of non-experts. H4 - Art experts prefer meaningless images to meaningful in case of non-art images. Additionally, we seek the answer for two more research questions as well: Is symmetry or prototypicality more important in the preference of meaningful images? Is there a difference in prototypicality preference between experts and non-experts?

5.4. Method

In the present study, we aimed to investigate the aesthetic judgment with an online preference choice task executed by experts and non-experts, while focusing on the presence of symmetry, meaning and prototypicality.

5.4.1. Instrument

We constructed the preference task in Google Forms, every participant could complete the task from home. With the help of a professional graphic designer, Ferenc Forrai[2], we designed special stimuli for measuring the effect of symmetry and meaning. We define these images as non-art objects, as well as we do not define and therefore did not frame the task as art appreciation. Our stimuli originally consisted of 10 image series, each containing 4 images constructed from the same elements: one of them is meaningless and symmetric, the second one is meaningless and asymmetric, the third is meaningful and symmetric and the fourth is meaningful and asymmetric. See an example of the sets in Figure 10. In every image set, one of the two meaningful pictures is the prototypical form of the depicted object. We also intended to create one prototypical form out of the two meaningful images in all sets. In 5 sets we tried to depict a symmetric, in the other 5 an asymmetric image as a prototype. The stimuli that we used had no biological or artistic significance.

[2] https://www.forraiferenc.hu

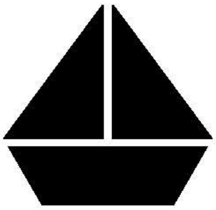
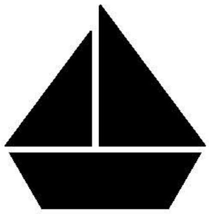
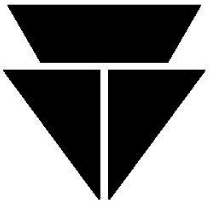
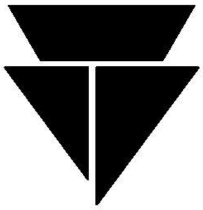
Set #2	Symmetric	Asymmetric
Meaningful	 2AA	 2AB (prototypical)
Meaningless	 2BA	 2BB

Figure 10: A set of images used in the experiment

5.4.2. Prestudy

To test which images are meaningful and which one of them is the prototypical form, we ran a prestudy with a different group of participants (N=77) with 62 females, 15 males, with a median age range at 26-35 years (see full age range in Table 3) in a Google Forms online questionnaire. It took about 10 minutes to complete. We categorized the current study's image set according to the collected answers.

Age range	Prestudy (N=77)
18-25 years	30
26-35 years	33
36-45 years	2
46-55 years	7
56-65 years	5
Over 66 years	0

Table 3: Number of participants in each age range of the prestudy

In the first part of the online pilot study, the “meaningless” pictures were shown to participants, one at a time with the instruction: “Do you recognize anything in the picture? If yes, what?” Participants could give short text answers. If an image received five or more similar answers, we excluded it from the meaningless category. Therefore, we discarded 2 from the original 10 image sets due to the lack of consensus regarding the meaningfulness of the images among the participants. In the second part of the prestudy, the meaningful images were shown. Participants had to choose between the symmetric and the asymmetric variants of the images based on non-direct questions regarding typicality, for instance: “The lady in the fruit market offers cherries from now. Which sign should she put above her desk?”, or „A lake Balaton based sailing club is looking for a new logo. Which one should they choose?”.

In 4 of the final 8 sets, the prototypical variation turned out to be the symmetric variation, in the other 4, it was the asymmetric one. Figure 11 shows the variations of one image set used in the study with the prototypes marked.

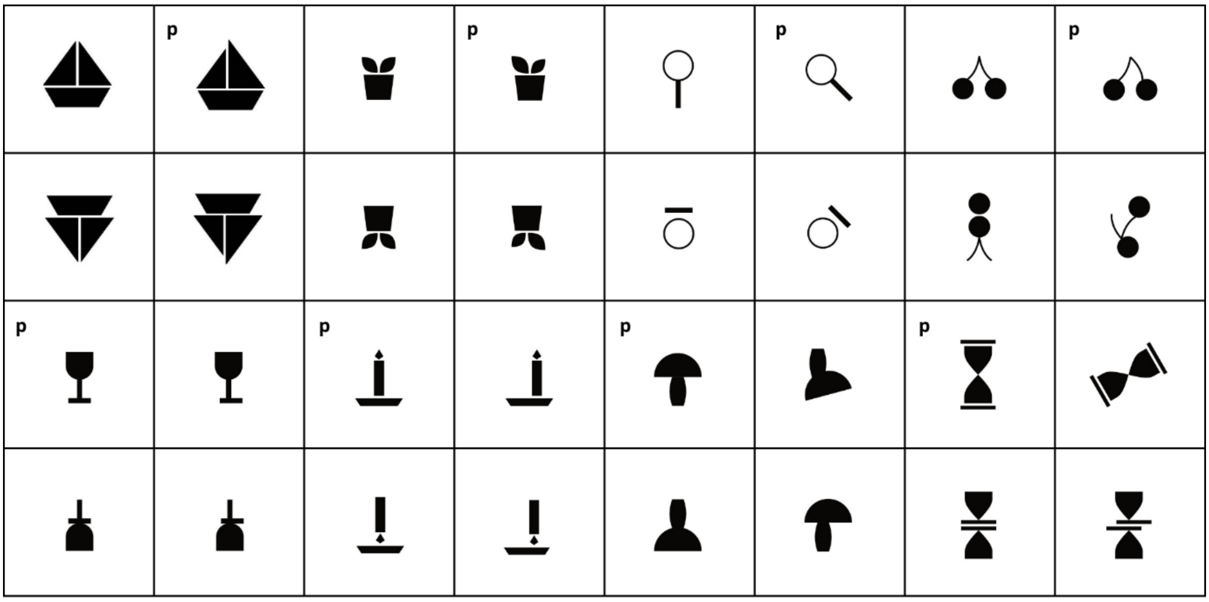


Figure 11: All stimuli set used in the experiment. The prototypes are marked with ‘p’.

5.4.3. Sample

To determine the required sample size for our study, a power analysis was performed using G*Power version 3.1.9.7 (Faul et al., 2007). As we used more statistical analyses, we relied to the one that needed the highest number of participants. Thus, with d=0.5, α=0.05 and power=0.90 the minimum sample size needed for an independent samples t-test was 70 participants in each group, which means a total target sample of 140 participants. Our sample originally consisted of 196 participants, 14 of them have been excluded due to an intermediate level of expertness, therefore not fitting the grouping criteria. There are 87 participants in the non-expert group, 68 of them are females and 19 males, the age modus of the group is between 26 and 35 years. The expert group consists of 95 qualified participants, experienced in the field of visual aesthetics and/or art history. There are 71 females, 21 males, and 3 uncategorized participants in this group, their age modus is between 26 and 35 years. For the full age range of both groups, see Table 4. The criteria for being considered an expert in the experiment were the following: a minimum of 2 years spent in university-level education in the field of visual arts, design or art history OR a minimum of 5 years spent working in the field of arts and design on a professional level. The study was approved by the Hungarian United Ethical Review Committee for Research in Psychology (reference no. 2019-110) and was carried out in line with the Declaration of Helsinki.

Age range	Non-experts (N=87)	Experts (N=95)
18-25 years	21	33
26-35 years	36	35
36-45 years	16	17
46-55 years	10	9
56-65 years	3	1
Over 66 years	1	0

Table 4: Number of participants in each age range of the 2nd study

5.4.4. Design

We constructed a forced-choice preference task consisting of 5 blocks, where participants had to choose between the images according to their preferences. Firstly, the meaningless pictures were shown next to each other, two at a time, the symmetric and asymmetric versions of the same set (Block 1). Secondly, the meaningful images were shown. Participants had to choose between the symmetric and asymmetric variations (Block 2). The symmetric pictures were shown in the third part with the meaningful and meaningless versions of the same elements (Block 3), and in the fourth part, participants saw the asymmetric pictures and they had to choose between the meaningful and the meaningless variations (Block 4). To eliminate the effect of laterality, each picture pair was shown twice in a different order. Within the blocks, the pairs were randomized. In the fifth part, a whole set was shown at a time, and participants had to choose the most preferred image out of the four variations. In total, participants viewed 160 images and made 72 choices.Additionally, participants had to answer open-ended questions about their expertise specifically regarding whether they have studied or worked in the field of visual arts or art history on a professional level, and if so, in which field and for how long. There were also questions about their age and gender. The task was assembled in Google Forms. With the instructions it took in total about 15 minutes to complete, there was not any time limit.

5.5. Data analysis

Statistical analyses were performed using the JAMOVI Statistics Programme (Version 1.2.27.0 for Windows). Outliers (the number of preference choices with more than 3 median absolute deviations from the median)– approximately 3.5 % of the collected data – were excluded. The absolute values of Skewness and Kurtosis were below 2, thus the variables were normally distributed.

First, the number of preference choices was summarized for each block, then we transformed these values into preference indexes (PIs). In Block 1, participants had to choose between meaningless symmetric and meaningless asymmetric figures, therefore we subtracted the number of meaningless asymmetric choices from the number of meaningless symmetric choices. Here, the positive preference index (PI1) indicates a preference toward meaningless *symmetric* figures. In Block 2, participants had to choose between meaningful symmetric and meaningful asymmetric figures, therefore we subtracted the number of meaningful asymmetric choices from the number of meaningful symmetric choices. Here, the positive preference index (PI2) indicates a preference toward meaningful *symmetric* figures. In Block 1 and Block 2, we manipulated the symmetry of the figures. In Block 1, all the figures were meaningful and in Block 2, all the figures were meaningless, consequently, PIs in Block 1 and Block 2 are indicators of symmetry preference. In Block 3, participants had to choose between meaningless symmetric and meaningful symmetric figures, therefore we subtracted the number of meaningless symmetric choices from the number of meaningful symmetric choices. Here, the positive preference index (PI3) indicates a preference toward *meaningful* symmetric figures. In Block 4, participants had to choose between meaningless asymmetric and meaningful asymmetric figures, therefore we subtracted the number of meaningless asymmetric choices from the number of meaningful asymmetric choices. Here, the positive preference index (PI4) indicates a preference for *meaningful* asymmetric figures. In Block 3 and Block 4, we manipulated the meaningfulness of the figures. In Block 3, all the figures were asymmetric, and in Block 4, all the figures were symmetric, consequently, PIs in Block 3 and Block 4 are indicators of meaning preference. For the means and standard deviations of the PIs, see Table 5.

	PI1 (Block 1)		PI2 (Block 2)		PI3 (Block 3)		PI4 (Block 4)	
	symmetry preference in meaningless images		symmetry preference in meaningful images		meaning preference in symmetric images		meaning preference in asymmetric images	
Group	Non-expert	Expert	Non-expert	Expert	Non-expert	Expert	Non-expert	Expert
Mean	2.11	-1.853	1.26	-0.484	8.55	.168	8.44	-.337
SD	8.95	8.11	7.17	6.68	7.22	9.07	6.73	8.57

Table 5: Means and standard deviations of the PIs (min. value: -16, max. value: 16) by groups

In Block 5, participants were exposed to four different types of stimuli at the same time (meaningful symmetric, meaningful asymmetric, meaningless symmetric, and meaningless asymmetric). Here, we summarized the preference choices of the participants for each figure type. For means and standard deviations, see Table 6.

	Meaningful symm.		Meaningful asymm.		Meaningless symm.		Meaningless asymm.	
	Non-expert	Expert	Non-expert	Expert	Non-expert	Expert	Non-expert	Expert
Mean	3.13	2.33	3.05	2.08	.988	1.86	.833	1.73
SD	1.63	1.71	1.36	1.39	1.22	1.44	.916	1.31

Table 6: Means and SDs of the number of preference choices in Block 5 by expertise groups

Regarding prototypicality, we tested the choices of Block 2, where participants had to choose between the two meaningful alternatives, and Block 5 where they had to choose the most preferred out of all the 4 variations. In Block 2 we calculated the preference index for the number of prototypical versus non-prototypical choices (PIP), where the positive value indicates a preference toward the prototypical appearance. In Block 5, we counted the overall number of prototypical preference choices.

First, we tested the differences between groups (experts and non-experts) with separate t-tests for the first four blocks. In Block 3 and 4, we accounted for Welch's correction as the assumption of equal variances was violated. As dependent variables, we used the PIs for each analysis. Furthermore, to determine whether the Preference Indexes within each group derive significantly from the neutral preference index 0, we used one-sample Wilcoxon W-tests, separately for the two groups for all PIs. We tested the blocks separately as the displayed pairs were created by different criteria for each block. To analyse the preference choices in Block 5, we used a 2x2x2 repeated measures ANOVA with two within-subject (symmetry and meaning) factors and one between-subject factor (experts and non-experts).

To test the effect of prototypicality, we compared the PIP values of the two groups using a Mann-Whitney U test, as well as to the neutral preference value "0" using a one-sample Wilcoxon W test. Since the number of prototype choices in Block 2 did not meet the assumption of normality, non-parametric tests were performed. Additionally, we used an independent samples t-test to test the difference between groups in the number of prototypical choices in Block 5. See Table 7 for the means and standard deviations of the prototype preference index (PIP) in Block 2 and the prototypical choices in block 5.

	Prototype choices in Block 2 (PIP values)		Prototype choices in Block 5 (number of choices)	
Task	Choosing one from the two meaningful images of a set, PIP values between -16 and 16		Choosing one out of four images of a set, a total of 8 choices	
Group	Non-expert	Expert	Non-expert	Expert
Mean	8.31	7.74	4.36	2.78
SD	5.00	5.87	2.15	2.03

Table 7: Means and SDs of the prototype preference index (PIP) in Block 2 and the prototypical choices in block 5

As vertical bilateral symmetry is the most salient in the preference choices, other types of symmetries appear on the 'asymmetric' images, namely on set 4's (magnifying glass) meaningful and meaningless 'asymmetric' image and set 5's (hourglass) meaningful and meaningless ‘asymmetric’ images. To test, whether these images align with the other stimuli in the ‘asymmetric’ category, we compared the number of preference choices to the other images the corresponding types. We included a detailed description of these analyses and their results in Appendix 2. According to these comparisons, the appearing symmetries in the ‘asymmetric’ labelled images, we found set 4’s ‘asymmetric’ meaningful image, set 5’s ‘asymmetric’ meaningful image as set 4’s asymmetric meaningless image being consistent with the other images of their type based on the preference choices. As in case of set 5’s meaningful ’asymmetric’ image some differences emerged, we decided to double check all the findings of the study with the preference choices of set 5 removed from the data. As the effects and differences between the groups and within the groups were consistent with the below presented, we consider our results as not affected by the mentioned alternative symmetries.

5.6. Results

Non-experts showed a higher preference for symmetry when meaningless figures were presented (Block 1) ($t(180) = -3.14$; $p = .002$; $d = -.466$), whereas there was no difference between the two groups when we presented them meaningful images (Block 2) ($t(180) = -1.70$; $p = -.090$) We also found significant differences in the preference toward meaningful images between experts and non-experts. Compared to experts, non-experts tended to show a higher preference for meaningful images both when we showed them symmetric figures (Block 3) ($t(177) = -6.92$; $p < .001$, $d = -1.022$) and when they were exposed to asymmetric figures (Block 4) ($t(176) = -7.71$; $p < .001$; $d = -1.139$). Results are reported visually in Figure 12.

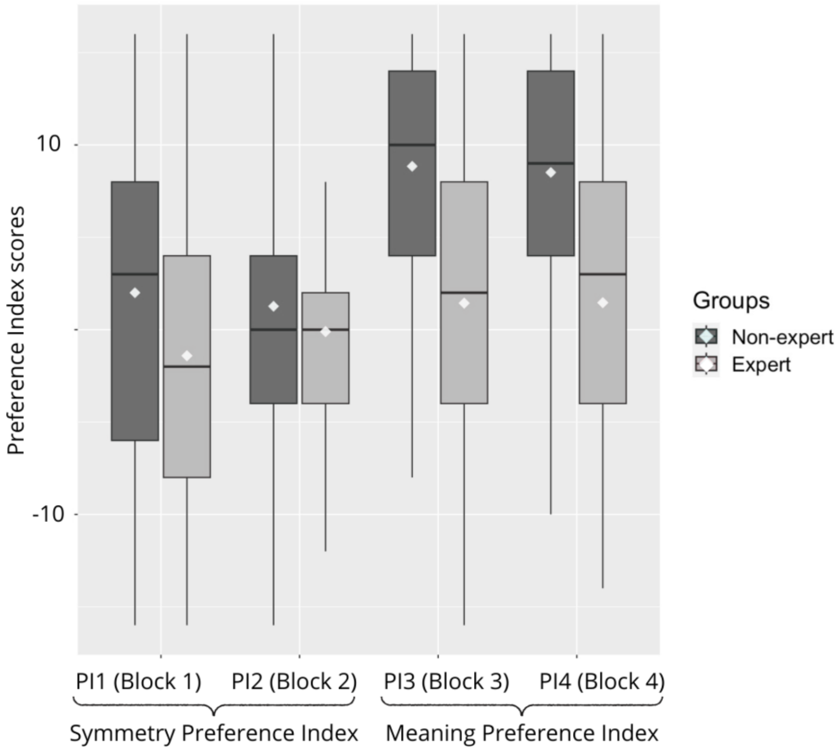


Figure 12: Preference Index scores of the two groups from blocks 1-4. Note: The distributions and means of preference index scores for Blocks 1-4, separately for the art expert and non-expert group. White diamonds show the mean scores, vertical lines represent the actual score range of participants.

Regarding the Preference Indexes of non-experts, we can conclude that there are significant differences in all PIs compared to the neutral preference index value 0. (PI1: Wilcoxon $W(83)=1902$, $p=.008$, $r=.334$; PI2: Wilcoxon $W(83)=1466$, $p=.020$, $r=.326$; PI3: Wilcoxon $W(83)=3187$, $p<.001$, $r=.919$; PI4: Wilcoxon $W(83)=3144$, $p<.001$, $r=.940$) All of them deviates towards positive preferences to symmetry (PI1 and PI2) and meaning (PI3 and PI4).

If we take a look at the effect sizes, we could show moderate effects of symmetry preference and strong effects of meaning preference. See the results visualized on Figure 13. Regarding the expert group, there were no significant differences between neither of the PIs compared to the neutral value zero.

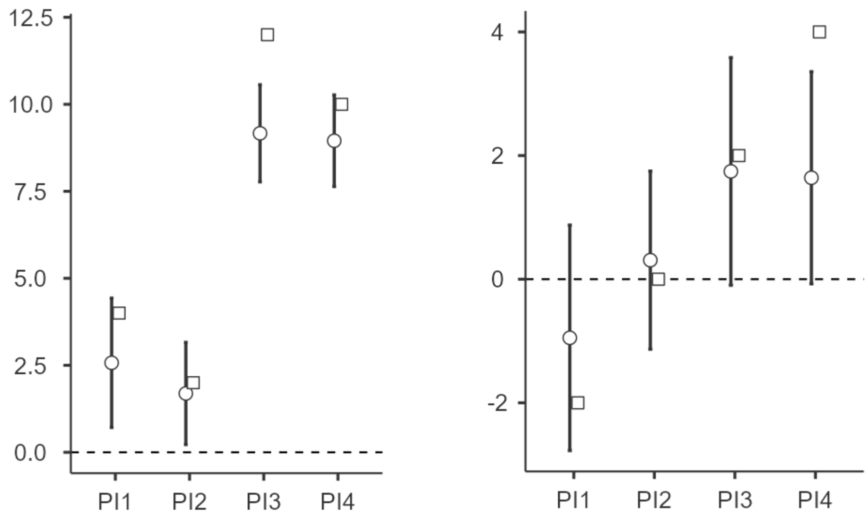


Figure 13: the Preference Index values of non-experts (left) and experts (right). Means are shown by circles, while median values are marked with squares.

In terms of symmetry, neither the main effect (F (1, 160) = 1.621; p = .205) nor the interaction between the groups and the number of preference choices was significant (F (1, 160) = .089; p = .765). In contrast, regarding meaning, both the main effect of meaning (F (1, 160) = 81.954; p < .001; η^2_p= 0.339) and the interaction between preference choices and expertise was found to be significant (F = (1, 160) = 38.237; p < .001; η^2_p= 0.193).

The Tukey corrected pairwise comparisons revealed that participants preferred meaningful images to meaningless ones for both symmetric (t (160) = 6.443; p < .001) and asymmetric images (t (160) = 8.260; p < .001). Interactions were nonsignificant for symmetry and meaning (F (1,160) = 0.017; p = .898) and symmetry, meaning, and groups (F (1, 160) = .403; p = .652). To test the significant interaction between the groups and the number of preference choices for meaning, we used a follow-up 2x2 repeated measures ANOVA with two within-subject factors (symmetry and meaning) for the two groups separately. Non-experts showed a preference for meaningful images over meaningless ones (F (1, 83) = 147.513; p < .001; η^2_p= 0.640), whereas symmetry did not affect their preference choices (F

(1, 83) = 0.518; p = 0.474). The interaction between symmetry and meaning was nonsignificant (F (1, 83) = .059; p =.809). For the experts, neither the main effect of symmetry (F (1, 77) = 1.133; p = .291) nor the main effect of meaning was significant (F (1, 77) = 3.316; p = .073). The interaction between symmetry and meaning was also nonsignificant (F (1, 77) = 0.150; p = .700). See the visualized results in Figure 14.

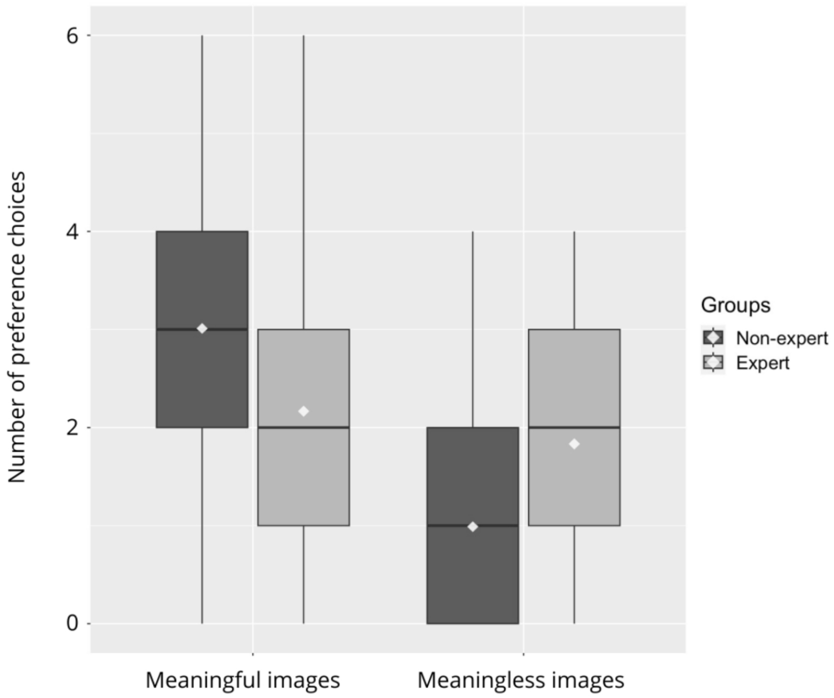


Figure 14: Differences between the groups in the preference of meaningfulness. Note: The distributions and means of the number of preference choices for meaningful and meaningless images in Block 5 (when choosing one out of all 4 images of a set) for both groups. White diamonds show the mean scores, vertical lines represent the actual score range of participants.

In terms of prototypicality, art experts' preferences did not differ from non-experts', when the two meaningful variations were presented (Block 2) (Mann-Whitney U=4004 p=.716). Namely, we found a preference toward prototypicality, based on a significant difference in the PIP values toward the positive side compared to the neutral preference index value “0” (Wilcoxon W=10620, p<.001). However, when choosing the most preferred out of the 4 variations (Block 5), the number of the expert groups’ prototypical choices was significantly lower than non-experts’ ($t(180) = -5.09$, $p < .001$, $d = .756$). Results are reported visually in Figure 15.

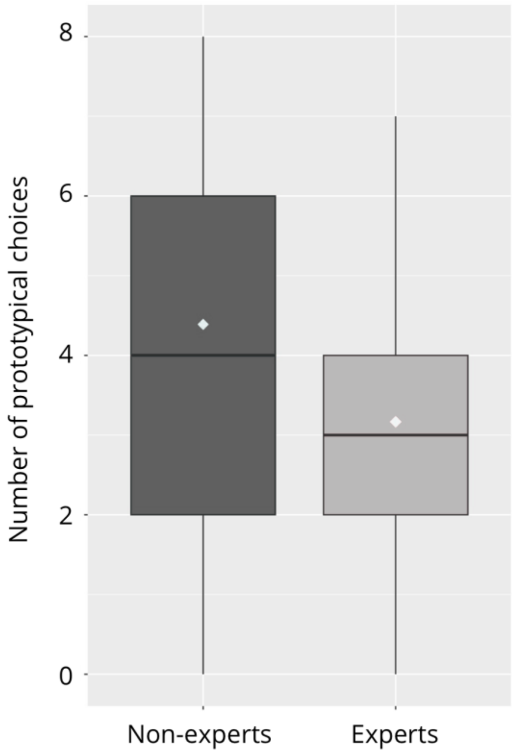


Figure 15: The number of prototypical choices in the two groups. Note: The distributions and means of the number of prototypical choices in Block 5 (when choosing one out of all 4 images of a set), separately for the art expert and non-expert group. White diamonds show the mean scores, vertical lines represent the actual score range of participants.

5.7. Discussion

In the present study, we aimed to map the boundaries of symmetry preference exploring its interaction with meaningfulness and expertness through a forced-choice preference task. In general, we conclude that both meaning and art expertise are likely to overwrite the biologically hard-wired effect of symmetry. It is important to note that our results do not refer to art appreciation, as we used simple black-and-white geometric images, not artworks. We discuss the results regarding each hypothesis and research question.

5.7.1. Competing preferences: meaning as a higher-order preference

To find out whether symmetry is more dominant in the preference choices of non-experts compared to experts (H1), we compared the Preference Indexes of the two groups, and concluded that in case of meaningless images, symmetry preference contributes to non-experts' preference choices, but not to experts'. See the means of the Preference Indexes in Table 5. However, in case of meaningful images, there is no remarkable effect of symmetry preference, thus interestingly there is no difference between the groups. It seems like being exposed to meaningless simple images evokes similar preferences as art appreciation, as the differences between the groups align with the relevant findings of the literature (e.g. Pihko et al., 2011).

Our second hypothesis referred to art experts' preference for asymmetry over symmetry. No explicit preference for symmetry or asymmetry could be found, neither using meaningful nor meaningless images. This is one of the main differences between the groups in our findings, aligning with the results of Gartus et al. (2020). In a recent face-asymmetry study, Monteiro et al. (2022) describes art experts' preferences as not rejecting asymmetric stimuli like non-experts do, to which our results also fit well. Their preferences of non-art images might be shaped by other variables, similarly to art appreciation, where the impact of stimulus-driven factors seem to have less influence on art experts' preferences compared to non-experts (Chamberlain, 2017). Corradi et al. (2020) found that regarding the preference for curvature expertise only have a significant effect if the stimuli are specific to the field of expertise of the participants. This may also be a relevant aspect in case of symmetry preference. Our stimuli were not specific to art history, design or fine arts. We aimed the aesthetic preference not the complexity of the art appreciation. In the future there should be developed an improved study focusing on this aspect of expertise.

Even though vertical bilateral symmetry is the most important in terms of visual sensitivity and preferences compared to other types of symmetry (Wagemans et al., 1992; Treder, 2010), rotational symmetry could also influence the preference choices to a moderate level in our study. Furthermore, the role of rotational symmetry in the preferences of simple geometric patterns among experts and non-experts could be the focus of future studies. This calls for methodological improvement regarding the stimuli. Therefore, in the future, we will avoid including different types of symmetry in the 'asymmetric' figure group for better control of variables, so that we can draw more straightforward conclusions on the preferences.

To summarize the results regarding our third hypothesis, whether meaning is more dominant over symmetry in the preference choices of non-experts, we can conclude that meaning is the more dominant feature in the preferences of non-experts. We found no differences between the preference for symmetric or asymmetric images as long as they were meaningful. However, we have found a preference for symmetry when being exposed to meaningless images. Thus, symmetry preference comes only to light when meaning disappears. This pattern of preferences can be explained with the hierarchy of the cognitive processes of aesthetic appreciation, according to which meaning and semantic content can overwrite the initial preferences for perceptual features (Leder et al, 2004; Leder et al., 2014).

To test whether art experts prefer meaningful images to meaningless in case of non-art images (H4), our analyses have shown no significant effect of meaningfulness in Blocks 1-4. Compared to the literature on experts' preference patterns, which tend to find a preference for abstract art (Bimler et al., 2019) and meaningless geometric patterns (Gartus, 2020), it is an interesting finding. Although the interaction between meaning and expertise was found to be significant in the preference choices of Block 5, it seems that compared to non-experts' clear preference toward meaningful images, experts do not show such differentiation between meaningful and meaningless images. This could be a feature of our stimuli, which encourages us to further investigations regarding this question.

5.7.2. Prototypicality preference – where differences disappear?

Is symmetry or typicality more important in the preference of meaningful images? The second block in our experiment has been created to assess symmetry preference using meaningful stimuli. Additionally, we could also test for prototypicality preference, since one of the meaningful variations was always prototypical. We observed no significant effect of symmetry on the preference choices of either group. However, both groups showed a preference toward prototypicality. This means that in case of meaningful images, experts, just like non-experts tend to choose the prototypical variation regardless of wether it is symmetric or not. This is aligning with the efficiency-model of prototypicality (Winkielman et al., 2006). Until now, we did not have such nuanced comparative results about these two features measured in expert and non-expert samples. This leads us to our last research question about a difference in prototypicality preference between the groups. Our results suggest that in certain conditions, the two groups are similar, while in others, they show differences. Aligning with the literature, we found a preference toward prototypicality in the non-expert group (Halberstadt & Rhodes, 2003). Experts exhibited a prototypicality preference similar to that of non-experts when selecting between two meaningful images. However, differences appeared when all four variations were presented. In this case, the preference for prototypicality diminished among experts, allowing for other preferences to emerge. A significant feature to come to light in the latter task could been novelty or originality among art experts, as shown by Hekkert and Van Wieringen (1996a). Another aspect in these results' explaination may be that non-experts' preference toward meaningful images causes a basic difference between the groups, which also affects the prototype choices in the last block. This result nuances the differences between the two groups' preferences on meaningfulness and prototypicality.

For investigating the preference for meaningfulness more representative images might be more appropriate, however this might have affected image features like complexity or color. As we tried to keep the number of variables as low as possible to only measure what our hypotheses targets, we choose to work with these simple stimuli. Future studies may find a way to include more representative images while keeping the number of varied images features low.

Even though prototypicality and meaning turned out to have the most significant role in our study, it is worth to take a look on asymmetry as a dimension of complexity as it is mentioned in Nadal et al. (2010). While we did not find differences in the stimuli, the perceived symmetry versus asymmetry could enhance the effect of complexity as well, which is one of the most studied aspects of the differences between experts' and non-experts' preferences (Eysenck & Castle, 1970; Van Geert & Wagemans, 2020; Gartus et al., 2020). Although, we created our stimuli as simple as possible, the dimension of complexity may still be there as an undetected variable.

By deepening the knowledge about the relation of different features contributing to preferences, our study emphasizes the robust effect of meaning in the aesthetic experience. We could also find interesting differences as well as similarities between experts and non-experts that bring us closer to the understanding of expertise in visual arts. Regarding symmetry, our results help us define the limits of its preference, as specifically for our stimuli set it seems to be unimportant in the choices of art experts, in addition to being secondary to meaningfulness in the choices of non-experts.

5.7.3. Limitations of the method and emerging questions

A methodological improvement could be to increase the number of stimuli in the task. Despite having a relatively high number of participants, our experiment included only 32 images with a total of 72 choices. Using more sets of stimuli with the same features could provide additional data on the measured variables, leading to more robust statistical results and more generalizable findings. The challenge to address in the future regarding this limitation is to create more image sets, ensuring they vary in symmetry and meaningfulness and include one prototypical variation.

A limitation of our study is that we have only measured explicit preferences without a time limit, thus we cannot draw further conclusions about the implicit preferences and the preattentive processes. This could tell us more about the differences and similarities of the boundaries of symmetry preference between art experts and non-experts. Future research could reveal more about these features by measuring implicit preferences and using a short exposure time, as the processing of perceptual features happens quickly and implicitly (see Wagemans, 1997). Furthermore, as we assembled the task in an online questionnaire in order to reach participants during the Covid-19 pandemic, we did not control for viewing times. As unequal viewing times could also influence preferences (see the mere exposure effect on p. 18), this could be an important component to include in the experiment. This study further extends our knowledge about the role of symmetry and meaning in aesthetic appreciation, as well as about the influence of art expertise.

6. Third study: Examining the implicit preferences through eye-tracking

6.1. Summary of the study

There are widely known results on the preference for symmetry as well as meaningful images, and how they both decrease with art expertise, but these measurements are usually done on separate sets of stimuli. We were interested in the perceptual process of the aesthetic experience, especially in the differences between the amount and qualities of the collected visual information during the preference-choice. Therefore, we constructed a forced-choice preference task in a remote eye-tracker laboratory, using previously empirically tested images varying on the above mentioned features (symmetric-asymmetric, meaningful-meaningless) and asked 31 art experts (mean age=25.5; 5 men, 26 women) and 39 non-experts (mean age 21.7; 10 men, 29 women) to participate in our experiment. We registered participants' preference choices, answer latency and eye movements. We also used a short questionnaire to collect demographic data and information about the level of expertness to be able to select participants who do or do not fulfil the criteria of art expertness.

The results from the detected eye movements show differences between the expert and non-expert groups, namely that experts spend more time on non-symmetrical images. The analyses of the numbers and the time of specific and overall fixations gives a new contribution to understand the nature of expertness in aesthetic preference. The result of this specific pattern of the perceptual behaviour in this complex setting opens up a new perspective for describing the aesthetic pleasure through the measurement of preference.

6.2. Theoretical background

To address the emerging questions and limitations from the second study, we conducted a third study using the same design but with essential methodological improvements. Firstly, we administered the task in a controlled laboratory setting to precisely measure stimuli exposure times and answer latency. Secondly, we explored implicit visual preferences among both art experts and non-experts by tracking eye movements using a remote desktop eye-tracker.

6.2.1. Measuring visual preferences

Empirical aesthetics offers a variety of methods with different advantages and disadvantages for assessing visual preferences. The oldest and most widely used among those are preference ratings and preference choices, which rely on operationalizing participants' self-reported experiences. While preference ratings are usually measured stimulus-by-stimulus on Likert items (e.g. rate your preference from 1-10) or continuous scales, preference choices (usually) force participants to choose one out of more stimuli according to their preferences. The most obvious advantage of ratings (PR), and therefore the reason for being the most used method in the discipline, is that they capture the nuances in the different level of preferences toward different stimuli. Thus, it turns preference into a scale variable, suitable for comprehensive statistical analyses between and within participants as well. Moreover, it is easy to generate both under laboratory and more lifelike circumstances, as well as it can involve the presentation of numerous stimuli without overloading the subjects. On the other hand, preference ratings can have the disadvantage of being subjective and therefore, doubtfully comparable. As the visual preference is a momentary personal experience, we can never be sure that different participants or even the same participant exposed to different stimuli can provide an absolute value of their preference. A more reliable alternative regarding this aspect are forced-choice preference tasks (FCPT), which rely on the comparison of participants' preferences between two or more stimuli. This method also provides easily analysable data by clear choices and makes it possible for researchers to compare preferences between and within subjects. The disadvantage however is the lack of capturing the variability of preference toward different stimuli. While it provides highly reliable information about which stimulus is the most (or in some cases less) preferred, it also misses the information regarding *how much* each stimulus is preferred compared to the other. Furthermore, in most cases participants must choose a preferred stimulus. Thus, there is no room for equal preferences or a lack of preference in forced-choice tasks. A method for assessing self-reported preferences that merges both above tasks' advantages and disadvantages is to ask participants to put the stimuli in preference order. However, this method severely limits the number of stimuli participants can handle with reasonable ease.

The method of production comes with completely different constellations of strengths and weaknesses. As we could see in the first study, production tasks often give space for different factors of preference to emerge instead of presenting the hypothetically salient stimuli or features to participants. This can also help to make experiments more ecologically valid. On one hand, this means that individual and intrapersonal differences (e.g. in the case of the beautiful / ugly compositions in the first study) can manifest on a very nuanced level. On the other hand, due to the more moderate control over the variables it makes comparisons far more difficult and thus, less reliable. Furthermore, it requires more effort not only from participants (compared for example to preference ratings), but also from the researcher (for setting up a creating task and turning the final product into data). Therefore, the method of production is way less popular in empirical aesthetics than preference ratings and preference choices.

Whereas preference ratings and preference choices are the most common methods in the discipline, they both assess self-reported or explicit preferences. Explicit preferences show us the conscious, verbalizable level of participants' experience. Thus, these information only cover a phenomenal layer of the preferences. Moreover, these ratings and choices can be manipulated by the subjects themselves, as well as they can miss to realize less conscious preferences. These limitations led to new methodological approaches in which the need for measuring of implicit preferences came to the spotlight.

The dual processing approaches (summarized by Evans, 2008) suggest a distinction between two parallel types of cognitive processing, whit one being fast, automatic and unconscious, whereas the other slow, deliberative and conscious. We can label the former type as implicit, whereas the latter as explicit processing. This can also be applied on the aesthetic experience, as can be seen for example in the Leder model (Leder et al., 2004), which describes automatic and deliberate stages of the processing. But how can we assess someone's aesthetic preference without directly *asking* them about it? To answer this question, there are two approaches in the empirical literature. On one hand, researchers tried to develop tasks with indirect preference responses, such as the Implicit Association Test by Greenwald, McGhee and Schwartz (1988). On the other hand, they tried map physiological variables related to preferences. As we have seen in the historic summary of empirical aesthetics, some hypothesized a correlation between arousal level (which they tried to capture through galvanic skin reaction) and preferences (see for example Berlyne, 1971; Kreitler and Kreitler, 1972). More modern methods made it possible to investigate the nervous system more directly. In the early approaches, researchers tried to locate a cortical brain area that is responsible for aesthetic preferences. According to this idea, a high activation of this particular area could be associated with experiencing aesthetic preference. Nowadays we rather look for functional network structures in the brain, hypothesizing that the (positive or negative) aesthetic experience emerges as an interplay in the activation of these networks (Chatterjee, 2013). Another notable and easier accessible method for measuring implicit preferences based on physiological functions is the tracking of eye-movements, which is also the method of the present study. For a comprehensive review of measuring preferences see Palmer, Schloss and Sammartino (2013), for a summary of the historical aspects of the development in concepts and methods in empirical aesthetics, see Illés's (2023) study.

6.2.2. Eye-tracking as a possible measure of implicit preferences

In case of visual perception, the tracking of eye movements is considered as a more accessible and less engaging method for measuring implicit preferences compared to EEG and neuroimaging. The relation between eye-movements and preferences is based on the direction of visual attention. Thus, the pattern of scanning our visual environment was found to be related to preferences (Glaholt et al., 2009; Schweikert, 2016).

Compared to self-reported preferences, Glaholt, Wu and Reingold (2009, 142) list four key advantages of eye-tracking: "First, current eye movement monitoring systems allow for relatively unobtrusive measurement of looking behaviour while the observer is interacting naturally with their visual environment. Thus, unlike overt preference ratings, the observer is not required to produce additional responses to indicate his/her preferences. Second, compared to preference ratings, looking behavior is likely to provide better measurement of unconscious preferences. Third, looking behavior is likely to be less susceptible to attempts on the part of the user to only report socially desirable, appropriate, or justifiable preferences. Finally, measurement of preferences by looking behavior can be obtained quickly and efficiently across multi-element arrays of items."

When tracking eye-movements, the most important components to measure are the fixations, the saccades and viewing times. During the visual information intake from our environment, our eyes glide over the desired stimulus, then stop on it, and then move on to observe a new point, and so on. This happens, for example, when reading or viewing a painting. In other words, we scan with an alternating series of saccades and fixations. Saccades are eye movements that occur at intervals of a few hundred milliseconds, resulting in looking from one point (object, person, figure) to another. The actual perceptual input occurs during the stops, the fixations, between saccades. Thus, visual information intake is not continuous. Nevertheless, our vision does not miss or blur during saccades. This is because our nervous system corrects and covers the gaps (Rolfs, 2009). We also experience this correction during blinks, which typically last about 20 milliseconds (Soslo, 1994). Our eyes - although we do not perceive it this way - are in motion even during fixations. The purpose of fixation eye movements is to shift the retinal representation of the seen image across the receptive fields of the ganglion cells, thus preventing their habituation and the fading of the image. This type of eye movement is difficult to register (Rolfs, 2009).

Even the gaze of one-month-old infants is attracted to prominent elements in the visual field (e.g. intersections instead of homogeneous surfaces) (Aslin and Salapatek, 1975). In adults, visual attention, and thus the direction of gaze, is likely guided by intention, interest, prior knowledge, movement, unconscious motivations, and context. If we detect a provocative, threatening, or interesting stimulus, we direct our eyes (and head) toward it so that its image falls on the fovea, allowing for detailed processing. The duration of processing (fixation) is also determined by several factors. For example, when reading a text, we scan sections deemed insignificant with shorter fixations, while interesting parts or difficult-to-interpret words are looked at longer or revisited multiple times (Rayner, 1978).

6.2.3. How do we look at something we like?

When we look at vision as an essential source of environmental information navigating us to the most adequate cognitive and emotional responses, we can say that (such as other perceptual modalities) it prevails through approach and avoidance reactions, mediated to a phenomenological level as complex behavioural and emotional experiences. Thus, the rapid and accurate extraction of salient information is crucial, as well as the reaction is necessarily linked to our emotional systems. Shimojo et al. (2003) described this relatedness as the orienting behaviour being intrinsically linked to emotionally involved processes, such as preference decisions. Therefore, they aimed to specifically map the looking behaviour during preference choices using a forced-choice preference task with pairs of human faces as stimuli. According to the results, they described the “gaze cascade effect”, which refers to the temporal pattern of looking behaviour. More specifically, participants’ gaze was equally distributed in the initial period of viewing, but then it gradually shifted creating a bias towards the face they preferred. This effect was also present when using abstract shapes (Shimojo et al., 2003) and scenes (Mitsuda & Glaholt, 2014). Furthermore, Simojo and coworkers (2003) also described a positive feedback effect of the longer viewing times, suggesting that this bias in viewing times does not only predict, but also influence visual preferences. This aligns with the mese exposure effect described by Zajonc (1968).

But this bias in the pattern of viewing times is not the only component of looking behaviour that has been found to be related to preferences. Glaholt, Wu and Reingold (2009) found that the general viewing time, the fixation durations and fixation counts were also reliable predictors of visual preference. According to the results of their two-alternative forced choice preference task, participants had a higher number and a longer mean duration of fixations on the preferred images, as well as participants viewed the preferred images significantly longer. On the other hand, the location of the first fixation did not emerge as a notable predictor of visual preferences.

Aligning with the findings of Glaholt and coworkers (2009), the "beauty demands longer looks" phenomenon (Leder et al., 2010) describes that we tend to spend more time looking spontaneously at aesthetically appealing faces. Furthermore, looking at the 'more attractive' person in an experimental setting is associated with longer fixation durations and higher fixation count (Leder, Mitrovic and Goller, 2016). This link between visual preferences and viewing times has been found to also be present when looking at abstract pictures (Mitrovic et al., 2020). Goller and coworkers (2019) investigated this phenomenon using both faces and paintings and suggest that this effect is domain-general.

These studies confirm that the tracking of eye-movements can be a valuable tool in understanding how people make preference decisions, as well as give guidelines for further research about the relation between visual preferences and the different components of the looking behaviour. In our study, we will also rely on viewing time, fixation duration and fixation count as the indicators of implicit preferences.

6.2.4. The ambiguous findings about the effect of expertise on implicit preferences

According to the Leder model (Leder et al, 2004; Leder et al, 2014) we expect the effect of domain-specific expertise to influence the final aesthetic judgement and aesthetic emotion through affecting the deliberate processing stages. Weichselbaum, Leder and Ansorge (2018, p. 4) describe this influence in case of art expertise as "only experts but not nonexperts would be able to incorporate into their explicit aesthetic appreciations their many positive experiences with asymmetrical images and objects for revisions of their initial implicit symmetry preferences. However, art experts might also even explicitly discard ''simple'' principles of beauty for their explicit appreciations." Based on these assumptions, Weichselbaum et al. (2018) investigated the differences in symmetry preference in meaningless non-art stimuli (abstract patterns) between experts and non-experts using a dual-processing assessment approach. Notably, their group of art expert participants consisted of art history students, not artists. They measured explicit preferences through preference ratings and explored implicit preferences using the Implicit Association Test[3] (by Greenwald, McGhee, & Schwartz, 1988). Their findings revealed that art historians exhibited a non-expert-like preference for symmetry at the implicit level. However, when it came to explicit preferences, they tended to rate asymmetric images higher than non-experts, even though they still preferred symmetry overall (Weichselbaum et al., 2018). This aligns with the Leder model's assumption that expertise influences preferences at an explicit level (Leder et al., 2004).

However, research using both representative and abstract stimuli suggest that that there could be differences in the implicit preferences of experts and non-experts. Mastandrea and Maricchiolo (2014) also used the IAT to measure implicit preferences of design objects among design experts and non-experts. According to their results, the effect of expertise did not only manifest in the explicit, but also in the implicit preferences. Similarly, Illés (2008b) and Pihko and colleagues (2011) found differences in the looking pattern of experts and non-experts when viewing representative and abstract artworks. The former study involved both

[3] The Implicit Association Test (IAT), published by Greenwald, McGhee, & Schwartz in 1988, uses words of positive or negative valence and targets for which the valence is to be tested. In case of visual preferences, participants are exposed to a visual pattern and a word at the same time. They are asked to decide whether the word has positive ore negative valence (usually with a key press), and whether the pattern has a certain visual feature (in this case Weichselbaum an coworkers' (2018) case symmetry) or not (with another key press). The laterality of the corresponding keys for valences is altered during the experiment. Therefore, the response for symmetry being on one side, with the positive valence response being on the same side creates a hypothetically congruent task, while the negative valence response on the same side creates an incongruent task. Researchers determine the implicit preferences based on the reaction-time difference between the congruent and incongruent tasks. Overall, this measure of implicit preference tells us the association between the specific image (feature) and the positive/negative valence words. See a review of the IAT's application on the field of empirical aesthetics in Pavlović and Marković (2012). More recently, there is a developing scientific discussion on whether or not it really assesses automatic (implicit) processes (see Schimack, 2021; Kurdi et al., 2021).

artists and art-related professionals (e.g. art critics and curators), whereas the latter involved art historians as art experts.

As one can see, the conceptual and methodological inconsistencies in the literature make it challenging to compare and generalize the existing results. Thus, the question whether the effect of expertise exhibits on an implicit level or is a deliberate influence on the explicit level of preferences remains to be explored. This study aims to deepen our understanding about this specific topic.

6.2.5. Differences in the eye movements between art experts and non-experts

Previous research has shown that visual-stimulation based domain-specific expertise such as medical imaging (Kundel and La Follette, 1972), pathology (Brunyé et al., 2014), professional soccer (Williams and Davids, 1998) or professional driving (Underwood et al., 2002) influences the temporal and spatial patterns of the looking behaviour. According to these studies, the general effect of expertise is that experts tend to pay more attention to task-relevant areas, while non-experts focus more on visually salient areas instead. As we would like to address the differences in the visual preference between artists and non-artists, let us review the previous findings regarding the differences between the two groups looking behaviour. For gaining a better understanding about these differences, both groups have been investigated and compared using different types of stimuli. There are findings regarding stimuli features such as stimuli categories. However, as we will see, the vast majority of studies targeting the differences of the looking behaviour of art experts and non-experts used artworks as stimuli. Therefore, the mapping of the expertise evoked differences in the eye-movement features is yet incomplete for non-art stimuli. Our study targets to gain a deeper understanding on this area.

In terms of stimulus features, Locher (1996) reviewed eye movement studies to understand the differences between the eye-movements of art experts and non-experts regarding pictorial balance. As reported in various studies by Locher and his coworkers (Locher, Nodine and Kupinski, 1993; Locher, 1996; Locher and Nagy, 1996), modifying the balance of images results in a change in how the image is viewed, more specifically, it influences fixation durations. They concluded that people untrained in the field of art are less sensitive to structural organization. Furthermore, the scan paths of artists showed fewer short fixations and more long ones when viewing a more balanced image.

Another notable stimulus feature that has been studied among art experts and non-experts is of course symmetry, which also has a contribution to the above-mentioned pictorial balance. According to Locher and Nodine (1989), symmetry is not only preferred, but also detected at first glance, with the axis of symmetry being an anchoring point of the eye movements among non-experts. When viewing symmetric patterns, they tend to exhibit generally more and longer fixations on the image compared to asymmetric images. The authors explain this as a result of the enjoyment of the easy processing of symmetry, along with a lack of engagement or difficulty in processing of asymmetry. On the other hand, experts' gazes were more balanced when viewing symmetric and asymmetric stimuli. They generally showed a higher number and longer duration of fixations compared to non-experts regardless of the symmetry of the picture.

Hu and coworkers (2020) also found generally higher fixation counts in experts' gaze patterns when viewing symmetric and asymmetric computer icons in a preference task compared to non-experts. They interpreted this result as art experts are processing the visual stimuli more deliberately, whereas non-experts are more driven by low-level features and automatic processes. According to our previous findings and to the empirical literature on this topic, we can conclude, that non-experts have a strong preference for symmetry, which is reflected in their eye movements, whereas experts are more neutral and exhibit more balanced fixation patterns when viewing symmetric and asymmetric forms.

Regarding meaningfulness, Vogt and Magnussen (2007) also aimed to gain a deeper understanding on the effect of art expertise on the looking behaviour. In their two-stage experiment they used two-types of edited photographs, including pictures depicting recognisable objects for evoking object-oriented viewing, as well as abstract pictures (edited photographs without any recognisable objects). According to their findings, non-experts tend to focus on representational objects, more specifically on human features and objects, whereas art experts tend to focus more on the structural and abstract features of the pictures. Furthermore, the second stage of their experiment revealed that regardless of the picture type, art experts remembered significantly more pictorial features compared to non-experts. Also, when instructed to remember the pictures, experts focus more on meaningful elements also, compared to the free viewing session.They explained these results aligning with the effects of art training on visual observation and drawing described by art teacher Edwards (1981). This suggests that initially, novices in the art training tend to overemphasize salient features of the human body when drawing a model, for instance they draw the face relatively bigger compared to other parts of the head. During the training, art students learn to observe and depict the right proportion, through paying consciously visual attention to less salient parts as well. Similarly, according to Vogt and Magnussen (2007), the main effect of art expertise on the gaze pattern is to extract physical properties that are not normally crucial for the visual perception of the environment. Although both their sample size (9 experts, 9 non-experts) and the number of stimuli (12 representational and 4 abstract pictures) was rather on the lower side, their findings contributed to the understanding of how meaningfulness modulates the gaze patterns.

Regarding stimuli without easily accessible meaning, Zangemeister et al. (1995) found that art experts tend to use more global scanning strategy on abstract artworks compared to non-experts. We have to note, that this study only involved 5 art experts with unspecified types of experience, as well as only 5 pictures as stimuli. Nodine, Locher and Krupinski (1993) found that when viewing a painting, art experts tend to focus more on elements that express narrative content, suggesting that expertise modulates the effort participants are likely to put in finding the meaning during visual scanning. Therefore, it is crucial that researchers distinguish between preferring easily accessible, obvious meaning and symbolic, less obvious meaning of visual stimuli when assessing art expert's preference for meaningfulness. In our study, we use simple geometric figures, from which the 'meaningful' labelled images depict unambiguous, easily categorizable, neutral valence everyday objects, whereas the images labelled as 'meaningless' do not have a consensual, obvious meaning. See the pre-study for controlling the meaningfulness and the prototypicality of the images in Study 2 (p. 63).

Pihko et al. (2011) investigated the effect of expertise in art history on the gaze patterns in connection with the abstraction level of the artwork. According to their results, both explicit preferences and gaze patterns are modulated by abstraction level among non-experts. They reported higher preference and higher valence for representational paintings, while there was no such effect of abstraction level among experts. Regarding the eye movements, the more representational a painting, the longer the duration and the lower the total fixation count (note that the lower number of fixations is a necessary side-effect of the fixed 5-seconds presentation time of the stimuli). This pattern of scanning the representational paintings with fewer and longer fixations, whereas abstract pictures with more numerous, shorter fixations were present in both groups. As an explanation, the authors suggest that in case of representational paintings participants fixate longer on the figurative details, whereas in case of abstract paintings, due to the lack of semantically salient elements, they keep scanning and searching for the meaning. According to these findings, the experts of art history are similar to professional artists regarding their explicit preferences, but not their eye-movements. Thus, unlike in Study 2 where we also included professionals in art and art history in our sample, for the present study we decided to only include artists in the expert group.

	Reference	Non-experts	Experts
Symmetry	Locher and Nodine, 1989	**Visual engagement for symmetry** → Longer fixation durations and → Higher fixation counts on symmetric images compared to asymmetric images **Lack of engagement for asymmetry**	**Balanced eye-movements for symmetry and asymmetry** → Long fixation durations on both symmetric and asymmetric images → High fixation counts on both symmetric and asymmetric images
Meaningfulness and typicality	Vogt and Magnussen, 2007	**Visual engagement for easily accessible meaning** → Longer fixation durations and → Higher fixation counts on meaningful and familiar elements compared to meaningless and unfamiliar elements **Tendency for focusing on central and salient elements**	**Tendency for putting effort in finding less accessible meaning** → Longer fixations on atypical and symbolic or narrative elements → Longer overall viewing times **Tendency for wider visual exploration**
	Pihko et al., 2011	**Visual engagement for representational pictures** → Longer fixations on representational compared to abstract images	(Art historians as expert group: Although their explicit preference choices align with artists', their eye-movements align with non-experts)

Table 8: The main findings regarding the effect of art expertise on the eye-movements linked to the three key concepts of our study, namely the visual preference for symmetry, meaningfulness and typicality.

This brief overview of the literature on the effects of art expertise on eye movements during the aesthetic experience highlights several areas where the field could benefit from further development. First, most studies rely on artworks as stimuli, which introduces numerous uncontrolled variables (e.g. style, sympathy for the artist, value etc.), making it difficult to isolate and analyse the impact of basic visual features. Second, there is often a lack of consensus on what constitutes expertise. The criteria for classifying someone as an expert are frequently vague or inconsistent, with expert groups often composed of a mix of artists and/or art historians, making comparisons challenging. Finally, there is a noticeable scarcity of recent studies on this topic. See the summary of the key findings regarding the looking behaviour behind the preferences for symmetry, meaning and typicality among art experts and non-experts in Table 8.

As we have observed, contrary to the assumption that art expertise only influences the deliberate processes of aesthetic experience, previous research has demonstrated significant differences in preference-linked eye movements between art experts and non-experts even at the automatic processing level. While non-experts' eye movements generally align with the broader findings on the correlation between visual preferences and longer, more numerous fixations, art experts display a different pattern that corresponds with their more balanced preferences.

For instance, – as we have seen above, – when viewing symmetric versus asymmetric images art experts do not exhibit the non-expert like bias toward symmetry in the form of longer fixation durations and higher fixation counts. Instead, their eye-movement patterns remain relatively consistent regardless of whether the image is symmetric or asymmetric. Similarly, in terms of meaningfulness, art experts – depending on the criteria of expertise – do not always show a pronounced implicit preference for representative images, as indicated by longer viewing times or higher fixation counts. Instead, they tend to exhibit longer viewing times and extended fixations on abstract or meaningless stimuli. These findings mirror our results on their explicit preferences presented in the second study. Although the number of studies on this topic is limited and methods vary, these findings suggest that art expertise can also impact automatic processing, thereby influencing implicit preferences. Our study aims to further explore this specific area.

6.3. Hypotheses

According to our previous findings about the visual preferences of art experts and non-experts regarding symmetry and meaningfulness, we now expect to assess implicit preferences through exploring the looking behaviour of the groups. Based on the previous findings about the relation between implicit preferences and eye-movements, we now address three amin components of the looking behaviour, namely the total viewing time of an image along with the number and duration of fixations. We hypothesize that in contrast to the theoretical framework of the aesthetic experience, the effect of expertise will show an effect also on the implicit level. More specifically, we expect non-experts to exhibit implicit visual preference towards symmetric (H1a) and meaningful (H1b) stimuli indicated by longer total viewing times, a higher average number of fixations and longer fixation durations. On the other hand, we expect art expert's implicit preferences to show differences to those of non-experts. Thus, in line with their explicit preferences, we hypothesize more balanced implicit preferences towards the symmetry - asymmetry dimension (H2a), whereas a more enhanced implicit preference for meaningless images (H2b) compared to non-experts, indicated by longer overall viewing times, longer duration and higher number of fixations on meaningless images.

6.4. Method

6.4.1. Participants

To determine the required sample size for our study, a power analysis was performed using G*Power version 3.1.9.7 (Faul et al., 2007). Based on our hypotheses, we relied on repeated measure ANOVA with between and within interaction as the statistical test for the power analysis. Thus, with two groups, 5 measurements, d=0.5, α=0.05 and power=0.90 the minimum sample size needed for a repeated measures ANOVA was a total of 26 participants. Of the originally 75 participants whose eye-movements could be tracked successfully we excluded the data of 9 subjects, due to intermediate or underdefined level of art expertise. Therefore, our sample consists of 66 participants. There are 39 participants in the non-expert group, 28 of them are females and 11 males, the mean age of the group is 21,9 years. The age range is between 19 and 48 years. The expert group consists of 27 qualified participants, experienced in the field of visual arts and/or art history. There are 24 females, 3 males, their age range is between 20 and 46 years, the mean age in the group is 26,1 years. The criteria for being considered an expert in the experiment were the following: a minimum of 2 years spent in university-level education in the field of visual arts, design or art history OR a minimum of 5 years spent working in the field of arts and design on a professional level. The study was approved by the Hungarian United Ethical Review Committee for Research in Psychology (reference no. reference no. 2019-110) and was carried out in line with the Declaration of Helsinki.

6.4.2. Instrument

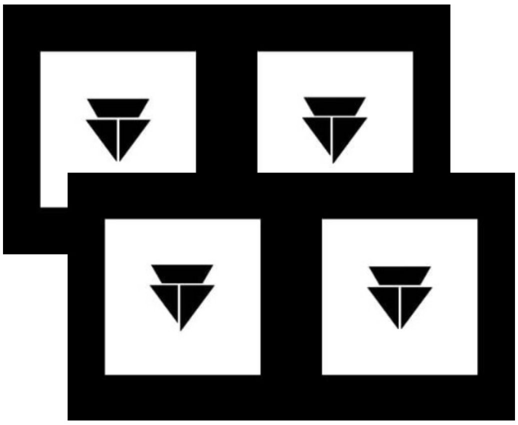
The task has been assembled using Tobii Studio 3.2 software. The stimuli presented in this experiment is the same design as in the 2nd study. For presenting the stimuli and collecting eyetracking data we used a Tobii TX300 remote desktop eyetracker. Stimuli were presented on a 23-in. TFT colour monitor, with a re solution of 1920 × 1080, 16:9 aspect ratio, a refresh rate of 60 Hz. Participants could execute the preference task using a Cedrus RB-844 response pad. The demographic and expertise data were collected in a Google Forms questionnaire, which was presented to the participants on a laptop in a browser. They could use the laptop's keyboard to give text answers in the questionnaire.

6.4.3. Procedure

Participants arrived at the laboratory one at a time. The experiment began with oral and written instructions about the eye-tracking method and the task. We showed them the non-invasive method of infrared eye-tracking, as well as the use of the response pad. During the written instructions, they also had to try out the use of the response buttons. The eye-tracking task consisted of 5 blocks. Each block started with a calibration process. The required distance between the screen and the eyes were approximately 60 cm. The calibration process helped to position participants in this space. In the instructions, we asked the participants to try to keep the calibrated position. Consistent to the task design of the first 4 blocks in study 2, image pairs were presented at a time. See the overview of the block structure with examples of the stimuli (set 1) on Figure 16. Each image pair has been presented randomized, two times in within one block to counterbalance the effect of laterality. Each trial started with a white fixation cross presented for 1,000 ms on a black background. The images were shown without a time limit, with the behavioural response (button press on the response pad) determining the end of the trial. The stimuli were presented on a black background. Ther response pad had 4 big white buttons in grid position. Participants were asked to use the upper two according to the laterality of their preference choice: if they liked the left image better, they should press the left button, if they liked the right image more, they should press the right button.

Example of the stimuli showed in the blocks

Block 1

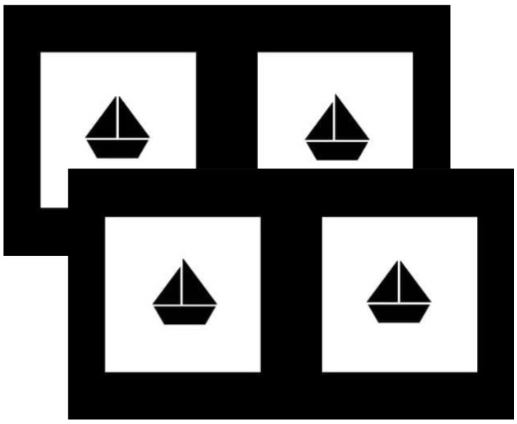


Meaningless pictures

Tested variable: **symmetry**

Calculated preference index: **PI1**

Block 2

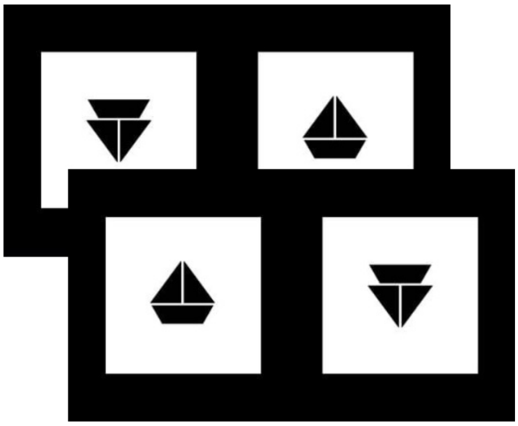


Meaningful pictures

Tested variable: **symmetry and prototypicality**

Calculated preference indexes: **PI2, PIP**

Block 3

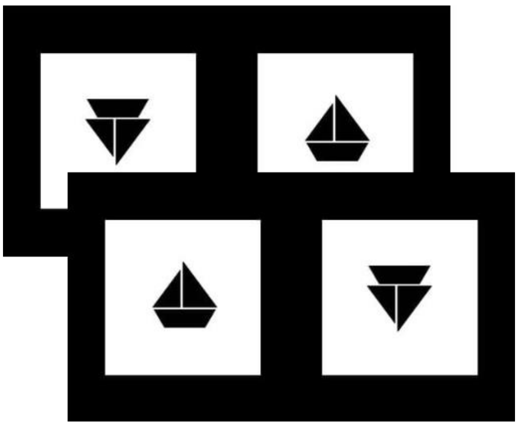


Symmetric pictures

Tested variable: **meaning**

Calculated preference index: **PI3**

Block 4



Asymmetric pictures

Tested variable: **meaning**

Calculated preference index: **PI4**

Figure 16: The block structure of the study with examples from the image pairs shown.

6.5. Data analysis

Statistical analyses were performed using the JAMOVI Statistics Programme (Version 1.2.27.0 for Windows). Outliers (the number of preference choices, fixation count, fixation duration and viewing time with more than 3 SD absolute deviations from the median)– approximately 0.6 % of the collected data – were excluded. The absolute values of Skewness and Kurtosis were below 2, thus the variables were normally distributed.

We addressed the differences in the looking behaviour through eye movements and viewing times between and within the groups. To test our hypotheses about implicit preferences, we registered the total viewing time, the number of fixations and the fixation durations for the four different image types (meaningful symmetric/AA, meaningful asymmetric/AB, meaningless symmetric/BA, meaningless asymmetric/BB) in block 1-4.

		Mean		SD	
Group		**Non-expert**	**Expert**	**Non-expert**	**Expert**
Total viewing time	AA	5,54	7,85	1,83	3,26
	AB	5,46	8,68	1,65	3,87
	BA	5,83	11,2	2,45	5,41
	BB	5,06	9,89	1,97	4,33
Fixation duration	AA	0,19	0,20	0,03	0,04
	AB	0,19	0,20	0,03	0,04
	BA	0,20	0,23	0,04	0,05
	BB	0,19	0,23	0,04	0,05
Mean fixation count	AA	5,4	4,97	0,841	0,76
	AB	5,37	5,05	0,832	1,17
	BA	5,19	4,48	1,07	1,04
	BB	5,17	4,46	1,02	0,817

Table 9: Means and standard deviations of the dependent variables of the looking behaviour for each image type. 'AA' labels meaningful symmetric, 'AB' meaningful asymmetric, 'BA' meaningless symmetric and 'BB' meaningless asymmetric image type.

As the total viewing times differed among each image (firstly because two images were shown at a time, and secondly because the presentation times of the image pairs were not fixed but determined by answer latency,) we calculated the mean fixation count per second, and used this variable for exploring any differences in the number of fixations. Therefore, we created with three eye-tracking variables for each image type. See the means and standard deviations among the groups for these 12 variables in Table 9.

To explore the between and within group differences regarding the looking behaviour, we used 2x2x2 repeated measures ANOVA tests with expertise group as between subject factor for each feature of the looking behaviour separately. We set meaning (meaningful/meaningless) and symmetry (symmetric/asymmetric) as the repeated measures factors. For interpreting the within-group effects, we performed follow-up 2x2 repeated measures ANOVA tests for the two groups separately. As the assumption of equal variances was violated in some of the variables of total viewing time, we accounted for non-parametric tests for testing the between-subjects effects. Therefore, we accounted Welch's one-way ANOVA for exploring the differences between the groups, and repeated measures ANOVA for exploring within-group effects.

6.6. Results

Regarding the mean fixation durations of experts and non-experts for the different image types, both the main effect of meaning ($F(1, 62)=42.953$, $p<.001$, $\eta^2_p=0.409$) and the interaction between meaning and expertise group ($F(1, 62)=14.552$, $p<.001$, $\eta^2_p=0.190$) was significant, with small to moderate effect sizes. On the other hand, neither the effect of symmetry ($F(1, 62)=0.079$, $p=0.779$) nor the interactions between symmetry and expertise ($F(1, 62)=0.026$, $p=.873$) or symmetry and meaning ($F(1, 62)=1.628$, $p=.207$) was found to be significant. According to the Tukey corrected pairwise comparisons, the fixation durations were longer for meaningless images both when looking at symmetric ($t(62)=-5.439$, $p<.001$) and asymmetric images ($t(62)=-4.407$, $p<.001$). In terms of the significant effect of the interaction between meaning and expertise, the Tukey corrected pairwise comparisons revealed that this effect of longer fixation durations on meaningless images is present among experts ($t(62)=-6.728$, $p<.001$), but not in the non-expert group. For a deeper understanding of the significant main effect of meaning, we performed the follow-up 2x2 repeated measures ANOVAs for both groups. We did not find a significant effect of meaning in the fixation duration of non-experts, whereas this effect of meaning was found to be present in the expert group ($F(1, 25)=60.339$, $p<.001$, $\eta^2_p=0.707$), indicating longer fixations on the meaningless image variations. See the visualized results of fixation durations for both groups on Figure 19a.

In terms of mean fixation counts, we also found the same pattern of results with the significant main effect of meaning ($F(1, 64)=25.858$, $p<.001$, $\eta^2_p=0.288$) and meaning and expertise interaction ($F(1, 64)=5.463$, $p=.023$, $\eta^2_p=0.079$), with small effect sizes. We report the results visually on Figure 19b. Similarly to fixation durations, neither the main effect of symmetry ($F(1, 64)=0.001$, $p=.974$) nor the interactions between symmetry and expertise ($F(1, 64)=0.203$, $p=.654$) or symmetry and meaning ($F(1, 64)=0.142$, $p=0.707$) was found to be significant. The Tukey corrected pairwise comparisons revealed that the number of fixations are higher on meaningful compared to meaningless images both in case of symmetric ($t(64)=3.986$, $p<.001$) and asymmetric ($t(64)=4.280$, $p<.001$) images. Regarding the interaction of meaning and expertise, we found significant differences indicating a higher number of fixations on the meaningful images in the expert group ($t(64)=4.828$, $p<.001$), but not in the non-expert group. To get a deeper understanding on the differences between the groups in terms of the effect of meaning on fixation durations, we performed a 2x2 follow-up ANOVA for each group separately. In case of the non-expert group, we did not find a significant main effect of meaning ($F(1, 38)=3.983$, $p=.053$). However, in case of experts the main effect of meaning was found to be significant ($F(1, 26)=30.332$, $p<.001$, $\eta^2_p=0.538$), showing a higher number of fixations on meaningful images compared to meaningless ones.

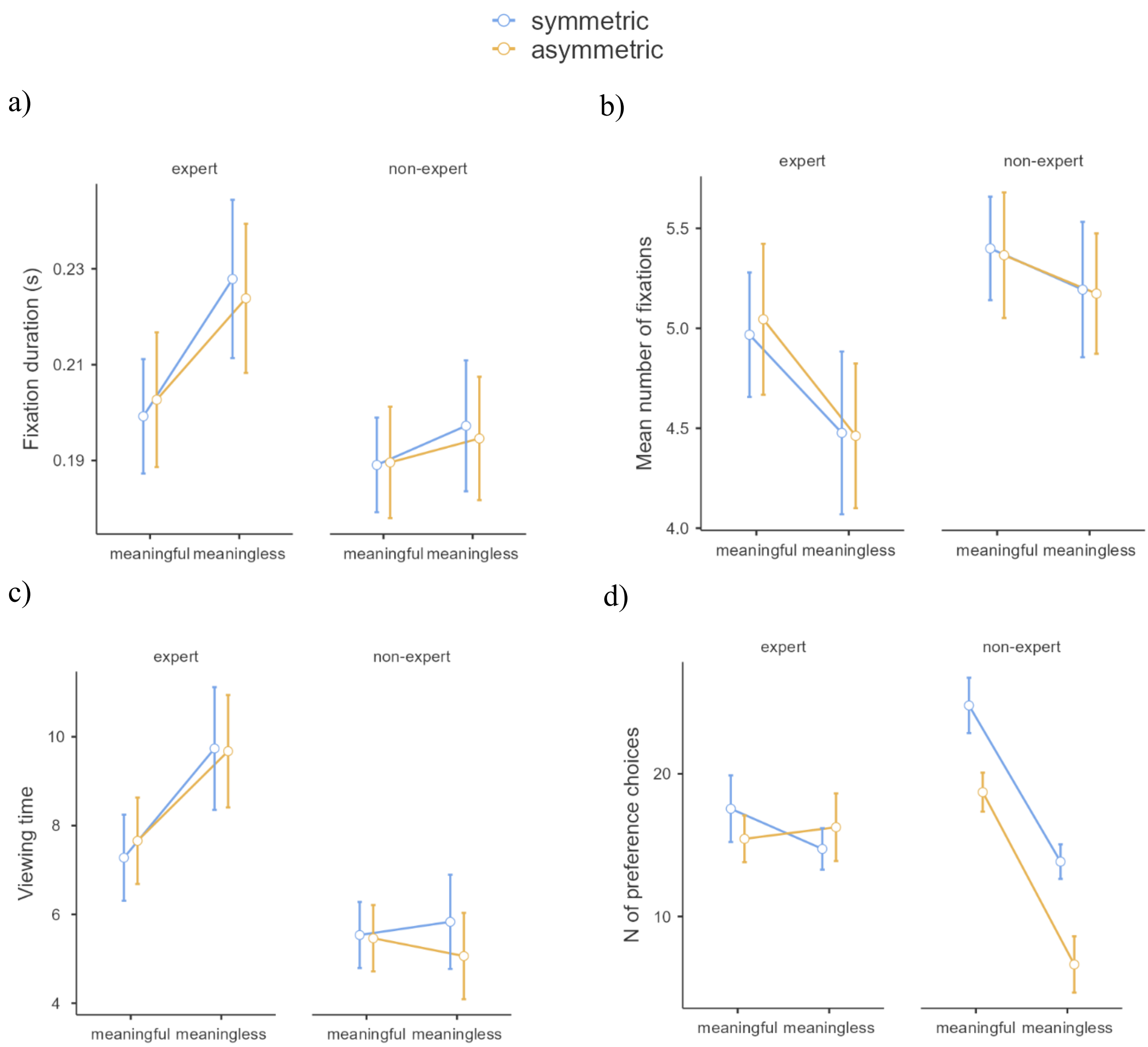


Figure 19: Visualizations of the results of the eye-tracking variables with (a) showing the fixation durations in seconds, (b) the mean fixation counts (c) the total viewing times in seconds and (d) number of preference choices in the two groups. Circles show the mean values, vertical lines show the confidence intervals.

Regarding the between-groups differences in total viewing times, we found significant differences for all four image type. In case of meaningful symmetric images (Welch's F(1, 35.6)=10.9, p=.002), meaningful asymmetric images (Welch's F(1, 32.6)=16.5, p<.001), meaningless symmetric images (Welch's F(1, 33.4)=22.9, p<.001) and meaningless asymmetric images (Welch's F(1, 28.9)=26.5, p<.001). According to the results of the 2x2 repeated-measures ANOVA for each group separately, we found a significant main effect of meaning in expert group ($F(1, 22)=32.330$, $p<.001$, $\eta^2_p=0.595$). The Tukey corrected pairwise comparisons showed that experts view meaningless images for significantly longer both when exposed to symmetric ($t(22)=-5.953$, $p<.001$) and asymmetric images ($t(22))=-4.816$, $p<.001$). However, when performing the follow-up ANOVA in the non-expert group, we did not found a significant effect of meaning ($F(1, 38)=0.071$, $p=.791$), instead a significant main effect of symmetry was present ($F(1, 38)=10.367$, $p=.003$, $\eta^2_p=0.214$) along with a significant interaction between symmetry and meaning ($F(1, 38)=13.682$, $p<.001$, $\eta^2_p=0.265$), both with small effect sizes. The Tukey corrected pairwise comparisons revealed that non-experts view symmetric images longer when the presented stimuli is meaningless ($t(38)=4.119$, $p<.001$), but not when it is meaningful ($t(38)=0.556$, $p=0.944$). The results are reported visually on Figure 19c.

6.7. Discussion

In this study, we aimed to gain a deeper understanding about the differences in the visual preferences of art experts and non-experts by exploring the implicit preferences for symmetry and meaningfulness using an eye-tracking method. Given the processing model of the aesthetic experience (Leder et al, 2004; Leder et al., 2014) and the empirical findings about non-experts' explicit and implicit preferences for symmetry (Weichselbaum et al., 2018) and meaningfulness (Vogt and Magnussen, 2007), we also wanted to contribute to the clarifying whether art expertise affects only the deliberate, explicit or also the automatic, implicit processing stages. We assumed that in contrast to the theoretical framework of the aesthetic experience, the effect of expertise will show an effect also on the implicit level.

6.7.1. Implicit preferences of non-experts

Our first hypothesis suggested that non-experts exhibit implicit visual preference towards symmetric (H1a) and meaningful (H1b) stimuli indicated by longer total viewing times, a higher average number of fixations and longer fixation durations. In terms of symmetry (H1a), we found that non-experts tend to view symmetric images for a longer time in a preference choice task, but this implicit preference for symmetry is only present when being exposed to meaningless stimuli. We did not find any implicit preferences for symmetry in case of meaningful images. These results suggest that the implicit preference for symmetry in non-art stimuli is modulated by meaningfulness among non-experts, highlighting the importance of using complex methodology. It seems that in case of meaningless images, lower-level stimulus features like symmetry can emerge as a predictor of preferences, but as soon as the image has a meaning, this effect gets overwritten by other aspects. This aligns with the findings on non-experts' explicit symmetry preferences of the second study, in which we also found that it only comes to light in case of meaningless images. However, we only found cues of implicit preferences in overall viewing times, but not in fixation durations or fixation counts, which were quite balanced for symmetric and asymmetric images. Therefore, we cannot draw straightforward consequences yet.

Notably, as we considered viewing times as an important factor of implicit preferences, we did not set a limited exposure time. However, this led to differences in viewing times of different stimuli types (see figure 19c), which also mean that the average number and duration of fixations were calculated from different amount of overall fixations. According to Molnar (1981), the visual exploration has two different stages. Initially, the viewer collects the main information in order to identify the stimuli. This explorative viewing is followed by the hedonic stage, in which the viewer can enjoy the visually pleasing or interesting elements. Whereas the initial phase was found to be operating with shorter fixations quickly following each other, the latter phase was associated with longer fixations. The unequal viewing times could result in an imbalanced ratio of explorative and hedonic viewing phases across the different stimuli types, influencing the interpretation of fixation durations and mean fixation counts. A possible methodological improvement could be to complement our current results with a preference scale task with images presented one-at-a-time instead of a two alternatives forced-choice task, and with a limited exposure time.

Regarding meaning (H1b) – in contrast with our expectations – non-experts' fixation durations, fixation counts and viewing times did not show an implicit preference for meaningful images. These results are in contrast with their explicit preferences for meaningfulness. These two findings are highly interesting in comparison. Meaningfulness modulates the implicit preference for symmetry in terms of viewing times, but does not evoke implicit preferences per se. A possible explanation for this can be, that the easily recognizable meaning overwrites the role of low-level feature symmetry even at an implicit level. On the other hand, the preference for meaning itself seems to manifests only at the deliberate stages of the aesthetic processing.

6.7.2. Implicit preferences of art experts

Regarding art experts, we expected their implicit preferences to show differences to those of non-experts. Thus, in line with their explicit preferences, we hypothesized more balanced implicit preferences towards the symmetry - asymmetry dimension (H2a), whereas a more enhanced implicit preference for meaningless images (H2b) compared to non-experts, indicated by longer overall viewing times, longer duration and higher number of fixations on meaningless images. According to our results, the expert group did not show any cues of implicit preference differences regarding the symmetry or asymmetry of the image (H2a). This aligns with the previous findings on their balanced eye movements (Locher and Nodine, 1989) as well as with their balanced explicit preferences for symmetry and asymmetry that we found in the second study. We indeed found differences between art experts' balanced and non-experts' biased implicit preferences, but only in case of meaningless images and only in the measure of total viewing time. These results are highly valuable as they do not fully align with the theoretical assumption about art experts having non-expert-like implicit preferences (Weichselbaum et al., 2018). Nevertheless, due to the lack of differences in fixation durations and fixation counts, as well as the hard comparability of the studies using various stimuli and expertise criteria, this question calls for further investigation.

In terms of meaning preference (H2b), art experts exhibited longer viewing times and fixation durations on meaningless images compared to meaningful ones and compared to non-experts. However, they exhibited higher fixation counts on meaningful images compared to meaningless ones and compared to non-experts – regardless of symmetry. Interestingly, while some measures of the implicit preferences (namely viewing times and fixation durations) show a bias toward meaningless images, others (mean fixation counts) show a bias towards meaningful images. Notably, the classic study of Vogt and Magnussen (2007) also found that art experts' fixation durations and overall viewing times – but not their fixation counts – show an enjoyment of looking at visual elements with less obvious meaning. The findings on average fixation durations being associated with the involvement of cognitive processing of visual data collected at the sites of eye fixation (Francuz et al, 2018) is also supporting this idea. Furthermore, we can assume according to Molnar's (1981) findings on explorative and hedonic viewing, that in case of meaningless images artists exhibited a longer overall hedonic viewing stage with higher total viewing times and longer fixation durations, whereas is case of meaningful images the explorative phase should be greater, given that they exhibited shorter fixations and shorter overall viewing times along with a higher number of fixations.

Another methodological improvement for interpreting the eye-tracking data more successfully could be to measure more detailed preference ratings of the images, allowing us to assess the nuances within individual preferences as well. Therefore, in the future, we plan to add an image preference rating section after each block of the study, corresponding the images of the block.

These results show a difference between the implicit preferences of art experts and non-experts, suggesting that expertise can influence the automatic processing stages too. According to Hu and colleagues (2020) we also found that non-experts are more driven by low-level features, like symmetry when processing visual stimuli compared to art experts. Furthermore, we found that art experts are showing preferences for meaningless stimuli even on an implicit level. Nevertheless, the more nuanced mapping of the relevant measures is yet to be done by future research.

7. General discussion

"Wearing this or that sweater, buying this or that poster, or facing this or that direction in the park may not seem to have much impact on our material lives, and yet, if we consider the alternative—a world in which we have no such preferences or could make no such choices—what a drab, dull, wearisome world it would be!" – Palmer, Schloss and Sammartino, 2013, p. 78.

This thesis aimed to contribute to the field of empirical aesthetics by addressing visual preferences. Understanding the aesthetic experience by exploring the features that determine our preferences is one of the oldest research topics of psychology with the initial work by Gustav Theodor Fechner in 1876. Fechner's original idea was to measure the level of preference for various visual stimuli to identify the main underlying factors. This initiative led to the emergence of a fruitful discipline, which we can refer to as traditional empirical aesthetics. Throughout many different theoretical and methodological frameworks, his core idea still drives researchers to present day. Although traditional empirical aesthetics is getting conceptually challenged by neuroaesthetics and the new psychological aesthetics, the "fechnerian" methods still provide a fundamental part of our knowledge (Leder, 2024). Furthermore, by identifying and measuring the factors determining our preferences, experimental methods contribute to the understanding of the underlying neural processes. The more we know about the behavioural foundations, the more precisely we can assess the functioning of the responsible brain regions and networks (Palmer, Schloss and Sammartino, 2013).

This thesis aimed to contribute to the existing knowledge on visual preferences among art experts and non-experts. Therefore, I presented the main frameworks, terms and key concepts of empirical aesthetics along with the theoretical and methodological challenges of the discipline. Furthermore, I presented three studies addressing the emerging questions.

Which factors differentiate between something beautiful and something ugly for art experts and non-experts? The first study was led by this question. The results showed that symmetry, balance and meaning are the main factors in the distinction between beautiful and ugly. I also found evidence about the effect of art expertise on the preference for stimuli features and meaningfulness.

To gather a deeper understanding of this modulating effect, I set up a second study with an innovative method, which made it possible to assess the preference for symmetry and meaningfulness in comparison. The main question of the second study was: *How does expertise modulate the preference for these factors?* According to my results, art expertise sets a limit to the preferences of symmetry and meaningfulness. This does not mean that experts show opposite preferences compared to those of non-experts. Instead, in both dimensions, the non-expert like biases in the preference choices disappear and a more balanced pattern emerges. Interestingly, the preference for prototypicality does not disappear like that due to art expertise – when being exposed to meaningful stimuli. Thus, whereas art expertise modulates the preference for stimuli features and meaningfulness, in case of simple, obvious meaningful images, art experts are driven by the same factor as non-experts.

The next key question of my studies was the following: *On which processing level does art expertise modulate the visual preferences?* To get a comprehensive understanding of visual preferences, I assessed implicit preferences by transforming the task into an eye-tracking experiment. Results revealed that there is indeed a difference between art experts' and non-experts implicit preferences. Namely, I found signs of implicit symmetry preference among non-experts but not among experts, as well as implicit preferences for meaningless images among experts, but not non-experts. These findings challenge the classical theoretical framework of the aesthetic experience (Leder et al., 2004; Leder et al, 2014; Weichselbaum et al., 2018) by indicating that expertise modulates the processing even on an implicit level.

As a recently scientifically trending alternative, processing based predictive coding approaches could provide an interesting and powerful explanatory approach for these results. The predictive processing framework (see Frascaroli et al., 2024; Van de Cruys et al., 2024) suggests that our brain unconsciously forms expectations and seeks patterns. This implies that some of our aesthetic experiences and preferences may operate at an implicit level, driven by how well an artwork aligns with or challenges our brain's predictions. As such, aesthetic experiences are shaped by predictive processing, which could imply that experts and non-experts engage with art differently. Since experts have more experience and knowledge, their brains likely make more refined predictions and recognize deeper patterns or meanings in artworks. This could mean they experience different epistemic arcs, perhaps finding pleasure in more complex or ambiguous works, whereas non-experts might prefer clearer, more predictable structures.

The most important finding of this series of studies is the conclusion that the preference for symmetry cannot be interpreted without considering the factor of meaningfulness, similar to the effect of expertise, which can also only be understood in relation to the meaningfulness of the presented stimuli. The thesis, therefore, highlights the interconnection between the factors examined, providing an initiative of the comprehensive assessment of them. Nevertheless, many limitations and critical issues need to be addressed in future research. By employing a diverse range of methods I presented a comprehensive assessment of visual preferences, which contributes to the understanding of the role of art expertise in the aesthetic experience.

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10. Appendices

10.1. Appendix 1: Correlation tables of the raters in study 1

		Rater 1	Rater 2	Rater 3
Balance				
Rater 1	Spearman's rho	—		
	df	—		
	p-value	—		
Rater 2	Spearman's rho	0.578	—	
	df	112	—	
	p-value	< .001	—	
Rater 3	Spearman's rho	0.464	0.406	—
	df	112	112	—
	p-value	< .001	< .001	—
Symmetry				
Rater 1	Spearman's rho	—		
	df	—		
	p-value	—		
Rater 2	Spearman's rho	0.709	—	
	df	112	—	
	p-value	< .001	—	
Rater 3	Spearman's rho	0.927	0.654	—
	df	112	112	—
	p-value	< .001	< .001	—
Integrity				
Rater 1	Spearman's rho	—		
	df	—		
	p-value	—		
Rater 2	Spearman's rho	0.494	—	
	df	112	—	
	p-value	< .001	—	
Rater 3	Spearman's rho	0.537	0.397	—
	df	112	112	—
	p-value	< .001	< .001	—
Complexity				
Rater 1	Spearman's rho	—		
	df	—		
	p-value	—		
Rater 2	Spearman's rho	0.625	—	
	df	112	—	
	p-value	< .001	—	
Rater 3	Spearman's rho	0.646	0.367	—
	df	112	112	—

	p-value	< .001	< .001	—
Stability				
Rater 1	Spearman's rho	—		
	df	—		
	p-value	—		
Rater 2	Spearman's rho	0.316	—	
	df	112	—	
	p-value	< .001	—	
Rater 3	Spearman's rho	0.478	0.248	—
	df	112	112	—
	p-value	< .001	0.008	—

10.2. Appendix 2: Testing the effect of alternative symmetries

Testing the effect of alternative symmetries in the stimuli used in study 2 and 3

Data analysis:

Statistical analyses were performed using the JAMOVI Statistics Programme (Version 1.2.27.0 for Windows). As vertical bilateral symmetry is the most salient in the preference choices, other types of symmetries also appear on the 'asymmetric' images. Namely, in set 4 (magnifying glass) both 'asymmetric' images have a 45° symmetry axis, as well as the meaningful "asymmetric" image of set 5 (hourglass), while the meaningless "asymmetric" variation of set 5 has a 180° rotational symmetry. To test whether these symmetries influenced the preferences we compared the preference choices within the same image types between the sets using the data of the non-artist group. Therefore, we summarized the number of preference choices for each image set's each image type across the first 4 blocks to keep the number of choices comparable. The new variables had a skewness and a kurtosis between -2 and 2. For the comparisons, we used a 2x2 ANOVA with the two factors of image type and image set. As sphericity assumption has been violated, and the Greenhouse-Geisser epsilon (ϵ_{GG}=0.47) suggested a severe violation of sphericity, the Greenhouse-Geisser correction was applied. For checking the consistency among the specific images, we used Tuckey corrected pairwise comparisons. As set 4's meaningful image is the set's prototype, we compared it to the other sets' meaningful, asymmetric and prototypical images (set 1, 2 and 3 has 1-1 image like this, labelled as 1AB, 2AB and 3AB). Similarly, we compared set 5's meaningful asymmetric image to the other sets' meaningful, asymmetric and non-prototypical images (set 6, 7 and 8 have 1-1 image like this, labelled as 6AB, 7AB and 8AB). Regarding set 4's and set 5' meaningless asymmetric images (4BB and 5BB), we compared them to all other set's meaningful and asymmetric images.

Results:

Regarding the appearing symmetries in the "asymmetric" labelled images, we found the following results. The interaction between the image type and image set turned out to be significant ($F(13.32,1105.82)=25.5$, $p<.001$, $\eta^2_p=.235$), which is understandable given the differences in prototypicality, but we wanted to specifically look at the Tuckey corrected pairwise comparisons (see Table 10). When comparing the number of preference choices to the other sets', neither in case of set 4's (magnifying glass) nor in set 5's (hourglass) meaningful asymmetric image (4AB and 5 AB) showed any significant difference to other images of the same type. In case of set 4's meaningless and "asymmetric" image (4BB) 0 out of 7 comparisons turned out to be significant, whereas in case of set 5's meaningless "asymmetric" image (5BB) there was 3 out of 7 significant differences (set 5 BB – set 1 BB: $t(83)=-4.325$, $p=.014$; set 5 BB – set 2 BB: $t(83)=-4.491$, $p=.008$; set 5 BB – set 7 BB: $t(83)=4.165$, $p=.024$). See the relevant part of the Post Hoc pairwise comparison table in Table 10.

Given that set 5's meaningful 'asymmetric' image did not clearly fit in its dedicated image type, we decided to double check all of the above findings (except the prototypicality preference analyses, as they do not involve this particular image) with the preference choices of set 5 removed from the data. As the effects and differences both between and within the groups were consistent with the above presented, we consider our results as not affected by the mentioned alternative symmetries. The data without set 5 is also available in the OSF folder of the study.

Discussion:

Even though vertical bilateral symmetry is the most salient in terms of visual sensitivity and preferences compared to other types of symmetry (Wagemans et al., 1992; Treder, 2010), rotational symmetry also could influence the preference choices to a moderate level in our study. Furthermore, the role of rotational symmetry in the preferences of simple geometric patterns among experts and non-experts could be the focus of future studies. This calls for methodological improvement. Therefore, in the future, we will strictly avoid including different types of symmetry in the 'asymmetric' figure group for better control of variables, so that we can draw more straightforward conclusions on the preferences.

Table 10 – The relevant parts of the post hoc comparison table for testing the consistency of image sets regarding the appearance of diagonal symmetries of images 4AB (*asymmetric magnifying glass, set prototype*), 4BB (*magnifying glass set, asymmetric meaningless*), 5AB (*asymmetric hourglass*) and rotational symmetry of image 5BB (*hourglass set, asymmetric meaningless*)

Comparison									
Type	**Set**		**Type**	**Set**	**Mean Difference**	**SE**	**df**	**t**	p_{tukey}
AB	1	-	AB	4	0.0952	0.1502	83.0	0.6342	1.000
	2	-	AB	4	0.1190	0.1601	83.0	0.7434	1.000
	3	-	AB	4	-0.2857	0.1594	83.0	-1.7925	0.995
	5	-	AB	6	0.4286	0.1713	83.0	2.5020	0.793
		-	AB	7	0.4405	0.1654	83.0	2.6633	0.684

Table 10 – The relevant parts of the post hoc comparison table for testing the consistency of image sets regarding the appearance of diagonal symmetries of images 4AB (*asymmetric magnifying glass, set prototype*), 4BB (*magnifying glass set, asymmetric meaningless*), 5AB (*asymmetric hourglass*) and rotational symmetry of image 5BB (*hourglass set, asymmetric meaningless*)

Comparison										
Type	**Set**		**Type**	**Set**	**Mean Difference**	**SE**	**df**	**t**	**p_{tukey}**	
		-	AB	8	-0.4286	0.1671	83.0	-2.5654	0.752	
BB	**1**	-	BB	4	-0.5476	0.1601	83.0	-3.4195	0.187	
		-	**BB**	**5**	**-0.7857**	**0.1817**	**83.0**	**-4.3246**	**0.014**	*
	2	-	BB	4	-0.6071	0.1616	83.0	-3.7574	0.079	
		-	**BB**	**5**	**-0.8452**	**0.1882**	**83.0**	**-4.4908**	**0.008**	*
	3	-	BB	4	-0.2024	0.1623	83.0	-1.2473	1.000	
		-	BB	5	-0.4405	0.2224	83.0	-1.9810	0.980	
	4	-	BB	5	-0.2381	0.2001	83.0	-1.1897	1.000	
	5	-	BB	6	0.5595	0.2091	83.0	2.6765	0.675	
		-	**BB**	**7**	**0.7857**	**0.1887**	**83.0**	**4.1648**	**0.024**	*
		-	BB	8	0.7738	0.2204	83.0	3.5108	0.150	