University of Padua

Department of General Psychology - DPG

Master's degree in Applied Cognitive Psychology

The Aesthetic Perception of Movement

Symmetry perception in Bharatanāṭyam dance

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INDEX

0) INTRODUCTION 7

1) SYMMETRY 11

1.1 Symmetry is all around us! 11

1.2 *Natura magistra vitae* 13

1.3 Symmetry-*made* 17

1.4 Symmetry-*taught* 21

1.5 How does the brain perceive symmetry? 23

1.6 Symmetrical face and beautiful soul 28

2) DANCE 34

2.1 Moving bodies 34

2.2 Beauty, Art and Aesthetics 39

2.3 Neuroaesthetic 43

2.4 Dancing bodies 47

2.5 *Bharatanāṭyam* dance: between history and myth 55

2.6 Dancing sculptures 60

3) SYMMETRY PERCEPTION IN *BHARATANĀṬYAM* DANCE 65

3.1 ABSTRACT 65

3.2 INTRODUCTION 66

3.3 MATERIAL and METHODS 69

3.4 Data analysis 76

3.5 Discussion 84

3.6 CONCLUSION 86

4) SPECIAL THANKS 89

5) REFERENCES 91

Figure 1 My teacher, Lucrezia Maniscotti, during her performance at the Narada Gana Sabha hall in Chennai (1/03/2020)

INTRODUCTION

ὁ δὲ ἀνεξέταστος βίος οὐ βιωτὸς ἀνθρώπῳ

"A life without research is not worth living."

[Plato – *Apology of Socrates*

The birth of this thesis starts from my passion for everything related to the vast and, at the same time, mysterious world of India. There are so many things to explore that you could lose yourself into this rich and manifold world! And it is very difficult to pay attention to just one of the disciplines because inevitably it connects to all the others: one thing I discovered when I delved into this culture, is that it is impossible to disentangle the very tight interweaving that unites the various aspects of Indian culture itself, as well as to try to separate the "spiritual" world from what in the West we would call "everyday" or "earthly" world. There is always a two-way link between microcosm and macrocosm (man and universe) as well as between myth, history and present reality. In this thesis I've decided to focus on dance (classifiable in the performing arts) because it is my passion. Always inspired by my family, I have nurtured the desire to find points of communication between the two wonderful worlds that are the East and the West: discovering points in common and differences to get closer and closer to a possible answer to the question that, as for me, has tormented many philosophers, writers and scholars for centuries, of what makes human beings such. What elements can we truly consider universal despite individual differences? Is what makes us human limited to our body, our brain, or the way our system work in relation to the world?

The objective of this thesis, therefore, at a macroscopic level, is part of this push to explore Indian culture in greater depth and try to find elements that can be considered common and cross-cultural and therefore be able to make parallelisms between the Eastern and the Western worlds. Specifically, the focus is on perception, in particular on the *perception of symmetry*. Especially in

recent centuries, a theme that has been much deepened, especially by Indian philosophy and literature, is precisely Aesthetics. It is a recent issue even in the West. Unlike the latter, a problem that concerns the studies made on Indian culture is that it is based on the oral transmission of information: a fascination and a study on aesthetics is known to have always been there[1] but little has been written and what little has been written is difficult to decipher or to attribute to a specific author. My question was: *since many studies show that there is indeed a preference for symmetry (initially in faces, but it can also be extended to body movements), and symmetry is a very present element in Indian dance, will there be a preference for symmetry in this dance even by people who are not dancers and do not know this dance?* With this question in mind, the investigation began: this thesis is a systematic review divided into three main chapters. In the first chapter will be presented a complete review of what is known about symmetry and how it influences our judgments on beauty not only at the level of physical attraction, but also at the level of personality. Is the attraction for certain mathematical proportions innate in man's birth and evolution or is it only the result of cultural conditioning? Since symmetry is very linked, in fact, to the judgment of beauty, the second chapter will focus more on Aesthetics and Art. These three concepts (beauty, Aesthetics and Art) are commonly conceived as synonyms, but they are distinct from one another and one does not necessarily imply the presence of the other. Some of the most recent Neuroaesthetic research will be addressed in an attempt to better understand, by the scientific community and beyond, what characterizes the Aesthetic experience (very complex and that goes beyond other types of intellectual or emotional experiences) by investigating neural correlates in the brain. Neuroaesthetics is a fairly new branch of Neuroscience and the exploration of dance through neuroimaging techniques is even more recent. Very few studies have been done, but in the last ten years their number have started to increase. In this chapter, moreover, the dance style examined in the research will be described: *Bharatanāṭyam* dance.

[1] I am anticipating here the concepts of *Rasa* (रस) the purpose of all indian art forms, especially visual art forms like dance, and the core of classical Indian Aesthetic.

I have been practicing this dance style for four years now and I have explored only the tip of the iceberg in my research of what is this art form, but is exactly what got me passionate about it in the first place. A characteristic of this style of dance (at least on a more technical level, of pure dance[2]), originating in South India (Tamil Nadu), is precisely the ability of the dancer to be able to create clean lines and geometric shapes in space, both with his body and through his movements. The movements are usually symmetrical and there is a constant search for balance in the position of the body: this makes the vision of the dancer aesthetically pleasing. The strong presence of symmetry in this dance brings us to the finale chapter, where I will expose the actual research. Participants who were not experts in dance (in general) were shown videos in which a dancer performed pure dance movements inspired by two of the most important textbooks[3] to which dancers of *Bharatanāṭyam* usually refer: *Nāṭyaśāstra* and *Abhinayadarpana*. Some of these movements are done as these textbooks say, that is, they are performed as they have always been taught: first the movement on the right and then the same movement (trying to be as symmetrical as possible) on the left. Other movements were deliberately mixed: after performing one movement on the right, a different one was performed on the left. There were sequences of different steps in the dance, but in this case, since there is no choreography at the base, they can be considered "non-following-the-rule" movements. After watching each video, participants were asked to give four judgments: the *pleasantness* perceived after seeing the movement, the *fluidity*, the *expressiveness* and finally, how much the movement was perceived as *codified* (following the rules) or not. The hypothesis is that, despite being an unknown dance here in Italy, the preference for symmetry will prevail anyway. Even if on an intellectual level *Bharatanāṭyam* dance is not known and on a practical level no other forms of dance

[2] *Bharatanāṭyam* is generally divided into two main categories, as it will be explained in more detail in the following chapters. Pure dance is called *Nritta*.

[3] All of the choices that are associated to the preparation of a dramatic act is contained in the *Nāṭyaśāstra,* an ancient treatise that is thought to be written by Bharata Muni between 200 a.C. and 200 d.C. For drama I refer to the greek word that is δρᾶμα -ατος, which derives from the verb δράω «act». "In a broad sense, and closer to etymology, any literary composition, whether tragic or comic, intended for representation on the stage." (Treccani, s.d.). Whereas *Abhinayadarpana* was written, according to scholars, much later: the works already existed in the XIII century. The words of this sanskrit treatise is attributed to Nandikeshvara.

are known by participants, since it has been shown that there is an automatic preference to symmetry, positive correlations should emerge more evidently between symmetrical movements and judgments of *pleasantness*, *fluidity* and *improvisation*.

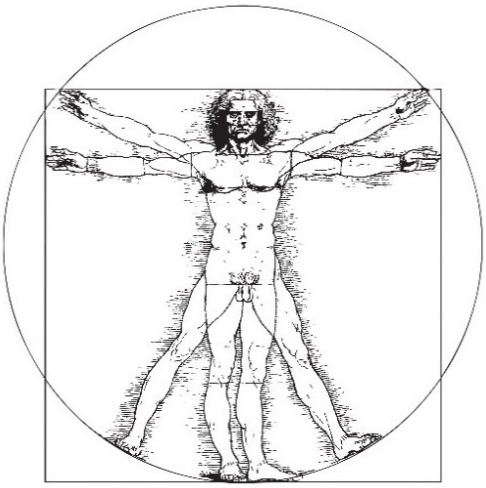
1 SYMMETRY

"The mathematical sciences in particular show order, symmetry and limit: and these are the greatest instances of beauty."

[*Aristotle*

1.1 Symmetry is all around us!

The fact that in the history of human beings we can find many examples, in the most varied areas, of symmetry, is a proof that this has always fascinated humankind and in some ways is part of man himself. Let's just think to how man is structured, imagining dividing his figure vertically in half: two eyes, two hands, two arms, etc., which are specular between each other.



[4]

Figure 2 Leonardo Da Vinci, Vitruvian Man, 1490, pen and ink on paper, 34.4 x 24.5 cm.

[4] *Vitruvian man*. Leonardo Da Vinci, 1490 ca. The Vitruvian man is a symbol of Renaissance Art and it refers to the proportions of the human body that are analyzed according to the writings of the Roman architect Vitruvius in his artwork *De Architectura* (15 a.C.). This drawing tries to represent, according to the mindset of that period when Leonardo Da Vinci lived, the man as *the measure of all things*. It is a famous representation of the ideal proportions of the human body, it tries to demonstrate how it can be harmoniously inscribed in the two figures considered, since the ancient greek philosophers, "perfect": the circle, which symbolizes the divine perfection, and the square, which symbolizes the earthly world. The man, inscribed in those figures, would represent the union between microcosm and macrocosm.

Even the brain itself can be thought of as communication between two mostly symmetrical hemispheres on the outside, but very different on how they constantly *cooperate in order to generate a unitary perception of the world* (Ornaghi, 2003). We always represent the human body as a whole, as one, but it is composed by almost symmetrical couples working together, even if in the case of the human being one cannot think of a perfect, let's say "geometrical" symmetry. Inevitably, while thinking of symmetry, the aspect of measurement and mathematical proportions comes to mind. As a matter of fact, the word "symmetry" itself derives from the combination of two greek words: *métron* which means "measure", and *sun*, which means "with", so the literal meaning of the word symmetry is "with measure". The general definition of symmetry could be *the ordered, uniform and invariant disposition of elements in a system,* usually referring to the world of mathematics and geometry as *the property of an object or system that remains unchanged when certain transformations are applied to it, such as rotation, reflection, or translation* (Treccani, s.d.). So, a figure can be defined as symmetrical when it can be divided into several parts, which are identical and can be overlapped on each other. There are several kinds of symmetry: the most common one is *bilateral* symmetry, which is when the symmetry refers to the antero-posterior axis which divides the object into two portions (usually left one and right one).

 [5]

Figure 3 Examples of symmetry in flowers.

[5] On the left and example of radial s., in the center the bilateral s., in the right an asymmetrical structure.

There are a lot of examples of this kind of symmetry in many animal species and, as said above, man itself. Another common type of symmetry is the *radial* symmetry, where the elements of a figure are identical and can be overlapped as compared to a central element. An example of radial symmetry can be snowflakes. Then there can be *translational* symmetry (Figure 4), which is characterized by the repetition of the same element of a composition as compared to a central axis. An interesting form of symmetry, which is common in nature, is *fractal* symmetry: it's a scale symmetry, which means that the elements of an object will repeat their form in an identical way but in different dimensional scales (for examples some kinds of vegetables such as broccoli or the fern). It seems that people do find these kind of "mathematical" or "geometrical" patterns attractive, engaging and beautiful and these are pattern that exist without an artist behind.

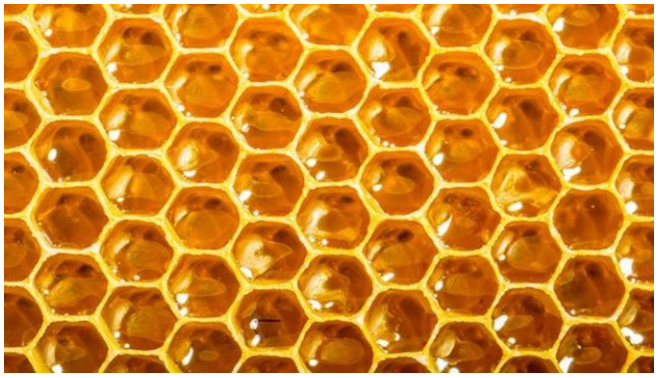


Figure 4 Example of translational symmetry: honeycomb

1.2 *Natura magistra vitae*

There are many examples in nature of attractive patterns, which are related to mathematical or geometrical proportion. One example of a "natural" number regarded as very beautiful by many mathematicians is the one known as "Phi", or the *golden ratio*. It was discovered by a Greek mathematician, Hippasus, in the fifth century BCE, and later elaborated by Euclid. The golden ratio is shown by a line divided into two segments in which the ratio of the whole line to the longer segment is equal to the ratio of the longer to the shorter segment. Phi is an irrational number (1.6180…), so it

cannot be described by a ratio of two whole numbers. The name of the number comes from Phideas[6], the architect who designed the Partenon. The golden ratio is an example of what was thought to give these classical structures their harmonious beauty (Chatterjee, 2014). The golden ratio is strictly linked to the *Fibonacci sequence*[7], which is a sequence of whole numbers in which each number is the sum of the previous two, and the sequence tend to infinity, to an irrational algebraic number, that is, as a matter of fact, the golden section. Phi and Fibonacci sequence show up in nature in many ways. We talked about fractal symmetry, which is associated to the golden spiral, described by the mathematician Jacques Bernoulli. In this spiral, the radius grows logarithmically as the spiral moves around its curvature. Taking Figure 5, the spiral is related to the golden ratio because if you take a golden rectangle and portion off a square within it, you are left with a smaller rectangle that also has the golden ratio. This is called a "self-similar" pattern because the geometric relationships are identical at different scales.

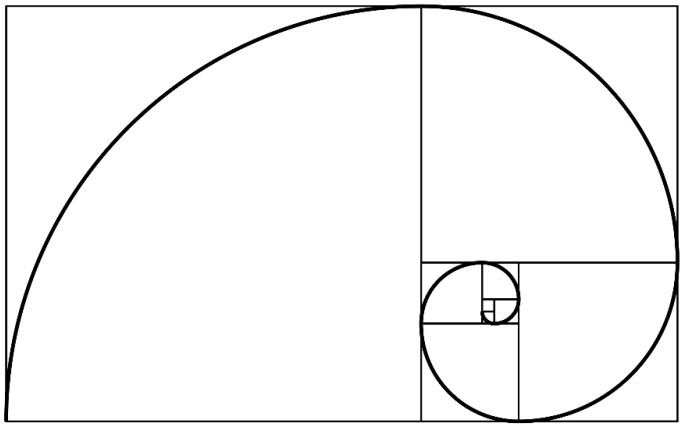


Figure 5 The golden (logarithmic) spiral

Over time this special proportion was used in several works of art as it was considered a canon of beauty and harmony, and for this reason, as the name itself tells, is associated to the concept of

[6] Also called *Phidias constant*. Phidias was an Athenian sculptor and architect , active from about 470 BC in Athens, Pellene, Plataea, Thebes and Olympia. He was one of the main protagonist in the building of Parthenon, but he used this mathematical proportion, thinking that it represented the divine perfection, also for other temples.

[7] Leonardo Fibonacci was a pisan mathematician. In 1202 he published the *Liber abbaci*, a treatise on arithmetic and algebra with which he wanted to introduce in Europe the Indo-Arabic decimal numeral system and the main methods of calculation related to it.

golden and "divine". As it is present in nature, lots of philosophers thought that it was a manifestation of the divine into the world and a link between microcosmos and macrocosms, where the human being is considered a medium between these two dimensions and "a measure of all things"[8]. There is, therefore, a long tradition in Western culture that agreed on the attribution to beauty and "good" something that is proportionate, balanced and that has "measure". Not casually, the way preferred by the Greeks was "(…) all with moderation" (Yalom, 2005). "(…) The forms of beauty are in the disposition (*táxix*), in the symmetry (*symmetría*) and in what is defined (*tohorismènon*), and the mathematics are what made these forms of beauty known more than any other science" (Grassi & Palumbo, 2021-2022).

Figure 6 Examples of golden spiral in nature

Even if this aesthetic appreciation was already present and it can be seen in many artworks, it remained at a philosophical and mathematical level, without an effective scientific approach to it. The modern field of Experimental Psychology largely owes its origin to Gustav Fechner, who was a German Physicist working at Leipzig University in the 1800s. He can be considered the founder of

[8] Protagora of Abdera was a greek philosopher (born in Abdera between 484 and 481 BC -and died at the end of the 5th century), the greatest representative of ancient Greek Sophistics. Originally from Abdera, it flourished in Athens around the middle of the fifth century. This famous sentence is a fragment of one of his literally artworks *Ἀλήθεια* o *Καταβάλλοντες*.

Psychophysics when he wrote his opus magnum *Elemente der Psychophysik* (Elements of psychophysics) in 1860. Fechner understands psychophysics as the 'exact teaching of the functional interdependence between the physical and mental, psychic and physical worlds' (Altmann, 2023). One of his interests was in how humans make fine perceptual discriminations between similar stimuli so he devised several empirical techniques to measure what is called "just noticeable difference" or JND between two stimuli, defined as the smallest change in sensory stimulation that can be detected reliably. A colleague at Leipzig, Ernst Weber[9], had previously found that these judgments were remarkably consistent and lawful, but they were limited to the physical aspect of the stimulation. Fechner extended Weber's work by exploring more the relationship between the physical stimulation and the *mental* events, the subjective perception (Mather, 2014). How does the perception of a stimulus change as the intensity of the stimulus changes? With Fechner's studies it was confirmed the fact that the relationship between the physical events and the subjective perception is *logarithmic*. If the relationship was linear the result would be a one-to-one relationship, that is to a stimulus' intensity increment should correspond an equally proportioned increment of the sensation in the subject. Whereas in this case in order to perceive a change in the stimulus, the increment of the intensity should be stronger. This relationship was defined as the *psychophysical law*. Fechner experimental methods to measure JNDs became known as psychophysical methods and variants of them are still widely used in experimental psychology.

He was also one of the first to use a scientific method applied to the investigation of aesthetic judgments (*Empirical Aesthetics*). In his later work, Fechner applied the new psychophysical approach to aesthetic judgments. His aim was to reveal the laws that relate objective measures of

[9] The relationship between a stimulus and its perception was first studied by Ernst Heinrich Weber (1795-1878) and only later was elaborated in the form of a theoretical model by Gustav Theodor Fechner (1801-1887). These studies represented the first foundation of *Psychophysics*, which was in turn the pioneering field of the nascent *Experimental Psychology*. The discovery of the relationship between stimulus and perception was made by Weber following the experiment consisting in increasing the weight of an object by a certain amount. The perception of this stimulus was less accentuated the heavier the object was. What is now called the Weber-Fechner Law, posits that the magnitude of the increase necessary for the variation to be perceived by the subject is not linear, but logarithmic.

aesthetic judgment to physical properties of the sensory stimulus. In 1876, Fechner described three empirical techniques for studying aesthetic judgments (Mather, 2014): method of *production* (the participant is asked to produce an artwork that conforms to their taste), method of *choice* (the participant is asked to compare artworks with respect to their "pleasantness") and method of *use* (artworks are examined under the assumption that the most commonly observed characteristics will be those that meet with the most widespread approval). In one experiment (Höge, 1995) his methods were used to find out if there was a preference for the golden ratio between subjects. The results were mixed: people preferred the golden ratio for rectangular frames (not for ovals) by using the method of choice, but when people were asked to produce rectangles or to measure objects there was no agreement. This were the first attempts to understand better the relationship between object and subject in aesthetic judgment. It is a complex relationship where lots of variables play a role and the question of whether the aesthetic appreciation resides into the eye of the beholder or into the properties of the object is still open and it will be explored more in details in the next chapters.

1.3 Symmetry-*made*

So, from where it comes the fascination for symmetry? There is evidence that there is a strong influence of the Greek philosophers about the concept of symmetry as something that automatically harmonious and balanced and for this reason "good". But is not always like that: for example the Islamic Aesthetic (Shabout M. N., 2018) is strictly linked to asymmetric patterns in their architectural artworks, but also in other kinds of manufactural art (such as carpets or fabric decorations). This idea is completely opposite to the aristotelic concept of art as *mimesis*, as the copy of reality. The motivation is religious: the artist cannot reproduce in the exact same way natural elements, not even the individual itself, let alone something considered as perfect as a symmetric pattern, because that would mean to overcome the power of God, the ultimate creator of life and the definition of perfection. However, the awareness of the irresistible attraction to mathematical arranged patterns

already existed since the early forms of civilization and maybe, unconsciously, even before that. Being surrounded by natural elements with specific mathematical proportion and some also with strong symmetrical features, probably led to the development of a "built-in" *preference* for symmetry during the evolution of human species: "(…) The pleasure in a feature *that happened to be adaptive* is what survived" (Chatterjee, 2014). According to the *Evolutionary Advantage View*[10], symmetry is an indicator of *fitness*: during the mating process, a male with symmetrical features is preferred to one with asymmetrical ones because having symmetrical features means "having good genes" and, as a consequence of that, having more probability to face the challenges of an environment and survive, guaranteeing the continuation of the species. "In the natural, as opposed to man-made, world, symmetry (…) serves as an early-alert system, drawing your attention. Even an infant, who has blurry views of his or her surroundings because of not yet developed acuity, has an innate preference for symmetry" (Chatterjee, 2014). Some researches show that this is probably because "(…) infestation with parasites can cause visible asymmetry in victims. As a parasite species evolves, it continuously tries to match its surface antigens to those of its host to evade immunological rejection. At the same time, there is a strong selection pressure on the host to be able to detect parasitic infestation and other abnormalities that might potentially reduce fitness and reproductive success. If parasitic infestation occurs sufficiently early in development, it can produce minor deviations from symmetry — hence the adaptive advantage of using asymmetry as a marker to avoid potential mates with poor health, weak genes or a challenged immune system." (Ramachandran S. V., 2009). Moreover, symmetry is more easily detected since it has an ordered and overall simplified pattern. Reality is intrinsically

[10] The *Evolutionary Advantage View* Charles Darwin's Theory of Evolution. Charles Darwin (Shrewsbury, 1809) was an english biologist, naturalist, anthropologist, geologist and explorer, famous for having formulated the Theory of the Evolution which he published his theory in the book *On the origins of Species* (1858), his best-known work. According to Darwin, living beings undergo random genetic mutations at each generation, which are transmitted to their children through the mechanism of natural selection. The individual mutated in a more functional direction towards adaptation to the environment is more likely to reproduce and therefore favors that specific mutation in the long run. Darwin's theory is a fundamental pillar of modern science and a revolution for the mentality of that period: his theory removed man from the center of the natural world and defined nature from the biological point of view, as a system in motion guided by precise laws, which can be explained by reasoning, without resorting to supernatural entities.

complex and unpredictable: symmetry is a useful tool that can help to detect immediately an object and this accessibility given by the ease with which symmetry is processed may be another aspect that contributes to the preference for symmetry. Symmetry has been proposed as a fundamental principle of aesthetics (Ramachandran & Hirstein, 1999) and the sensitivity of the human visual system to symmetry, and reflectional symmetry in particular, has been confirmed by other neurophysiological works (Bertamini & Makin, 2014; Makin, Rampone, & Bertamini, 2015; Sasaki, Vanduffel, Knutsen, Tyler, & Tootell, 2005). This sensitivity seems to be present since childhood.

In a study (Griffey and Little, 2014) where eye-tracker was used, it was demonstrated that infant's (between the ages of 12 and 24 months) appreciation for facial attractiveness in adult images is based on some, but not all, traits that adults find attractive. It's important to point out that in this context "attractiveness" does not mean, as it is commonly thought, sexual attractiveness, but actually it is "the power of objects to attract our attention" (Chatterjee, 2014). Newborns usually prefer large objects, that are curvilinear rather than sharp, structured rather than uniform and complex rather than simple: not surprisingly, the stimulus favored by the child is the human face. Many scholars believe that the newborn has an innate predisposition to the human face and to direct the gaze towards it (Goren, Sarty, & Wu, 1975). This predisposition, just like that for the human voice, seems to have an adaptive value to favor the bond of attachment, the acquisition of information on people and human relationships. The baby's visual apparatus, interestingly, initially seems to be predisposed to focus only on objects about 25 cm away, which is the distance of the mother's face while breastfeeding it (Vianello, Gini, & Lanfranchi, 2015). A few days after birth, based on the first experiences of life, newborns are able to discriminate (and prefer to look longer) the face of the mother compared to that of another woman. From the perceptual point of view, various studies have shown that the child is attracted to the face for the sharpness of the contours, movement, *symmetry* and complexity; at least the preference for vertical symmetry seems to be innate (Bornstein, Ferdinandsen, & Gross, 1981). It is interesting to note that there is a tendency in human being to also personalize objects: it is the

phenomenon called *pareidolia*[11]. Pareidolia is a perceptual distortion, that is, a misperception of an external stimulus: is the characteristic of the brain to associate casual and disordered images to faces. It is believed that this mechanism of rapidly identifying human faces and using this scheme to quickly elaborate reality reflected an evolutionary advantage in prehistoric men to allow them to identify dangerous situations (like finding a predator camouflaged in nature). Moreover, not only there is the tendency of associate human faces to objects, but there is also the tendency to attribute psychological intentions to "humanized" objects. This reveals that the preference for human faces is so rooted and important in our system that we tend to generalize this perception into other inanimate objects to give a meaning to ambiguous or random patterns (Wardle, Taubert, Teichmann, & Baker, 2020).

So, infants orient themselves and stare longer at configurations that have more a face-like arrangement rather than non-face one and this preference seemed to be dependent on orientation: infants' preferences for attractiveness are apparent only when faces are upright and not inverted. Moreover, infants prefer to look at human faces rated as physically attractive by adults over less attractive faces and these preferences seem to be generalized across sex, age and race. A large number of studies conducted with human adults have identified that three parameters contribute to facial attractiveness, none of which is unique to any specific ethnicity, that can be used to "measure" facial attractiveness: symmetry[12], averageness and sexual dimorphism (Chatterjee, 2014). With symmetry being already explained, averageness means that the averaged features of a face are more attractive than each individual face[13] and sexual dimorphism refers to the differences in physical features based

[11] We can see some famous examples of this phenomenon in art: Giuseppe Arcimboldo, an Italian painter, is known for is painting where he assembled fruits and vegetables and the final result was the portrait of a man. Another example could be in Psychology, where in the and also in Psychology field with the Rorschach Test that has become famous especially in the Psychiatric field. The Rorschach test is a personality projective test where the subject is asked to say what the ink blot looks like.

[12] The anthropologist Karl Grammar and the biologist Randy Thornhill measured facial symmetry by measuring the distance of different facial landmarks on both left and right side of the geometric center of the face. They showed that symmetry index correlated with judgments of attractiveness of men's and women's faces.

[13] Francis Galton was interested in whether specific facial features were characteristic of personality traits: he wanted to know if it was possible that one could identify common features in the faces of criminals. He overlaid the faces of many criminals onto a single photograph, hoping that the composite face would reveal the prototype look of a criminal. Instead, Galton found that composite faces were more attractive than each individual face that made up the composite.

on gender. Specifically, the sex hormones (estrogen for women and testosterone for men) produce sexually dimorphic physical features. Adults prefer average and symmetric face images. As for women's faces, femininity is generally preferred, but for men's faces studies report mixed findings with preferences for feminine and masculine male faces seen across studies. Are these known parameters that characterize adult preferences the same that characterize what for infants is an "attractive" face? In a study (Griffey & Little, 2014), to see if there were some similarities between infants' perception and adult perception, visual preference for each trait was tested using visual paired comparison (VPC) task for each one of the three facial dimensions investigated and then, using the data collected from eye-tracker registration, it was calculated by taking the average fixation length for average, symmetric, and feminine images and subtracting the average fixation length for less average, asymmetric, and masculine images. In line with adult preferences, the data indicated that infants spent significantly longer time looking at symmetrical over asymmetrical faces. Infants also looked longer at feminine faces over masculine faces. Unlike human adults, who commonly display a preference for facial averageness, infants displayed a significant visual preference for the non-average rather than the average versions of faces. One plausible explanation for infant's preferences for non-average faces may be an attentional bias for new and unusual stimuli rather than a preference for attractiveness. Indeed, a number of experiments have found that infants display visual preferences for unexpected stimuli: as faces that are high in averageness are typically low in distinctiveness it is likely that non-average faces appear unusual or distinctive.

1.4 Symmetry-*taught*

There is another hypothesis regarding the preference for symmetrical features in objects and human faces: *the Perceptual Bias View*, which posits that symmetry preferences are a consequence of greater ease of processing symmetrical images in the visual system and so that symmetry preferences can

emerge as an outcome of a generalized learning process. According to this theory, symmetry preferences observed in nature can be independent of any *fitness* relationship: it is not related to genes, but it is a familiar prototype. In a study (Swaddle, Judy, & Clelland, 2004) on European starlings (*Sturnus vulgaris*), this theory is empirically tested: trials lasted 40 minutes where the birds were trained and tested in blocks of four, one at a time and in random order. From these data, the percentage of feeding visits to S^+ dishes (those with the bar images of different percentage of asymmetry) was calculated. Results showed that symmetry could be preferred just because it represents the average expression of bilateral traits: birds were significantly more likely to visit and feed from dishes displaying images that were the average of their learning set (learning trials). The birds trained in both condition (left and right asymmetry), where more likely to fed from dishes containing symmetric images than left and right birds combined. These results confirm the *Perceptual Bias View*, but there are other studies which disconfirmed this hypothesis (Little & Jones, 2003).

Thus, it can be said that the preferences for symmetry could be the outcome of the interplay between biological and ecological adaptation. Findings from a studio (Huang, Lyu, Kue, & Peng., 2020) on 4 years old children indicated that the formation of an aesthetic preference to symmetry may also be associated with perceiver's interactive experience with the objects. This could be said to be a *constructivist* view, which emphasizes the interactive experience between subjects and objects in the process of aesthetic preference formation. Here, 4-year-olds did not spontaneously choose the symmetric objects as more pleasurable, however, after receiving perceptual exposure by playing a picture matching game, the preference for symmetry emerged. Meanwhile, the exposure did not cause any effect on asymmetric pictures. Furthermore, this effect not only existed for the pictures exposed to children but also extended to new pictures with similar symmetric features that the children had never seen. It can be said that children indeed differentiated the symmetric forms better, which suggests that the symmetry was better perceptually encoded. Therefore, the "good feature" accepted and "defined" early by the perceptual system provided an advantageous cognitive foundation for the preference of aesthetic appreciation to be built upon. Then, the preferences were finally promoted by

the nourishment of an external exposure experience. To summarize, the evidence at hand suggests that some faces are universally regarded as attractive. This claim does not deny cultural and contextual influences. So, if people are attracted by faces that have universal features, are our response to these features built into our brains in the same way?

1.5 How does the brain perceive symmetry?

As different other studies have shown this phenomenon of being "hard-wired" to perceive symmetry, we could say that symmetry detection is an automatic process, meaning that it is a visual process that is constantly applied to any visual input, and it affects the way we perceive our visual environment. To start, let's review how our brain *see* the world around us and how our visual system is structured. Everything starts with the light, that we can say it is a form of energy known as electromagnetic energy, because it has both electrical and magnetic properties and it is carried in small particles called photons. Each photon has a characteristic vibration frequency and the standard way of measuring it is in term of the distance between adjacent peaks in the vibrating wave (wavelength). The wavelengths can vary from very short (which can pass through objects such as X-rays) to long waves (with lower frequencies). We can see just a tiny portion of this electromagnetic spectrum, corresponding to wavelengths between 400nm and 700nm (visible band-light). This means that it reflects off most surfaces and can be focused by our lenses.

Seeing begins with an image formed on the inside surface of the eye: the light rays enter the eye through the pupil (the small black aperture in the center of the eye) and it is brought to focus by the cornea (the curved transparent surface in front of the pupil) and by the flexible transparent lens positioned behind the pupil. The rays, then, hit the retina, a sheet of nerve cells that line the inside of the eye. The retina contains a dense matrix of light-sensitive cells, called photoreceptors[14], which

[14] There are more than 120 million distributed unevenly (more concentrated in the central part of the retina, the fovea). They are cones (three classes that process colors and work during the day, also called "chromatic channel") and rods (adjustment of light contrasts, also called the "achromatic channel").

each produce a small electrical signal to the brain when struck by the light: the electromagnetic signal goes into the optic nerve at the back of the eye towards the visual cortex in the brain.

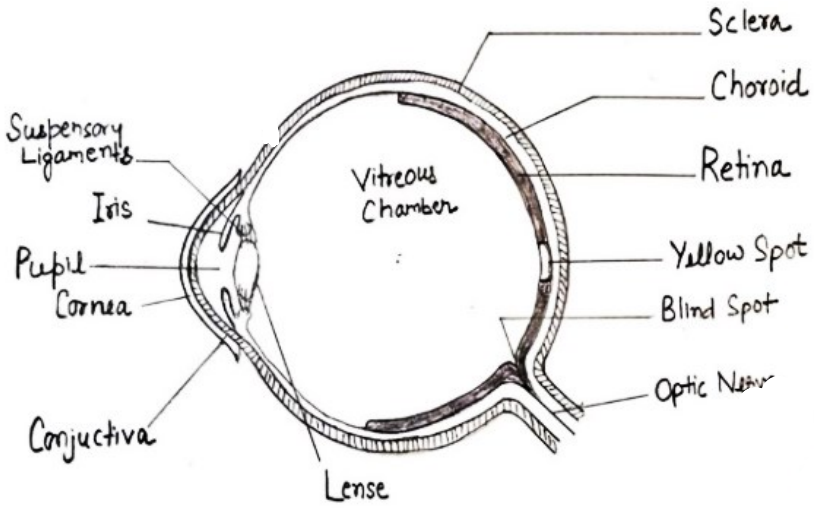


Figure 7 Simplified example of the human eye and of its main components.

About one-fifth of the cortical surface of the brain is devoted to primary sensations (vision, sound, touch, balance, smell and taste) and to movement control, while the remainder is devoted to secondary or high-level cognitive functions. The most posterior part of the brain (in the occipital cortex) is known as the primary visual cortex (V1), which receives the input form the eyes and it is responsible for vision. Therefore, the population of neurons that specialize in processing visual information in the human brain occupies the entire occipital cortex. This reflects the complexity of the visual processing. The primary function of the visual cortex is *to combine the information from the two eyes* (Bressan, 2007), so, usually, a visual scene (especially a complex one) is perceived as the combination of different attributes into one whole image that we perceive as one[15]: spatial form, color, movement and depth are each handled by different populations of cortical neurons. After all the activity received in the retinal ganglion is sent to the primary visual cortex, V1 divides the signals relating to different attributes distributing them to different groups of neurons. Then, these V1 cells

[15] It is interesting to note that our perception of reality is nothing but a series of electromagnetically impulses that are perceived separately and only after they are united together as to form a meaningful representation of the world.

send the signals to specialized areas of the secondary visual cortex in the occipital lobe. For example, an area known as V4 specializes in the analysis of color information, while an area known as MT is specialized in analyzing motion. Specialization is a fundamental feature of cortical processing and can be found even in individual cortical neurons, which are each highly selective in terms of the visual stimuli to which they respond.

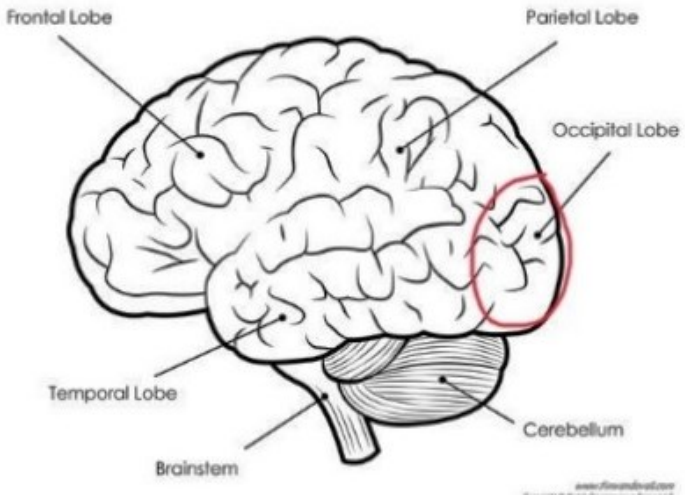


Figure 8 The human brain, viewed from the left-side. The cerebral cortex is divided anatomically into four lobes: frontal, parietal, temporal and occipital. In red the occipital cortex: the brain area dedicated to visual processing.
https://timvandevall.com/science/human-brain-diagram/diagram-of-the-human-brain/

We can say, then, that there are set of photoreceptors connected to ganglion cells (called "receptive field", the area of the retina within which light must fall for the cell to respond) and different ganglion cells respond best to different levels of spatial details. Ganglion cells, then, leave the eye to form the optic nerve and terminate in a large mass of cell bodies in the center of the brain called the lateral geniculate nucleus. Signals are relayed form there to the primary visual cortex, where there are groups of cortical cells and different cortical cells have different preferred orientations of a contour in order to generate a strong response. This process can be called *neural circuit* (Mather, 2014) and there can be different neural circuits that can create cells responding selectively to particular colors or to specific depths. However, the specialist areas for processing color, motion and so on do not converge on a single, super-ordinate "master area" that collates and interprets their output

to create a single coherent representation of the entire visual scene, but each area has multiple connections with other areas and these interconnections should ensure that the representations of different visual attributes that are constructed in different areas are knitted together in a coordinate fashion.

How does our brain process the symmetrical property of an object? First of all, a number of different studies suggests that symmetry processing is directly involved in the grouping and segmentation of visual input: symmetry was shown to affect figure-ground segregation (Machilsen, Pauwels, & Wagemans, 2009), one of the principal operations during *object formation*. In stimuli with ambiguous figure-ground arrangements, participants tend to perceive symmetric shapes as figures and asymmetric shapes as ground. Furthermore, evidence converges towards the view that symmetry serves as a *one-object cue*, that is, it signifies the presence of a single object, and, finally, there is evidence that this fact is appreciated by our visual system. All of this show that symmetry is somehow perceived really fast and in an easier way than non-symmetrical figures and that this helps detecting objects in an environment by distinguishing them from the ground. It seems that symmetry is tuned in our brain as a "guide" to adapt better in the environment. However, symmetry not only affects the way we perceive objects, but objects also affect the way we perceive symmetry. The different levels and characteristic of an object do have an impact on symmetry detection. So, it can be said that the perceptual organization process is not a unidirectional bottom-up process from images to objects but is a highly complex and combinatorial process which, for a given image, seems to search for the best-fitting object.

Symmetry, as already said before, is not only involved in object formation but also is one of the three factors that contribute to aesthetic judgment of a face or objects. Also, as evidence suggest, it seems to be a universal and innate factor, since it is present also in infants. Such a conclusion does not deny that cultural factors can also play a role in beauty and aesthetic judgment. As people find symmetrical faces more attractive than asymmetrical ones, how is this reflected in the brain? Results

from a study conducted by Chatterjee et al. (2009) showed that specific brain areas responded to more attractive faces. In the study it was used a fMRI, a functional magnetic resonance imaging[16]. For this particular experiment, people had to look at pairs of faces to observe their brain's responses to facial attractiveness. The faces were generated by a computer program and were made so that they varied in how similar they were to each other and in how attractive they were. In one session people judged the identity of the faces, and in the other session they judged how attractive they were. In this way, the experiment allowed to see how the brain responded to attractive faces even when people were not thinking about attractiveness. The results showed that specific parts of the brain responded to more attractive faces: these areas included the face area and the adjacent lateral occipital cortex, that processes objects in general. Even if it was engaged, not all the visual areas were active during the task, like for example, the area tuned to places didn't change as faces became more attractive. In addition to these areas, it was found more activity also in the parietal, medial and lateral frontal regions of the brain when people judged the faces. Probably these areas were engaged because people had to make decisions about which faces they thought were attractive (Chatterjee, 2014).

What is more interesting is that even when people looked at the faces without thinking about attractiveness (the first condition), but when they were thinking about the identity of the faces, the face area and the lateral occipital cortex continued to be active and to respond more vigorously to more attractive faces than to less attractive faces. This may mean that the visual brain reacts to facial attractiveness automatically. Even if this study did not report any neural activity in areas linked to reward, other investigations have found that these areas also respond to attractive faces. In a biological context, rewards can be defined as *stimuli that positively reinforce behavior*, meaning that they increase the likelihood that the behavior will be repeated. Food, water, sexual stimulations are well known as primary rewards, which can produce intense feelings of pleasure. Animal studies have

[16] The fMRI enables the researchers to see where in the brain the blood flows is changing when a person is doing a particular task. The changes in blood flow are a response to changes in underlying neural activity. Scientists design experiments to see which parts of the brain are active when people are engaged in different tasks.

identified a particular neurotransmitter called dopamine and a reward circuit in the brain that seem to control reward-related behavior. The circuit includes neurons in the brain regions called orbitofrontal cortex and ventral striatum. The orbitofrontal cortex receives direct connections from several regions of the sensory cortex, including visual stimuli, as well as playing a role in processing the reward value of sensory stimuli. It has been found that aesthetic appraisal is mediated by the same brain processes that serve aesthetic appraisal for objects that have survival value (Brown et al. 2011). The activation of the reward circuit demonstrates that aesthetic judgments is not purely an intellectual exercise. Aesthetics objects are rewarding in the same general way that food and sex are rewarding. So, what role does aesthetic appraisal play in the give-and-take for survival? What adaptive value might be attached to aesthetic experiences? Neuroimaging evidence demonstrated that aesthetic appraisal for objects cannot be detached from their utility. The psychologist J. J. Gibson coined the term *affordance* (Mather, 2014) to describe the properties of an object that determine just how it could be used. Aesthetic experiences must have evolved as part of a motivational system that steers humans towards certain forms of visual stimulation (like symmetry) in preference for others. That is because, the ability to perceive the affordance of an object rapidly would help to ensure survival in a challenging world, and symmetry serves to this purpose.

1.6 Symmetrical face and beautiful soul

As described in the preceding chapters, symmetry has always been present in man's life and man has always been attracted to it. Already from its etymology one can guess the link with the measure and proportions. The importance of measure starts from the ancient Greeks, for whom man himself is considered "measure of all things": the canon of Polykleitos in the creation of sculptures depicting man, based on a precise system of proportions that had to be respected for a work of art to be considered beautiful is one of the examples. The other paradigmatic example of the importance of symmetry and harmony of parts in man can be observed, as already explained earlier, with Leonardo

da Vinci's *Vitruvian Man*, demonstrating the fact that the human body can be inscribed in the perfect figures of the circle and the square, both centered in the navel, considered the "natural center of the human body": the aspect of unity of the limbs is emphasized in relation to each other by a system of defined numerical ratios, as happened in the classical sculpture. “(…) the human body, to be able to say well proportioned: the face is one tenth of the whole height; the distance from the height of the nipples to the top of the head is a quarter of the whole figure; such as the distance from the tip of the hand to the elbow; the hand, from the tip to the end of the wrist, is equal to the length of the face, from the chin to the hairline; therefore it is also one-tenth of the whole height; (...) The human body can be perfectly inscribed in a circle, but also in a square: 'The natural center of the human body is the navel; In fact, if a person lay on the ground supine with arms and legs apart, pointing the compass at the navel and drawing a circumference, this would touch both ends of the feet and hands. Nevertheless, as it is possible to inscribe the body in a circumference, so a square can be obtained from it' (…)” (Mercadini, 2022). The cleverness of Leonardo Da Vinci was to create and immediately understandable representation of the long list of proportions given by Vitruvius: “(…) reading Vitruvius' accurate and dense list, the intricate cluster of mutual proportions, it is impossible to get an idea of the whole. (...) Then the two friends have an idea: turn the text into an image; draw a human figure that corresponds exactly to the indications of the Roman architect (...) Leonardo executed a single drawing (...) destined to become one of the most famous images ever produced by an individual of our species. Nowadays practically everyone knows it, always;” (Mercadini, 2022). Even for the Romans, famous for innovation in road construction and architectural works, symmetry was a fundamental element to make a work of art beautiful. Over time, then, the association between symmetry and beauty has been consolidated and rooted in culture, especially the Western one, not only as "harmonious proportion of the parts of the body", but also as inner beauty: a statement that effectively encompasses this concept is found again in the thought and works of the ancient Greeks: καλὸς καὶ ἀγαθός (*kalos kai agazos*), that is, “that what is beautiful (which respects the mathematical harmony of the parts of a whole) is also automatically good”. It is what is also called the “Halo Effect”

(Thorndike, 1920): *when someone is thought to be physically attractive, then is automatically judged also as a good person*.

This mechanism is still deeply present in our system as previous findings of facial attractiveness have shown. Certain traits make a face be more attractive and, moreover, usually that person is also automatically judged as a beautiful person "inside", that is, he or she is also a good person. In a study facial symmetry and judgments of attractiveness (Fink, Neave, Manning, & Grammer, 2006) were observed, and the results confirmed the preference of subjects for symmetrical faces, but also the personality traits were investigated. Based on the assumption that facial symmetry is an indicator of physiological health Shackelford and Larsen[17] (1997) hypothesized that more facially symmetrical people should also be "emotionally healthier" and found some support for this assertion. It was hypothesized that an association between facial symmetry and personality attributions should remain even when controlling for perceived attractiveness. If this were true then it would tie into accumulating evidence against the perceptual bias view of symmetry preferences. In this study, twenty randomly selected faces of Caucasian females aged 18–25 out of a database of 100 female faces were presented in randomized order and participants were asked to rate them on 10 adjectives using a 7-point Likert scale (1 = least attractive, 7 = most attractive). These adjectives were: 'attractive', 'healthy', 'sociable', 'intelligent', 'dominant', 'lively', 'careful', 'self-confident', 'balanced', and 'anxious'. This study hypothesized that symmetric faces would be judged higher on attractiveness, health, and certain personality attributes such as 'intelligent' and 'sociable'. The data presented here support this view: faces high in symmetry received more positive attributes than faces low in symmetry. In contrast, asymmetric faces were perceived as being more 'anxious'.

[17] This line of research was initiated by Shackelford and Larsen (1997) who suggested that facial asymmetry may signal psychological, emotional, and physiological distress. Although the study of attractiveness and health perceptions of faces is most prevalent in the literature, information about personality attributions to facial characteristics is not well studied, especially within an evolutionary framework. With regard to facial symmetry, two recent studies pursued the hypothesis that facial symmetry may be a proxy also to certain personality characteristics. Noor and Evans (2003) reported that asymmetrical faces were rated as being significantly more 'neurotic', less 'agreeable' and less 'conscientious'. Similarly, Fink et al. (2005) found some associations with facial symmetry, extraversion and openness.

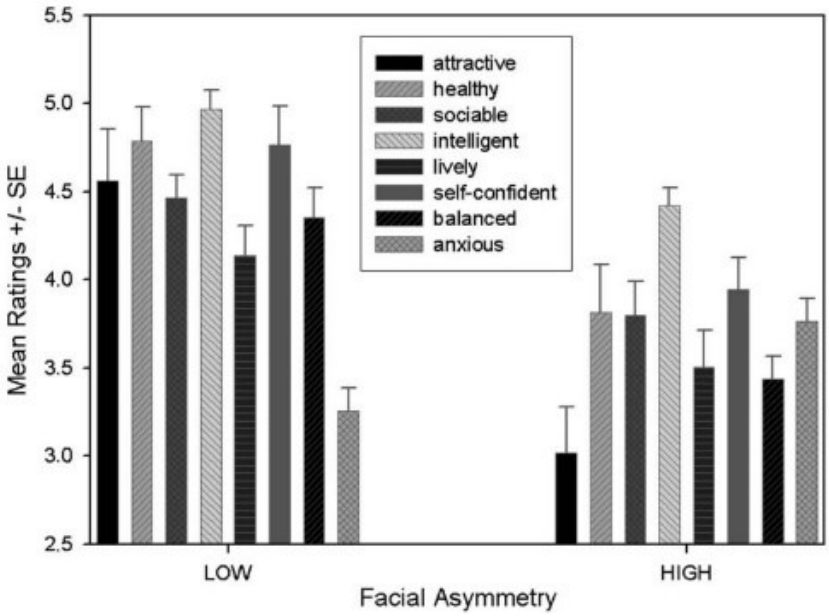


Figure 9 These bar charts illustrate differences between the mean scores of ratings on a 1–7 scale for the low (LAS) and high (HAS) asymmetry faces. From the original adjectives only those are presented which differ significantly between the two groups as result of the one-way ANOVA (Fink, Neave, Manning, & Grammer, 2006).

These bar charts illustrate differences between the mean scores of ratings on a 1–7 scale for the low (LAS) and high (HAS) asymmetry faces. The major contribution of the present study to this research is probably the information that facial symmetry may be linked to personality characteristics even when attractiveness perception is controlled. As such, facial symmetry may provide information about an individuals' personality quality, which is most relevant in social relationships and mate choice. However, the mechanisms underlying associations between facial symmetry and personality traits is still not clear: one possibility relates to the effect of sex steroids on the developmental processes of the face and on sex dependent aspects of personality. Hormones such as testosterone and estrogen can affect growth rates and facial proportions, and also may suppress the immune system. Environmental stressors can cause imbalances in the endocrine system and, as a consequence, can have an impact not only on health but also on the "temper" and the personality of and individual. However, it is evident that further research is required to support or dismiss such a causal association. These findings tie into the literature suggesting that human preferences for faces are shaped by adaptive mechanisms, which are driven by the interest of mate choosers in detecting good quality of

a potential mate that finally results in positive fitness effects. With this study it was supported the idea that, in humans, this quality may not be restricted to physical or psychological condition but may also relate to certain personality characteristics.

Starting from the hypothesis that symmetry signals health (Shackelford & Larsen, 1997), Noor and Evans (2003) wanted to examine weather facial symmetry has a causal effect on personality perception, specifically the domains of the *five-factor model* (Costa & McCrae, 1992). The five-factor model is the core of the *Big Five theory* of McCrae and Costa. This Theory posits that the personality of a subject could be described on the basis of five dimensions (Big Five) each of it forming a bipolar *continuum*: Extroversion, Openness, Agreeableness, Consciousness and Neuroticism. This model constitutes an important personality classification and description system that is based on scientific studies and vastly used both on a clinical level and on an organizational one. The participants used the 44-item Big-Five Inventory V44 (John & Donahue, 1991) to rate targets' personalities. This study evidenced how symmetry had indeed a significant effect on personality ratings: the asymmetrical faces were rated as more Neurotic, less Agreeable and less Conscientious (Noor & Evans, 2003). There was no significant main effect for symmetry on ratings of Extraversion or Openness. It seems that Neurotic individuals are more vulnerable to psychological problems and are less well equipped at coping with mental stressors (Costa & McCrae). Facial asymmetry may cause impressions of this vulnerability directly, or this vulnerability could lead to higher levels of fluctuating asymmetry over the course of a lifetime if, as argued by others, a major source of fluctuating asymmetry is life stressors (Kowner, 1996).

Another interesting study (Jacobsen, Schubotz, Höfel, & Cramon, 2006), which analyses the brain activation, showed that aesthetic judgments of beauty trigger activation in a brain network that generally underlies evaluative judgments, and so, that shares neural substrate with social and moral judgments. This fMRI study aimed at identifying the neural correlates of aesthetic judgments of beauty: novel, abstract graphic patterns were employed to minimize influences of memory-related

processes. As aesthetic judgments are known to be often guided by criteria of symmetry, evaluative aesthetic judgments were compared with descriptive symmetry judgments on the same stimulus material. Results revealed both types of judgment to rely on a set of areas supporting high-level visual analysis: specific activations for aesthetic judgments were located in the inferior precuneus and bilateral ventral prefrontal cortex, regions which have been previously reported for social or moral evaluative judgments on persons and actions[18]. Aesthetic judgments also engaged the left temporal pole and the temporoparietal junction. In contrast, symmetry judgments elicited specific activations in several areas related to visuospatial analysis, including superior parietal lobule and intraparietal sulcus as well as dorsal premotor cortex. Interestingly, when participants judged a pattern to be beautiful (as in contrast to not beautiful), not only areas dominant in aesthetic judgments, but also one area specifically engaged in symmetry judgments (left intraparietal sulcus) showed an enhanced BOLD signal. The valence of aesthetic judgments had a significant influence on the BOLD signal in several of these areas and also on the left intraparietal sulcus involved in symmetry judgments: beautiful judgments caused higher signal changes than not-beautiful judgments in left intraparietal sulcus engaged in symmetry judgments. It can therefore be said that the aesthetic judgment is not confined into specific areas, but it implies a wide communication between different areas. Moreover, the results showed also that when a pattern was judged as beautiful, specific areas linked to symmetry processing were activated. These findings can reveal that, in many participants, symmetry guides aesthetic judgments of beauty.

[18] Aesthetic judgments of beauty recruit partially overlapping networks with social and moral judgments, but also specific areas which have not yet been reported for the latter. One of these areas, fronto-median, was the center of activation during aesthetic versus symmetry judgment. The fronto-median area is a very large brain region in humans: in volumetric terms probably the largest single architectonic region of the frontal lobes. This region is possibly the last to achieve myelination, and it has been argued that tardily myelination areas engage in complex functions highly related to the organism's experience. This region has been related to the introspective evaluation of internal mental states: one's own thoughts and feelings. As also confirmed by other reviews, it appears plausible that evaluative aesthetic judgments necessitate complex relational integration in terms of multiple relations between external entities and mental states.

2 DANCE

The same current of life
that flows in my veins,
night and day flows through the world and
dances in rhythmic measure.
It is the same life that sprouts
joyfully through the dust in the
infinite threads of grass and
bursts into tumultuous waves
of leaves and flowers.

[*Rabindranath Tagore*

2.1 Moving bodies

Since now we saw that many studies confirmed the presence of a preference for symmetry in human beings. Symmetrical objects are elaborated faster and are considered more salient than non-symmetrical objects. Moreover, it seems that not everything is about the property of the object itself, but also, somehow, our brain is already "tuned" to elaborate primarily symmetrical features and to prefer those feature as they are indicators of good genes and good health (from an evolutionary point of view). Studies took in consideration as their stimuli only "static" objects or faces presented to their subjects. So, what about *movement*? Is there a preference also for symmetry in movement?

Movement could be associated to life and creation: with movement, at least for living beings, there is life. The most visible and immediate example is breath: the simple movement of inhaling and exhaling, which we usually underestimate, or we are not even aware of it during most time of the day, permits us to be alive and to live our lives. Even for checking if someone is alive, the first thing we look at is the movement of the chest. Going deeper into the structure of living beings we could say that even cells and particles move in order to keep an organism functioning. Cells breathe, they have

a metabolism, and they keep sub-dividing themselves in order to reproduce and keep on living. "(…) Bodies move. Back in 1872, Darwin observed that we use dynamic cues to guess what other people are doing. How people move gives us a lot of useful information. Neurologists are trained specifically to observe the way people walk, because a person's gait gives us the best quick index of the nervous system's health. While infants grow, the development of the ability to grab things and to slowly start walking at a certain age is an indicator of a healthy development. Moreover, in the brain, (…), we have areas that are specialized in perceiving people's movement" (Chatterjee, 2014).

Movement allows us to *survive*. Firstly, by hunting, looking for food, defending from predators and to reproduce. Movement is what composes the word *motivation* (from the latin word movĕo, to move). Since we are born we move and we are moved to achieve *deficit* needs[19]: feed ourselves, look for a safe place, reproduce (Maslow, 1968). We are moved also to achieve more than *deficit* needs (Higgins, Roney, Crowe, & Hymes, 1994): walking to school or to the university to have an education and maybe to fulfill our dream life, to have a job, to make friends, to make experiences and to feel realized about ourselves, to give a meaning to our life. At a more philosophical level, we could say that *being* is itself a movement: all living beings and also non-living beings are changing constantly and changing implies motion. For ancient philosophers, such as the pitagorics, the static, non-materialistic condition which permits movement is *emptiness*, like the space that exists between atoms which enables them to move and aggregate to create a materialistic form. In a more everyday observation, while we communicate, the silence, which implies not moving our mouth nor producing any sound, it's in a constant dialectical relationship with the words, that are movement of the breath united to sound (the vibration of the vocal cords in order to produce a frequency is itself movement). Many ancient scripts and philosophies have the concept of the movement of the breath and the sound

[19] I'm referring here to one of the most famous the psychological theory proposed by Abraham Maslow: the hierarchy of human needs explained in his work called *A theory of human motivation* (1943). The scale of needs is described as a pyramid of five levels: the first four levels can be grouped as "deficit needs", while the upper level is called "self-realization" or "being needs". The assumptions underlying the theory are that one can arrive at higher needs when lower needs have been met, and that everyone aspires to satisfy higher needs. This theory was used later on in many fields, not only psychological ones, but also in business and marketing sectors.

(the voice and the words) linked to the concept of creation. Let's just think about the Bible, where the creatin starts with the movement of the breath becoming sound: "[1] Ἐν ἀρχῇ ἦν ὁ ***λόγος***, καὶ ὁ λόγος ἦν πρὸς τὸν θεόν, καὶ θεὸς ἦν ὁ λόγος." ("In the beginning was the *Word*, and the Word was with God, and the Word was God"). And "[14] Καὶ ὁ λόγος ***σὰρξ*** ἐγένετο, καὶ ἐσκήνωσεν ἐν ἡμῖν, (…)" ("And the Word became *flesh* and dwelt among us, (…)")[20].

Also in spiritual indian philosophy there is a reference to cosmic energies which create and move the world. These energies are known as the male one, *Śiva*, one of the three main Deities of *Trimurti*[21] and "(…) one of the most popular deities, the cult of *Śiva* is widespread throughout India (…)" that "(…) has very ancient origins, it is thought to be pre-arya."[22] (Maniscotti, 2021). He is the one responsible for the creation, maintenance and destruction of the universe, He is a powerful and above-materialistic-world force, so it is not in movement. It could be compared to "Motore Immobile" (or "Prime Mover") of Aristotle (Aristotele, 2000)[23]: an eternal force which creates motion, but its

[20] Gospel according to John (VV. 1-18).

[21] *Trimurti* is a sanskrit adjective that literally means "three shapes". It indicates a threefold form of the *Supreme Being* of Hinduism, which manifests itself in the three deities of *Brahmā* (the Creator), *Vishnu* (the Preserver) and *Shiva* (the Destroyer), and exercises its saving power through *avatars* (the most important being the heroes Rama and Krishna, or human manifestations of the deity. "(…) it is important to underline that this vision of Hinduism as a single religion presided over by a *Trimurti* represents, in reality, an interpretative framework that came into being only in the nineteenth century, when European and Indian intellectuals tried to describe an extremely varied and contradictory set of religions as a unitary religion (…). The truth is that, since the action of the Brahmans was not guided by a central religious authority, their effort to integrate the various local traditions into Brahmanism could only give rise to a set of similar religions but, despite the many and conspicuous common characteristics, different from each other." (Torri, M. *Storia dell'India*. Bari, Laterza, 2000, pag. 107).

[22] We refer to the testimonies that date back to before the arrival in India of Indo-Aryan peoples around 1500 BC, in particular to the seal found in the excavations of the ancient city of Mohenjo-Daro, located in the current Pakistani territory. The seal, which reproduces a figure sitting cross-legged and surrounded by animals, is considered a proto-Śiva, seems to be, therefore, one of the first traces of the cult of this divinity, dating back to about the third millennium BC.

[23] Concept found in the *Metaphysics* of Aristotle. Aristotle (Stagira - 384 BC, Chalcis - 322 BC) was an ancient Greek philosopher, scientist and logician, considered one of the most innovative and influential minds of all time: together with Plato, his teacher, and Socrates he is considered one of the fathers of Western philosophical thought. The books indicated with the name of *Metaphysics* were not written by Aristotle with the idea of composing a unitary work, nor were they indicated by him with the current title: according to a traditional anecdote, *Metaphysics* derives from the fact that the publisher Andronìco of Rhodes arranged them 'metà tà physicà', which in Greek means 'after the books on Physics'. The books of *Metaphysics* are about what is 'after (and beyond) physics', that is, beyond the objects of which we have daily experience. This could be interpreted both in the sense of notions that could be applied to all existing objects beyond their differences, but also in the sense of something that is above objects and from which these objects derive.

nature is to be out of time and space. The other form of energy, which is linked to the materialistic and human world, is *Shakti*, the female energy characterized by duality, and so, to movement. The feminine concept in the traditional indian culture is complex and often ambivalent: it could refer to a manifestation from the society in that period of control on women in order to make them fulfill their given role of good mothers and good wives. But it is also tightly linked to various hinduistic religious currents, where the feminine deity has an important role. Even when thought as deities, goddesses have different aspects[24], but anyway it is believed that all of the different goddesses are hypostasis of one goddess: *Shakti* (vital energy). From this term the *Shaktism* was born, one of the main branches of Hinduism religion, where *Shakti* is considered the dynamic and creative energy of the supreme divine (*Brahma*) which, in intimate union with the static principle of it, generates and maintains the material nature of reality (*prākṛti*). This conception is symbolically represented by the union between the god Śiva and his consort, identified from time to time with Umā, Pārvatī, Durgā, Kālī and other feminine representations.

Figure 10 Representation of Shivashakti done by R. Dubey Mitra. https://dallastellaallaterra.com/2020/07/17/shiva-shakti/

[24] Chiara Poilcardi makes a distinction between the goddess of "breast" and the goddess of "tooth". The first one represents the procreative and protective instance, a generous goddess usually thought as an obedient spouse (who also respects the social ideals). The celebration and offerings to the breast goddess usually are not cruel. As opposed to the breast goddess, the tooth goddess breaks the rules of the "good wife", she is autonomous and dominant. These goddesses have terrifying, martials, erotic characteristics. They are ambivalent: a "powerful seduction that unsettles", the complete opposite values of brāhmaṇic social codifications. Taken from a conference in 30/09/2021 with references to (Policardi, 2020).

So the fact that there is a movement from stasis (a "non-dimension") it's a gesture that creates a dimension that has time and space, and with its repetition of frequencies it creates also all the form of perceivable matter. This concept of movement that can also be found in many philosophical and religious concepts. Moreover, "(…) Movement exaggerates some body parameters that are attractive when viewed statistically. Movement can really display the efficient use of a symmetrical body (…)." (Ramachandran & Hirstein, 1999). This does not mean that the context in which the movement is seen has to be ignored. Of course, a person's physical and emotional state of being of in a precise moment has an impact on how the movement is perceived. Thinking bigger, also the culture and the values transmitted in a society influence how we perceive the others around us. But, still, "(…) it turns out that the parameters that make bodies beautiful are similar to those that make faces beautiful. We prefer bodies, like faces, that are symmetrical. We also experience bodies, like faces, that exaggerate sexual dimorphic features as beautiful" (Chatterjee, 2014). As said before, our visual system is a very complex network of neurons which permits us to elaborate the world around us. It has areas specialized in elaborating different properties, for example, of a face, a static object or a moving object, a landscape, etc. The area that processes faces is called *fusiform area*, the area that processes places is the *parahippocampal* (it includes both natural and human-made environments). An area located on the side of the occipital lobes processes objects (the lateral occipital cortex) in general. Next to this is an area that responds to the form of human bodies (the extrastriate body area, EBA). From middle temporal and medial superior temporal area is specialized in visual motion, while moving bodies or biological motion is processed by the superior temporal sulcus. "(…) Is it a coincidence that much of visual art is about landscapes, portraits, nudes and still life? Is it also a coincidence that we have an area specialized for biological motion and that dance is such a popular form of art?" (*Ibidem*).

2.2 Beauty, Art and Aesthetics

"Art is what you don't understand the meaning of, but you understand to have meaning."

[*Anonymous*

Since now we talked about attractiveness and about some specific featured which trigger our system into what we can call an "aesthetic experience". We have seen features of faces and of objects, but what exactly is this experience and why this experience is usually associated with the concept of beauty and of art? Are they really the same thing? "(…) What is art? Unfortunately, it is not easy to come up with a satisfying definition. (…) It is worth underscoring the fact that aesthetics and art are not the same. They are overlapping but different ideas. Aesthetics (…) focuses on properties of objects and our emotional responses to those properties. The object need not be art. (…) Aesthetics typically relates to the continuum of beauty and ugly. (…) However, aesthetic encounters need not to be confined to beauty. (…) Art can and usually does have aesthetic properties. However, the artist's intentions, the artwork's place in history, its political and social dimensions are also relevant to art." (Chatterjee, 2014). Starting always from greek philosophy, it was thought, as already said before, that a face or a body with certain features or proportions is judged as "beautiful", considering beautiful something that evokes pleasure and positive sensations. Moreover, if it's the case of a person, it will be judged not only beautiful physically but also regarding the personality. Another important idea that characterized greek philosophy and that influenced later on other artistic periods was that "art depicts the world". Plato[25] and other Greek scholars developed the idea of art as imitation. We can see the revival of this idea during Renaissance: in this artistic period it was thought that the ability to

[25] In the second and third section of *Repubblica*, Plato considered art not a good thing because, as he thought it was imitation of reality, it was something that distracted us from the reality itself.

render objects accurately defines an excellent artist. This lasted until the advent of photography, which made the goal of painting to imitate the external world less relevant. Art was also considered "(…) *a ritualized behavior that brings a community together by solidifying communal values. Before the eighteenth century, much of what we regard as art was done in the service of the church or the state.* (…)" (Chatterjee, 2014).

The first attempts to explore the aesthetic experience started with Alexander Baumgarten and with his book, *Aesthetica* (1750) that marks the beginning of modern aesthetics. He linked the term aesthetics, then associated with sensations, to the appreciation of beauty producing what he called "sensitive cognition". So, aesthetic judgment is usually a judgment that involves a judgment of beauty. Is beauty in art all subjective? One of the most debated questions is if the Aesthetic is something that could be defined with objective parameters. Historically, theories of beauty were divided into three camps: *objectivist* theories which argue that beauty is an inherent property (such as balance and proportion) of an object that induce the feeling of pleasure in the perceiver. *Subjectivist* theories take the opposite view. Arguing that beauty is in the eye of the beholder: it is an idiosyncrasy of the perceiver and his culture, it is a socio-cultural construction. The most modern theories argue that both these theories tack an essential element of beauty assessment: both the perceived object and the perceiver are necessary. Thus, the modern interactionist theories argue that beauty and aesthetic experience emerge from the interaction between the two. A famous philosopher that better explains this concept of interaction could be Immanuel Kant, whose ideas still continue to influence scientific aesthetic. He thought beauty was an innate and universal concept and that judgments of beauty were grounded in features of the object itself. The judgment of beauty was placed within the realm of reason rather than simply a reflexive emotional reaction to objects. He thought that features of beautiful objects interact with our perception, intellect, and imagination. Kant's general (Kant, 2005) view is compatible with how scientists typically approach art, which is to try to figure out the dynamics of those interactions. "(…) Kant emphasized the notion of disinterested interest, which could be recast as liking without wanting. (…) This distance removes practical consideration of

objects and opens people to new and deeper experiences that are personally emotional and the root of any aesthetic experience (…).” (Chatterjee, 2014). By the twentieth century the idea that art can be the same thing as beauty and pleasure came to an end. A popular view during the mid-twentieth century was that art could not be defined: this view was called anti-essentialist. That means there is no essential ingredient that allows us to say that an object is art when it contains this particular ingredient. Morris Weitz was the main exponent of this artistic view, and he makes two arguments for this position: one is that art is inherently revolutionary, so it cannot be defined in any way. The other one is that art cannot be defined with necessary and sufficient conditions. Rather, art is a collection of objects with a family resemblance. When confronted with a new object, we judge whether or not it is art based on how well it resembles objects we already accept as art. The most common feeling, as the anonymous quote at the beginning of this chapter says, is that we know what art is, but we can’t define it. The only way to mentally get a grasp of what art may be is, as a functional position suggests, is in the relationship with art: the focus is not on which properties make an object art, but on what makes the encounter with an object that we regard as an aesthetic experience, special.

According to the neuroscientist Jean-Pierre Changeux, "(…) when the viewer meets the work he assigns it a meaning and a symbolic value, projects on it his own inner state, attributes emotions and intentions to the characters who enter the composition, thus retracing the path of the artist (…)." (Changeux, 2013). It seems that in the reception of art something more and different happens than the simple purely neurophysiological and localizable appreciation in terms of brain areas, but that a "(...) a transformation in the individual mind of the reader, peculiar and original although resonant with what has happened in an equally original way in the mind of the artist (...)." (Di Nuovo, 2021-2022). In the aesthetic experience we therefore go beyond simple understanding. Perhaps it is better to talk about a deeper involvement that implies not only the intellectual aspect, but also involves perceptions, sensations, emotions (more complex and different from the "universal" emotions related

to survival[26]) and memories. Leder and colleagues (Leder H., Belke B., Oeberst A., Augustin D., 2004) proposed a model trying to explain the complexity of the aesthetic experience: the *Information-Processing model of aesthetic experience*. For Leder the aesthetic experience is a cognitive process with continuously upgrading of affective states. The more we understand the more we feel pleasure. The process of aesthetic evaluation leads to aesthetic judgment on one hand and to aesthetic emotions to the other. This model gives an idea of the complexity also of aesthetic emotions, that still cannot be precisely defined, even though an integration with brain discoveries helped understanding more the neural correlates. The pleasure derived from a work of art is usually present in the aesthetic experience, but is not a necessary feature of it, it always depends also on the subject and the context where is perceived. Better then to talk about something that is more than just bodily perception or intellectual perception or just emotional perception. Describing an experience with words is always reductionist: we just *know* what we are thinking or feeling in an automatic way. This is the beautiful and still somehow mysterious job of our mind that for Buddhism considers one of our senses like the taste and touch and not something external to us (like we could normally believe). Moreover, mental life is not limited to the brain but is extended into a specific "body". How will be deepened later the experiences made and, even more so the aesthetic one, concern an organism: "*The root of all suffering is separation. If we perceive our body separated from the world around us* (...) *This separation creates great suffering. Our whole sense of who we are and what we are is based on our bodily sensations and body image*." (Carrère, 2021). Therefore, a complex system in which it is difficult to separate the functions in watertight compartments, but inevitably each part communicates with the others so that the organism itself is as efficient as possible. For this reason, experience is often referred to as an "embodied" experience: the human system has been shown that to fully understand something it

[26] On an evolutionary level, emotions are of fundamental importance. They can be considered messages, whose purpose is to signal how we react to the external environment, what could hurt us or what, on the contrary, promotes the survival and development of the species. In 1972, Paul Ekman, one of the main researchers in the field of emotions, defined the existence of seven primary emotions in the human being (those experienced most often and in a more recognizable way). Regardless of the culture, history or personality of each one manifests itself in the same way in each of us. They are: happiness, anger, disgust, contempt, fear, sadness, surprise. From here the Theory of Universal Emotions developed.

usually carries out an internal "simulation" of it, and it is precisely this ability that has been investigated in even greater depth by Neuroscience and Neuroaesthetics.

2.3 Neuroaesthetic

With the arrival of advanced neuroimaging techniques[27] during the early 1990s the interest was moved to what happen exactly in our brains when we experience art and/or a feeling of beauty and/or and aesthetic experience. Even though the question of what exactly an aesthetic experience and which areas of the brain it activates still has no univocal answer, the neuroimaging techniques facilitated the frequency and ease with which scientists could understand better the neural architecture and the patterns of activity that support thought, reasoning, action, and emotion. Neuroscience, which is based on these tools, when is focused on capture which brain areas and neural networks are active during an aesthetic experience is called *Neuroaesthetic*. Neuroaesthetics is an emerging interdisciplinary field combining neuroscience, psychology and the arts to understand the neural correlates of aesthetic experiences such as art and beauty. Neuroaesthetics was first coined by Semir Zeki, a professor of neuroscience at University College London, who describes artists as neuroscientists in disguise, exploring the potential and capacity of the brain through employing different creative techniques. In 2011 with research at the Wellcome Laboratory of Neurobiology of University College of London (Ishizu & Zeki, 2011) he demonstrated that the brain dedicates to beauty a specific area which is activated when the pleasure of observing an artwork is experienced. The artworks perceived as beautiful activated more an area called field A1 in the medial orbitofrontal cortex. The activity of this part of the brain is directly correlated to perception of beauty. This shows that beauty is something

[27] These techniques enable *in vivo* investigations of brain function in healthy human subjects with different methods. It can be through measuring changes in blood flow like the functional magnetic resonance imaging (fMRI), the positron emission tomography (PET) or the Near-Infrared Spectroscopy. It can be through measuring changes in local electric (EEG - electroencephalography) or magnetic (Magnetoencephalography - MEG) fields beneath the scalp. The understanding of the relationship between brain structure and function is further advanced by complementary structural neuroimaging methods, which leads to more in-depth look at the anatomical adaptation in the brain.

abstract, which goes beyond its different representations. Moreover, it shows that beauty can be objectively measured.

Since the introduction of such techniques, scientists form also other disciplines were able to explore question of the complex interactions between individuals and their environments in greater details than ever before, such the perception between action production and action perception. In the study of action, the interest was on the brain's ability to integrate different types of physical and perceptual experiences lo learn new movements. There is evidence of a brain system that is active while watching a movement, this means that specific principles with a biological basis exist which can facilitate the experience of beauty. A neural system that matches action with perception was found, by accident. Scientists were recording from single neurons within the ventral premotor cortex of the monkey brain to determine how these neurons responded when the monkey grasped different items. The researchers found out that the same neurons that fired when monkeys performed a specific action also fired when the monkey watched another monkey, or a researcher execute the same action (Gallese, et al., 2018). The researchers named these particular neurons which responds preferentially to action that they either observe or perform, "mirror" system. Mirror neurons appear to compose a cortical network that matches observation of actions with execution of those same actions. "(…) Since the discovery of mirror neurons in monkeys, many studies have investigated similar functional regions within the human brain, providing evidence for a human action observation network (AON)" (Cross & Ticini, 2011). In addition to the premotor cortex and the inferior parietal lobule (the core mirror system regions discovered in non-human primates), the action observation network includes the superior temporal sulcus, a region involved in biological motion processing, as well as the supplemental motor area, a region implicated in action sequencing and planning.

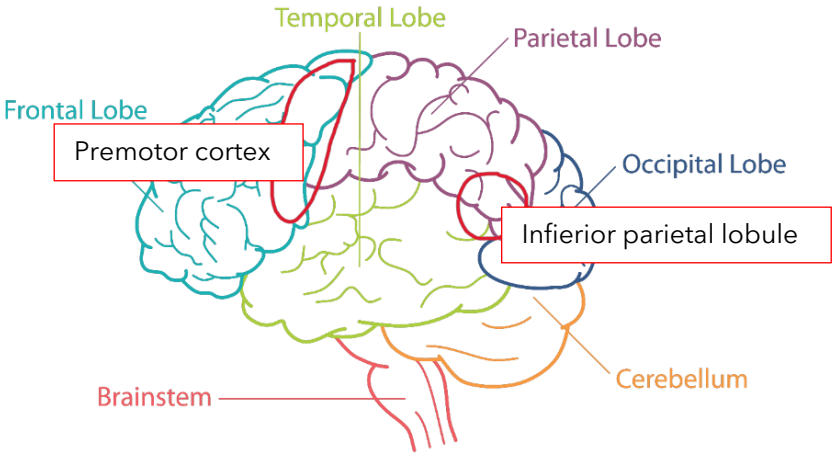


Figure 11 mage of the human brain in lateral view. The red circles highlight the two areas involved in the Action Observation Network: the premotor cortex and the inferior parietal lobule. https://mhanational.org/human-brain-101

As said before, movement is important, but every movement is the same? What makes one movement more attractive than another one, what makes a beautiful movement? Will people be attracted to the same features that influenced the attractiveness for faces? Experimental aesthetic has largely focused on static visual stimuli, such as paintings or faces. Only few attempts have been made to study aesthetic perception of human movement in general. In one study (Orgs, Hagura, & Haggard, 2013), a hierarchical model of aesthetic perception of human movement was presented to participants that were not dance experts. This model includes three dissociable levels of movement representation: body posture, movements and choreographic structure. The researchers hypothesized that: in the *static* level, symmetrical static postures would be preferred over asymmetrical ones. In the *dynamic* level, "good continuation" of the illusory movement given by static postures associated together in a sequence. "Good continuation" means that successive postures always followed the most continuous trajectory possible (transitions between postures that did not imply path reversals). The "good continuation" of a symmetrical sequence should be preferred, because of its greater processing fluency. In the structural level, where individual movements were arranged into longer phrases following compositional rules, sequential symmetry should be a predictor of the aesthetic judgment.

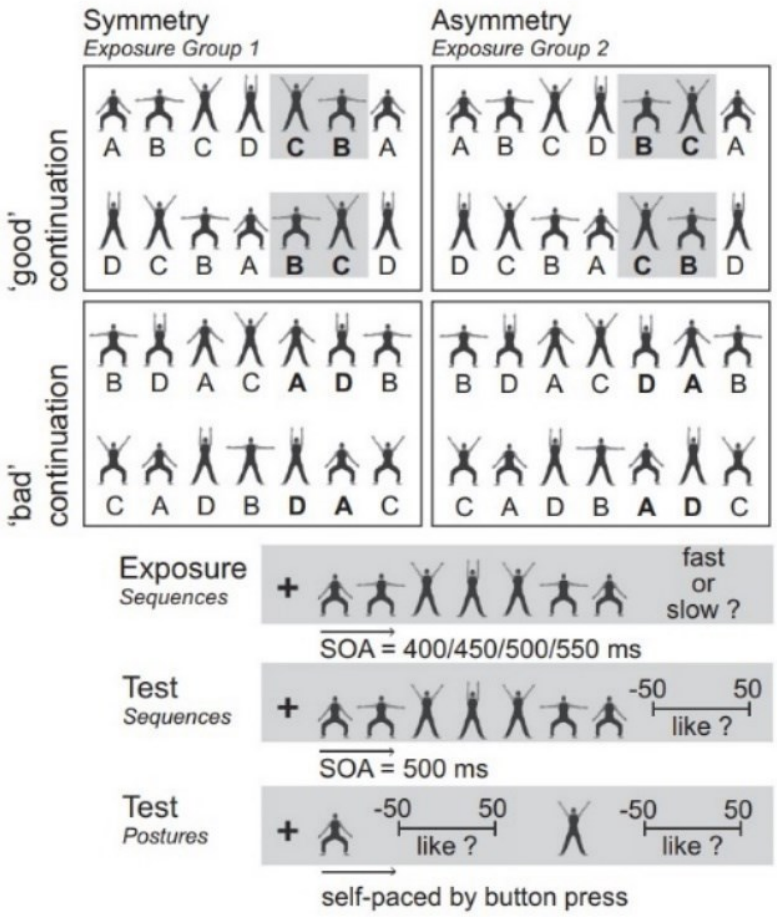


Figure 12 Experimental design (upper panel) and examples of trials in the exposure and the test phase of the Experiment (lower panel). During the exposure phase one group of participants was familiarized with symmetrical sequences only, the second group was familiarized with asymmetrical sequences only. Both groups saw all sequences in the test phase. Aesthetic ratings for apparent movement sequences and single postures were measured. (Orgs, Hagura, & Haggard, 2013).

Even if it's not relevant the perception of single static postures, as we are talking about movement, it is interesting to note that in the result of this study the posture most preferred where the ones with leg extended (leg posture that implies less effort) and arm extended diagonally (arm position that implies more effort), a posture that is "double" symmetrical both on the vertical axis and on the horizontal one. As for the movement, the participants gave higher aesthetic ratings to symmetrical sequences than to asymmetrical sequences. Further, sequences with "good" movement continuation tended to be preferred to "bad" movement continuation sequences. It seemed that the *grammatic structure* of the sequence of postures affected differently the aesthetic perception of motion. This result is in contrast with previous findings which favours complexity over simplicity: in this case, the simplicity is in the logical consequentiality of the movement, which becomes less

difficult and more intuitive for the brain to elaborate. In addition, “good” continuation did not influence aesthetic ratings for asymmetrical sequences. This means that aesthetic preferences for asymmetrical sequences depended on prior exposure. This result is in line with other findings, where preference for stimuli are associated with more familiar actions. Prior exposure influences aesthetic judgments only for asymmetrical but not symmetrical sequences, suggesting a “baseline” preference for sequential symmetry that does not depend on familiarization in the exposure phase.

Even if in this study a “fake” movement is analyzed: the movement consists in static postures put in a sequence, so the perception is that of a movement, the results show that there is a preference for sequential symmetry for the movement. If the sequence of posture is symmetrical referring to the central posture, it is considered more “pleasurable” than the asymmetrical sequence. Moreover, in the same symmetrical sequence, a more “natural” continuation of the movement (called “good” continuation) is preferred. All of this, finally, cannot be justified just with the mere exposure effect: still there is a preference for symmetry. Until now we talked about movement, a movement created for a laboratory experiment: but what is the difference with dance?

2.4 Dancing bodies

*“*First dance, then think. This is the natural order of things*.”* [*Samuel Beckett*

My teacher one day asked us during dance class: “What does dance movement has that is different from a normal movement, an everyday movement?”. The first time she asked this I did not know how to answer, because I’ve never thought about it. I’ve always thought that everyone, at least once in their lives, could say that she or he had manifested such behaviors that could be associated to “dance”, hence a succession of body movements articulated through rhythm and that could become part of a

choreography, the choreography of life. An interesting definition of dance is as "(…) rhythmic movement which as the aim of creating visible geometries, thanks to a sequence of postures and thanks to the drawing of pattern into the space while being into precise rhythmic units, the two components, the static one and the kinetic one, which receives emphasis in different ways, (…) and which are executed by different parts of the body, while being in tune with the character, the artistic precept and the intention of the dance art" (Raman J., 2015). The word that makes an everyday movement different from a dance movement is the *intention*. We could say that dance is different because, as my teacher says, is "*extra*-ordinary": dance, which is a unique way of communication and a prerogative of human beings, has something special, every movement has the power of intention, it has more attention, it has more effort, it has the awareness and the connection of being in the present moment of what someone is in that moment, with whichever emotion and period of life is living. In our everyday life we are usually distracted by the thousands of hundreds of things we have to do. We are not paying attention to what is going on with our body (except maybe when it hurts so bad that we can't ignore it) or with how is moving into time and space. At least one time in our life happened that we thought we had put our, for example, house keys, on the table, but we just imagined the movement and in the meantime, we were thinking about something else. We are used to be multitasking, but one thing that I have learned while dancing (but it can be applied also to an athlete when practicing a sport) is that if I try to be multitasking during dance class for sure a mistake will happen, the movement will be less powerful, less effectful. "(…) With attention we give energy, we nourish any event, object, situation, person, sensation, thought, as a perfume expands in the body the presence (…)" (Ferigo, 2021). To say it with Carrère words: "(…) If you try to pay attention to what you are doing, to have even a shred of awareness, (...), you do not have time to get bored." (Carrère, 2021). Awareness is another important word: being present to a whatever action gives quality to that action and makes it dance (in this case, an asana in yoga for example). There are two ways to become aware of a gesture or action: a passive one (the action is invoked by something else)

and an active one (the *desire* to focus attention on something). The second type is the one that can also determine the quality of the gesture (quality more linked to intention than to technicality).

Dance has always been part of all living being. Darwin thought that dance was a courtship ritual that signaled the quality of the dancer. Birds and insects dance. Female fruit flies choose their mates based on how well they dance (Siviniski & Burk, 1989). For most of the species (Fink, et al., 2012) the mating process consists in a dance made by the male to attract the female. The dance has to respect certain movements, it has to be beautiful in order to have success. In some cases there is a specific mathematical or geometrical pattern to follow in order to be successful (Chatterjee, 2014). Not by chance is that dance is associated to rituals, to something that is also sacred and that can connect the dancer to more powerful entities which assume different names in different cultures. Another important feature is the connection not only on a "vertical" level (let's say between sky and earth), but also on a "horizontal" level, so between people. For classical Indian aesthetic and philosophy, the term *Rasa* is used, which literally means the "essence", the "juice" of something. As it is described in *Nāṭyaśāstra*: "*Rasa* is the cumulative result of vibhāva (stimulus), anubhāva (involountary reaction) and Vyabhicārī bhāva (volountary reaction). For example, just as when various condiments and sauces and herbs and other materials are mixed, a taste (different from the individual tastes of the components) is felt, (..) so also along with the different bhavas (emotions) the Sthāyī bhāva becomes a 'taste' (rasa, flavor, feeling)" (Rangacharya, 2010). As previously anticipated, it is a difficult term to explain because it is not at all a concept, but an experience. To better understand this state, think for example to the "(...) *painting of a particular flower by different artists. Though the number and shape of petals are fixed, the color basically the same, yet each artist will paint the flower in his own way."* (Sri Aurobindo Institute of Research in Social Science)[28]. There

[28] Here the reference is to *Rāga*. *Rāga* is another art form of the *Rāsa* referring to Indian classical music. It is interesting to note that both terms have as their root the word *Ranj* which in Sanskrit (रंज) literally means "to soak" referring to a white, untouched wall or canvas. Symbolically, art (music, dance, painting, sculpture), dyes, imbues, gives life to the mind of the spectator, of man itself. Each *Rāga* has its own identity, like the features of a person: it has its "(…) *own characteristic movement, pauses and gait*." (Sri Aurobindo Institute of Research in Social Science) and its own "color" with which to dye the soul of the viewer. The *Rāga* is linked to precise moments of the day, to individual emotions, to elements that touch certain points of the body and therefore memories, thoughts and feelings.

is this component of *exaggeration* (Ramachandran & Hirstein, 1999) which make a dance movement (talking specifically about dance, but it can be about other art forms as well) special: exaggeration of face expression, of the emotion conveyed in the movement, of the effort put into a certain movement or presence in the space. This exaggeration creates a direct contact with an audience, that if its receptive, it will experience *Rasa*. "But what it is this thing called *rasa*? (…) Because it is enjoyably tasted, it is called *Rasa*. How does the enjoyment come? Persons who eat prepared food mixed with different condiments and sauces, etc., if they are sensitive, enjoy the different tastes and feel pleasure (or satisfaction); likewise, sensitive spectators, after enjoying the various emotions expressed by the actors through words, gestures and feelings feel pleasure, etc. This (final) feeling by the spectators is here explained as (various) rasa-s of *nāṭya*" (*Ibidem*). A lot of people assimilate it to a spiritual state of being, but as also in the *Nāṭyaśāstra* is pointed out, Rasa is an *incarnated* experience. A way of defining *Rasa* that I liked really much is the one given by Professor Giuliano Boccali[29]: "Rasa creates a state of *contemplation* which, for a moment, it will bring you above your daily sorrows". It is a special thing, but also really interconnected with a more human and everyday life state, rather than be spiritual in a more mystical sense (like bringing your mind somewhere else) or give some more precepts (Pollock, 2016). This *exaggeration* is immediate, it has a direct impact on the people receiving it, which can connect their experience with this rasa experience. With a more scientific term it is called a *peak shift* effect (Ramachandran & Hirstein, 1999): a principle in animal discrimination. If a rat is taught to discriminate a square from a rectangle and it is rewarded for the rectangle, it will soon learn to respond more frequently to the rectangle. Paradoxically, however, the rat's response to a rectangle that is even longer and skinner is even greater than it was to the original prototype on which it was trained. An example that Ramachandran made, that fits also into the indian culture, is

[29] Giuliano Boccali is professor at the University of Milan and honorary president of AISS (Italian Association of Sanskrit Studies); He specialized in classical Indian literature (*kāvya*), of which he edited the translation of many masterpieces. Taken from a conference *Kāvya and Rasa* organized by Accademia Sangam and held by Professor Giuliano Boccali (2021).

the reference to a Chola bronze representing the Goddess Parvati. This bronze is essentially a caricature of the female form: the artist, by amplifying the roundness of the hips and the bust, has chosen to amplify the very essence (*Rasa*) of being feminine[30].

Figure 13 On the left side the Venus of Willendorf, 30.000-25.000 BC, 11 cm heigh statue carved in limestone and painted in red ochre, not native of the area of discovery. https://it.wikipedia.org/wiki/Venere_di_Willendorf. On the right-side a standing Parvati, Chola period (ca. first quarter of 10th century), Tamil Nadu, copper alloy. https://www.metmuseum.org/art/collection/search/39325.

There is a powerful activation in the limbic system because this is an amplification of something that characterizes women and that men cannot do, and our brain has probably developed neuron connection specialized in detecting the sensuous feeling typical of that posture. The idea of

[30] To this it can be added another very well-known example are the paleolithic Venus "fertility" figures. The Venus of Willendorf which has been found in caves as representation of the Neanderthal Art, can be thought as an example of symbolic thought, an important distinction with previous prehistorical phases. The characteristic of these figures is exactly the exaggeration of precise part of the body: the face is not as important as the breast, the waist and the stomach. Those body parts are associated to the capacity of creation that is characteristic of women. In fact, these sculptures were probably used as fertility rituals. The emphasis on breast and waist is similar between the two sculptures, while a difference, that is more of a *plus* in the chola statue, is the *Tribhaṅga*, that can be literally translated as the "triple-bend position". A characteristic symbol of femininity in indian aesthetic is the fluidity of the curve created by the bending in opposite direction of the neck, chest and hips. It is a typical position that can be found also in another indian classical dance style that is Odissi.

Rasa is a fundamental part of Indian aesthetics, but we can compare it also for example to that "flow" feeling (Csikszentmihalyi & Csikszentmihalyi, 2006)[31] when we are really into something: while painting, while walking, while listening to music. The time flies and we are lost in an activity which has almost the same characteristic as dance and *Rasa*: there is a deep connection with ourselves in the present moment, there is an emotional activation, there is this surrender where we are lost in what we are doing. Studies on aesthetic experience in western culture are not many, especially the ones linked to neurology studies, to understand better what happens in the brain while we have an aesthetic experience. The field of neuroaesthetic is young, but until now it is possible to say that there is some connection with art and with the concept of beauty, which, again are all subjective concept and linked more to the experience rather than something explainable with words. Does this intention, manifested through effort and an amplification of the movement, make a dancing body an attractive or beautiful body? Neuroaesthetic has made big steps into the understanding of how the brain works while observing a static body. However, there are still few neuroscience studies that examine the brain when it looks at moving bodies: can it be predicted that people will react implicitly at beautiful bodies the same way they do to faces? That is difficult to anticipate, but a lot of studies has been conducted using dancing bodies as stimuli. How do our brains respond to movements, to beautiful bodies in motion? Among the few studies conducted using bodies in motion, the ones of Beatriz Calvo-Merino and colleagues are maybe the first neuroaesthetic studies which explored this subject and the most informative for this reason. What is known is that humans appear to be the only animals to have developed the practice and culture of art, and also, human brain contains specialized circuits for observing and understanding actions. These special processing circuits are presumably associated with distinctive experiences, called aesthetic experiences, and preferentially evoked by artistic stimuli. So, it was hypothesized that positive and negative aesthetic judgments are a function of these

[31] *Flow* or Optimal Experience is "a state in which the person is completely absorbed in an activity for his own pleasure and pleasure, during which time flies and actions, thoughts and movements follow one after another, without stopping" (Csikszentmihalyi & Csikszentmihalyi, 2006). It refers to a state of mind in which a subject is totally immersed and focused on the activity he is doing.

neuroaesthetic circuits. However, the localization of these circuits in the brain is what still remains unclear: activations that correlate with "liking" could be purely epiphenomenal and may not indicate the neural circuit that actually underline aesthetic experience.

In this study, Calvo-Merino et al. applied transcranical magnetic stimulation (rTMS)[32] on candidates' brain areas to disrupt the aesthetic processing while the participants made aesthetic preference judgments between pairs of dance postures, or control non-body stimuli (Calvo-Merino, Urgesi, Orgs, Aglioti, & Haggard, 2010). The aim of this study was to investigate whether body-sensitive areas also contribute to aesthetic experience of dance perception. They proposed a dual-route model: the ventral premotor cortex (vPMC) and the extrastriate body area (EBA) were the targets. The extrastriate body area, an occipital area specialized for bodies, is believed to process a local representation of body parts, while the ventral premotor cortex processes a configural representation of complete body postures. The results showed that rTMS over either EBA or vPMC reduced the contributions of the stimulated area to body processing, leaving processing more reliant on the unaffected route. So, disruption on EBA reduces local processing of the stimuli and reduces observers' aesthetic sensitivity, while disruption of vPMC increased aesthetic sensitivity. The participants had to rate how much they liked each stimulus using a visual analogue scale (VAS): "subjectivist" approach, meaning that is based on the individual perception of each participant. The measure of changing from VAS predictions was not simply a measure of aesthetic bias due to rTMS, but a measure of decreased or increased *aesthetic sensitivity*: the rTMS impaired the aesthetic sensitivity necessary to perform an aesthetic evaluation judgment itself. These results contribute to the examination of which areas are involved in aesthetic perception and evaluation and they allow to

[32] Transcranial magnetic stimulation (TMS) is a non-invasive technique of electromagnetic stimulation of brain tissue performed by placing sensors (coils) near the skin. Through this technique, it is possible to stimulate and study the functioning of the circuits and neuronal connections of the brain, causing a reduced and transient alteration of electrical activity.

conclude that different routes within the two-route model of body processing play a complementary role on aesthetic perception.

Aesthetic perception goes beyond brain areas associated to visual stimuli processing. The results of the studies done using dance shows that is more plausible to think about a sensorimotor aesthetic of performing arts. In another studio Beatriz Calvo-Merino and her colleagues conducted an evaluative study of movement. In this study, people watched 24 short dance movements. Half of the movements were from classical ballet and half were from capoeira (the Brazilian dance-martial arts form). The researchers found more neural activity in the right premotor cortex and in parts of the medial occipital cortex for movement that people liked than for those they did not like. They suggest that these areas are part of the brain that organizes sensations and implement dance are also involved in their evaluation. The pattern is analogous to face studies, where the area that classifies faces responds more vigorously to the attractiveness of faces. (Chatterjee, 2014)

An action observation network (AON), comprising sensorimotor brain regions including premotor, parietal, and occipitotemporal cortices that are engaged when watching others in action responds more robustly when observing actions that have been physically practiced (Cross & Kirsch, 2015) or visually experienced. The activity of this network may be an index of embodiment during action observation: this means that while we experience the observation of a movement (or even imagining that) the experience is not just a visual one (at a more basic perceptual level) but is also a motor one and the two systems (perceptual and motor one) are overlapping. These two levels are difficult to separate, for this reason we can say that the experience is never a visual experience alone, but is something more, is a senso-motor experience. As Cross and colleagues explained: "(…) The complex and scenographic use of human bodies evokes visceromotor and somatomotor resonance, in addition to activating emotional and reward-related centers within the brain (…)". (…) Recent research seems to suggest that multisensory perceptions are generally preferred to perceptions in just

one of the sensory domains". (Cross & Ticini, 2011; Calvo-Merino et al., 2004; Calvo-Merino et al., 2004).

2.5 *Bharatanāṭyam* dance: between history and myth

I will talk about an Indian dance style because I have always felt an attraction towards India: I have always been immersed in an "indirect" way in Indian colors, scents and philosophy through the passions cultivated by my parents towards this mysterious and varied subcontinent. This initial infatuation with India has become a real passion when I entered, now it's 4 years ago, in the world of *Bharatanāṭyam* dance, one of the eight styles of[33] Indian classical dance originating from South India (Tamil Nadu).

Figure 14 Map of India. Highlighted in purple is the Tamil Nadu state and on top right its capital: Chennai, the hometown of Bharatanāṭyam.

[33] The other styles of classical Indian dance are: Odissi (Orissa), Kuchipudi (Andra Pradesh), Manipuri (Manipur), Mohini-Attam, Sattrya, Kathak (North India), Kathakali (Kerala).

Although delving into the historical-cultural, artistic and philosophical world of India is risky because it is complex and vast to be treated here, I could not resist but share my passion; of course, this theme cannot be fully explored, but my desire is to give some cause for reflection by focusing on the aspects that most impressed me and that most recall and intertwine, enriching it, with my "western" passion. "(…) *Bharatanāṭyam* is a means of communication, a specific language of gestures used to tell stories, feelings and cultural values (…)" (Raman, 2015). The name *Bharatanāṭyam*, which refers to a systematized performing art, however, appears and spreads only in the mid-twentieth century, replacing the term *Dasi-Attam, or Sadir,* which refers to the traditional dance that was performed by the *devadāsī* in the temples or by the *Ganika (*or Rajadasi*),* professional dancers who danced for kings in the courts. The *devadāsī*, on the other hand, are dancers-priestesses (women of great culture, educated in all areas, including the arts) who dedicate themselves from childhood to the divinity, taking care of the daily rituals of the temple, dancing and singing both in daily ceremonies and in processions or extraordinary holidays. By taking care of this sacred space, they are concerned with the maintenance of *dharma* (the cosmic order), and for this they were valued for being the link between human beings and the gods[34]. The dance known as *Bharatanāṭyam*, therefore, is the result of a specific process of stylistic, historical and cultural reformulation, which has profoundly changed the previous forms of dance. The center of the tradition from which the modern evolution of this style flourished is the city of Thanjavur, where, between 1600 and 1800 AD, all the musical and dance art of India was systematized. In the early 1800s, specifically, the musicians and dance masters, the *Tanjore Quartet* (a historical quartet for the development of music and dance), began to systematize and codify traditional dance, laying the foundations for founding the future *Bharatanāṭyam* repertoire.

[34] Another term with which they were called is *nityasumamgalī*, a term that literally means "eternally auspicious" and refers to their condition as "divine brides".

With the arrival of the British, however, the Indian population begins to refer to a series of British models and values that are considered more "civilized" when compared to local traditions, often labeled as archaic. Since the traditional arts, such as dance, no longer match these new models, they begin a slow decline: a real change of social paradigm takes place: in fact, it is precisely in the eyes of the Indians themselves that traditional dances begin to seem almost vulgar when compared to Western models now absorbed by most of the educated population. Madras (the current Chennai, capital of the state of Tamil Nadu) becomes the artistic center where artists migrate and begin to work for a new élite of masters, made up of private individuals who finance shows and concerts inside the palaces, but also changing the aesthetic taste and bringing it closer to the Western one. Despite this, however, the beating heart of the art of the origins remains alive: the *devadāsī Balasaraswati* (1918-1984), survived the decline by bringing his art to the Western world; another figure of great importance for the birth of *Bharatanāṭyam* is *Rukmini Devi Arundale*[35] (1904-1984), who in January 1936 founded the *Kalakshetra* Academy: an institute dedicated to teaching traditional arts, dance and music in particular. It is in this revival, based on the principles codified in the *Nāṭyaśāstra*, that the term *Bharatanāṭyam*[36] was born: it is thought that this nomenclature can refer to *Bharata Muni,* the mythical author of the ancient treatise *Nāṭyaśāstra,* but also to the term *Bhārata* (which in hindi language means India), or it is thought to be the acronym of three words that refer to the main elements of dance: *bha*, *bhāva* (emotion, mood); *ra, rāga* (the sequence of sounds that composes the ways on which the classical musical systems of India are based) and *ta*, *tāla* (rhythm), while the term *Nāṭya* indicates the theatrical art, the danced drama. The intent was to bring the dance back to its former glory, referring in particular to ancient texts, connoting art in a purely spiritual sense and codifying it

[35] A young woman of *brāhmaṇic* family, who already shocked public opinion by marrying a foreign man and much older than her, but above all scandalized when she decided not only to study traditional dances, but even to debut in public with the aggravating circumstance of age, considered very advanced at that time.

[36] The *Nāṭyaśāstra* is an ancient and detailed treatise, composed approximately between the first century BC and the second century AD, a compendium of everything related to the staging, from dramaturgy, costumes, acting, etc.

in a technically[37] precise way. This is what happens in Tamil Nadu, but similar processes have taken place in other states of India, leading to the birth of so-called "classical" dances[38]. Since then the *Bharatanāṭyam* dance has spread widely, regaining trust and interest from all social strata, as well as being the best known, along with the Odissi dance, also in the West.

The mythical origin of the scenic art is always described in the *Nāṭyaśāstra*: the myth tells that, since the gods were not able to use the treatise to the fullest, *Brahmā* himself (the creator) summons a sage named *Bharata* (a term that by extension will also mean actor) so that he put into practice the so-called fifth *Veda*[39]. The theme is the struggle between *the devas* (divine beings) and the *asuras* ("anti-gods"), the latter get angry because they are put in a bad light in the story and so begin to pollute the representation by putting confusion in the actors. *Brahmā* intervenes by starting a reasoning on the importance of scenic art and on the search for beauty, which will appease the souls of the asuras, and thus introduce a fundamental element, of which I have already mentioned in the previous paragraphs, which is also the purpose of art, namely the *Rasa*. *Brahmā* believes that the actor must stage every action, feeling or thought (therefore both good and evil) to summarize knowledge and bring elevation to humanity: theater is not indifferent to duality, but it is also non-

[37] That internal psycho-emotional state (which as mentioned goes by the name of *Rasa*) that has been most discredited, for example, is that linked to erotic feeling, the *śṛṅgāra*, in favor, especially to the *Kalakshetra*, of the technique (also inspired by Western classical ballet). The process of re-ritualization is put in place, in this case, through a continuous reference to *Bhakti*, to devotion. *Rukmini Devi* believed, in fact, dance as an act of transcendence of the devotee and is the initiator, in fact, of the tradition still existing today to dance with the presence (on the place where you dance) of a statue of *Shiva Naṭāraja*.

[38] The term “classical” does not really do justice to the complexity of Indian art, not reducible to what for a Westerner is "classical". In this regard, Professor Boccali, referring to Indian literature, but which can be extended to all Indian art, says: "(...) the *adjective classic to a Western audience brings to mind perfect forms of expression, to be taken as a model, just think of the Greeks and Romans.* (...) *In India it is totally different: it does not refer to a limited time, but classical poetry is characterized by the purpose, which is to arouse the rasa from the listeners*". Taken from a lecture given by Professor Boccali: *Kāvya* (classical indian literature) and *Rasa*, on 23/10/2020.

[39] The word *Veda* means "knowledge": they are, in fact, among the oldest philosophical documents that have come down to us, which contain the foundations of Indian thought, culture and spiritual life. Historically, the *Vedas* had already existed orally and passed down from master to student for generations, when between about 1500 and 500 BCE (the so-called Vedism/Vedic Period) they were written down in India. The texts that make up the four *Vedas* are: *Ṛgveda*, Sama *Veda*, *Yajur Veda* and *Atharva Veda*. Each of which is further divided into four parts: *Aranyaka* (rites and ceremony), *Brahmana (*commentaries and rituals), *Samhita* (blessings, prayers and mantras) and *Upanishads*: philosophical narratives and dialogues.

judgmental, it represents all the impulses to facilitate that state of contemplation linked to savoring (*Rasa*), a state that "(...) temporarily suspends the human constraints that cause suffering (time, space and randomness) and that allows you to have a clear and present vision of oneself, not filtered by the Ego".[40] This is the only experience comparable to the spiritual one precisely because it has *alaukeka* ("not worldly/beautiful world") nature, a condition of total unity with a divine power that goes beyond human boundaries. In this thesis I will focus on one aspect that characterizes *Bharatanāṭyam* dance: *Nritta* (pure dance). To introduce better the elements that characterize this dance I will report below a sloka (devotional test), one of the most famous devotional tests linked to indian classical dance, as it describes Lord *Śiva* dancing: *Śiva Nāṭarāja* (which literally means "king of the dance"), is a form of *Śiva* as the cosmic dancer, a form that became symbol of protection for dancers and that for this reason became vastly present into *Bharatanāṭyam* repertoire.

आंगिकम भुवनम यस्य

वाचिकं सर्व वाङ्गमयम

आहार्यं चन्द्र ताराधि

तं नुमः (वन्दे) सात्विकं शिवम्

The verses say: "The whom body is the whole universe, the whom voice is the sound of the world, the whom decorations are the moon and the stars, etc., I bow to Him, the one who is purity and knowledge, oh *Śiva*". (Ghosh, 1975)[41] These verses describe the four elements on which dance

[40] Taken from the conference *Bharatanāṭyam and Aesthetics* held by Professor Giuliano Boccali (3/06/2021).

[41] *Mangalamsloka*, a passage from *Abhinaya Darpana* (another important theorical reference for the practice and the teaching of this dance).

is based: *Āṅgika*, which refers to body movements that usually aim at telling a story, *Vāchika*, the words (lyrics) sang with the music and translated physically with facial expressions, *Āhārya*, the decorative aspect, the makeup and the costume, and finally *Sāttvika*[42].

2.6 Dancing sculptures[43]

The focus will be on *Āṅgika*: the body movements. It could be said that, by simplifying a lot, *Bharatanāṭyam* can be divided in two main "dances", a more "emotional" one called *Abhinaya*, that aims to describe a story usually taken from the mythological repertoire, by using facial expressions and the codified language of *mudras*[44], and the other one is "pure dance" (*Nritta*), a sequence of technical steps (called *adavus*) based mostly on the *Nāṭyaśāstra* (the antique treatise and an important guideline for dancers), which don't have a meaning and don't aim to tell a story. Even if *Nritta* does not *per se* intend to convey a precise emotion, it contributes to evoking an aesthetic experience, or, as it is called in indian aesthetic theory, *Rasa*. As all of indian art forms are usually one intertwined with the others inevitably. "In the West there are no such complex artistic forms, in which different levels of involvement are condensed into a single all-encompassing practice; In fact, as proof of this, theater and dance are considered separately. (...) On the contrary, Indian art forms, (...), are artistic *syncretism*: theater, dance, poetry, music, almost all forms of art merge in this artistic form. Even in dance, artistic complexity becomes a totality of involvement: body, spirit and intellect; The dancer is

[42] *Sāttvikam* literally means "purity, deep knowledge". According to classical Indian theatre, the first three types of *abhinaya* deal with outward expressiveness, *Sāttvikam* with the innermost, less visible but much more significant one. It is, perhaps, the most complex characteristic to describe, since it includes the interiority of the dancer-actor: it is, in fact, the expression of the emotion that should lead to the achievement of the *Rasa*: the purpose of the Indian (and not) performing arts.

[43] The aspect of the alignments is so important that the dancer becomes almost a "dancing sculpture": "(…) as with dance, even in creating sculptures there is an intention that makes them alive. The sculptures have their own language based on measure and lines". Quote from the conference *Dance and Sculptures* (29/04/2021) held by archaeological and Sanskrit researcher Anna Tosato.

[44] Literally with the meaning of "seal", is a real gestural alphabet: a very precise code used instead of words, which can be divided into three broad categories: one-handed gestures (*asamyukta*), those with two hands (*samyukta*) and mixed ones (*miśra*).

not only a person who must be technically devoted to the discipline of dance and acting (that is, have adequate physical preparation, know body language, hand and face expressions), but he is also a musician and poet: he must know the rhythm, resonate with the music, make it his own, as well as make the literary text and its meaning his own.." (Ferigo, 2021).

A parallelism could be made between the body of the devotee (and also of the dancer in this case) and the geometrical structure of a temple. The rules to build a temple were written in the *Śilpa Śāstra*[45] between VII and VIII Century. The *Śilpa Śāstra* is part of the *Sthapatya Veda* along with *Vāstu Śāstra* (the design of a building, Vāstu literally means "space") and *Aagama Śāstra* (the specific procedure to build a temple, also containing the rituals and the philosophy behind the image of the god related to that temple) (Jayakumar, 2020). The word *Śilpa Śāstra* contains the word *Śāstra* which means, like for the *Nāṭyaśāstra*, "knowledge", whereas the word *Śilpa* means arts and crafts, so is "what it has to be known about arts and crafts": the art of building a temple. In these books is written in detail what the artist has to do in order to build a temple in the best way: from the choosing of the material, to the place, but also the attention to bring at the spiritual aspect, like specific rules when it comes to hinduistic iconography.

The measurements on which dance is based are similar to the ones guiding an artist creating a sculpture. The human form could be also measured along various axes on different planes: the measures along these different sections guide the sculptor into the making of images. A system of proportions was present not only in the Greek art, but also in indian literature: the temple has to be thought and then created respecting precise mathematical proportions. Each part of the temple corresponds to specific energy points in the human body and the measurements between each part of the body is transposed to create the temple. One of the five main vertical axes described in the *Śilpa*

[45] "Architects used *Tāla* (rhythm) to create a statue or the image representing god. They used music and "time" to give life to images. Not casually, the temple are important spaces dedicated to dance and music (at least in the past) to celebrate a specific god". From the conference Cultural History of South India – Online lecture series, organized by Sāraswatham Foundation in collaboration with Accademia Sangam. The conference was held by classical musician, researcher and entrepreneur S.K. Jayakumar (15/11/2020).

Śāstra, which represent also a philosophically key concept and a guide for the architect as well as for the dancer, is the *Brahmasūtra*: the center, the vertical axis from where the other parts of the body depart. We already saw that the vertical axis which create a bilateral symmetry is salient for our brain and for creating an aesthetic experience. The beauty of the pure dance in *Bharatanāṭyam* is in the ability to create symmetric and geometrical lines and forms into the space starting always from the center, that is like our "home"[46], where we always return. The dancer, therefore, can be thought of as a "dancing sculpture" so the aspect of alignments is important: "(...) As with dance, even in creating sculptures there is an intention that makes them alive. The sculptures have their own language based on measure and lines" (Tosato, 2021).

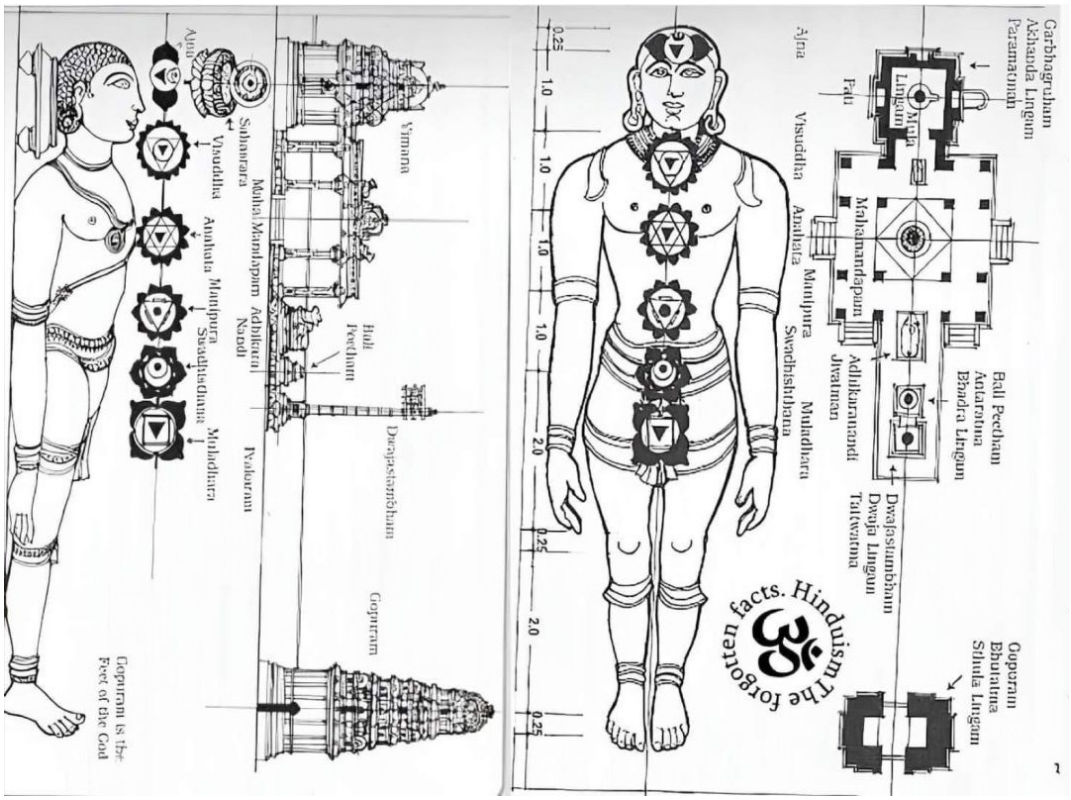


Figure 15 An example of the parallelism between human body and architecture in indian culture: the important steps taken by the devotee in a sacred place like a temple are linked to energetic points in human body so that the path taken by the devotee in the temple corresponds to an awakening also inside himself.

[46] A beautiful expression that will always remain in my heart given by Mavin Khoo during a workshop. Mavin Khoo is an amazing *Bharatanāṭyam* dancer and teacher originated from Malaysia. His main dance mentor was Guru Padma Shri Adyar K. Lakshman, the same Guru of my teacher Lucrezia Maniscotti.

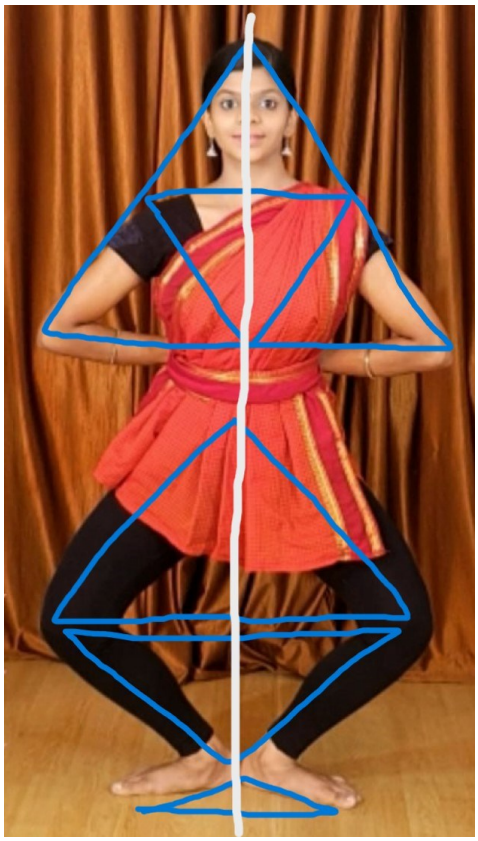


Figure 16 An example of araimandi: with blue color are highlighted the triangles formed by head, chest, navel and shoulders, while with white color is highlighted the Brahmasūtra.

One geometrical figure that the *Nāṭyaśāstra* makes particular reference to is the triangular shape. The triangle is a figure that connects three points into a center. Let's take for example the *aramandi* position (fig.), similar to a *plié* in ballet. The *ardhamandali* (or *araimandi*) is the fundamental dance position used in *Bharatanāṭyam*. Almost all *Bharatanāṭyam* movements categorized as *Nritta* are performed in the *araimandi* position. To form this stance, a dancer must align the arms, knees, torso, and feet to create a series of three triangles[47] in space. As, Dr. Kapila Vatsayana explains: "The first triangle is formed with the line joining the shoulder points as the base; and, with the waist (navel, *Nabhi*) as the Apex. This inverted triangle is further highlighted by the

[47] It is not surprising that also in Western culture, the number three, also according to numerology, is a sacred and important number as it refers for example to the concept of Trinity as a religious reference, but also in literature, the most famous composition Divina Commedia of Dante Alighieri has a repletion of the quantity three in the verses (there are 33 chants and every chant has thirty-three triplets).

outstretched arms, which make another triangle, in space, on either side of the vertical median. Another triangle is formed with the waist as the apex; the line joining the knees, in their extended position, as the base. The third triangle is formed with the line joining the two knees (flexed and outstretched), as the base; and, with its apex at the heels (where the feet are outstretched)." (Rao). It is said that while performing *Bharatanāṭyam* dance, the artist visualizes her body as made up of triangles; and conceives her movements in space as following either straight lines or triangles. The steps of the dance are based upon a balanced distribution of body weight and firm positions of the lower limbs, allowing the hands to cut into a line, to flow around the body, or to take positions that enhance the basic form. There is an incredible relation between dance, geometry and numbers. The postures are characterized by linear formations and circular patterns. The straight-line patterns, circular movements and the symmetry in formation of the postures, all these are vital aspects of dance.

The anatomical requirements of *Bharatanāṭyam* are based on its existence as a kinetic enactment of the ancient Indian sculptures that depict Hindu mythology. In the classical Indian arts, the statues that represent the deities, kings, and queens of Hindu mythology focus primarily on the bones and joints of human anatomy. Although bones are dynamic – they grow, adapt, and deteriorate in response to various stimuli – and form complex connections with each other and with muscles, they offer visual exactness that contrasts with the seemingly ambiguous shapes of musculature. As a result, any poses or movements depicted in the classical Indian sculptures are limited to what is allowed by the major joints of the human skeleton. These ideas reflect the Indian aesthetic, which is concerned with the need to find "absolute form" – an abstract concept in Hindu philosophy based on finding perfect alignment and structure in disorder. A *Bharatanāṭyam* dancer, therefore, can use the geometric exactness of the human skeleton to establish absolute form. The dance form demands physicality that is sculpturesque and mirrors the same concepts of proportion that influence the Indian sculptor. The research of the dancer to find the absolute form through symmetric and perfect geometrical shapes contributes to the creation of *Rasa* and aesthetic appreciation.

3 Symmetry perception in *BHARATANĀṬYAM* dance

"Bharatanāṭyam is an art which consecrates the body (…) the dancer, who dissolves her identity in rhythm and music, makes her body an instrument, at least for the duration of her dance, for the experience and the expression of the spirit."

[*Balasaraswati*

3.1 ABSTRACT

Recently, the field of Neuroaesthetic has started exploring the aesthetic experience of observing bodies in movement. In this experiment we have used short, and selected movements derived from an indian classical dance style called *Bharatanāṭyam*. Each movement is based on the instructions given both by the *Nāṭyaśāstra*, an ancient treatise on indian dramaturgy, as well as the *Abhinaya Darpana*, another important reference for dance postures and hand gestures. The aim of this experiment is to investigate the aesthetic appreciation of this foreign dance style, and to see if there is a cross-cultural preference for symmetry. The short movements were presented to participants who were non-experts in dance in random combinations. Some combinations were symmetrical: the same movement done first on the right side and then repeated on the left side, some others were asymmetrical both regarding the side as well as for the type of movement. After watching each couple of movement the participant had to answer, by sliding a bar on the screen, four questions regarding: how much they liked the movement (*pleasantness*), how much "fluid" they thought the movement was (*fluidity*), if they perceived the movement was expressive (*expressiveness*) and, finally, how much they thought it was "coded" (*improvisation*), as following the rules of a manual or textbook, or if it was improvised. We predicted that, despite the fact that it is an unknown dance style for the majority of people in the western countries, the subjects would prefer more the symmetrical condition both regarding the side and the type of movement. Moreover, this preference for symmetrical

movement should correlate positively especially with *pleasantness* and *fluidity* conditions, but it should correlate negatively with *improvisation* condition, as the symmetric movement should be perceived as more "coded".

3.2 INTRODUCTION

Across millennia, humans have expressed themselves through dance. Dance spans cultures, generations, social classes, and geography. Similarly to music and the visual arts, dance is a universal human behavior whose earliest manifestations can be traced back to rituals and social expression. While dance shares many features with other art forms, one attribute unique to dance is that its expression entails moving the body through time and space. While the study of dance performance and dance spectators' experience has traditionally been the realm of dance practitioners, scholars, and historians, more recently, psychologists and neuroscientists have been turning to dance to help address a number of questions about both the objective and subjective features of the relationship between perception and action (Cross & Ticini, 2011). One of the purposes of Neuroscience and, specifically, of Neuroaesthetic, is to study how the observation of dance as an art form can help our understanding of how the brain processes aesthetic experiences. It is still difficult to have an exhaustive definition of what is an aesthetic appreciation in terms of both brain activation and affective activation. Usually, the term aesthetic is automatically associated to art and beauty, but as already explained before, those are distinct concepts. Despite the fact that the brain circuits that activates during the observation of an artwork are similar to the ones activated while observing something considered beautiful (Di Nuovo, 2021-2022), the subjective perception commonly felt and called aesthetic experience is something "more". The problem for scientists is that this "more" is difficult to grasp and to quantify. How much of this experience we can say is universal and measurable and how much is individual variability?

In the present work we decided to explore the aesthetic perception of movement and, in particular, we selected movements of an Indian classical dance style called *Bharatanāṭyam*. As presented in detail in the previous chapter, *Bharatanāṭyam* is one of the eight classical dance styles and its origin is from South India (Tamil Nadu). For this work we decided to focus on one of the two main aspects in which this dance style is commonly divided: *Nritta* or "pure dance". Pure dance is different from the other main aspect, *Abhinaya*, because its purpose is not to tell a story using specific facial expressions or codified hand gestures (*mudras*). *Nritta* is a set of steps (*adavus*) that are continuously practiced in order to reach perfect and proportioned execution during a performance. What is considered to be aesthetical about *Nritta* is the capacity, after years and years of practice, to create perfect allied lines and geometrical shapes in space while dancing. The other aspect that we wanted to investigate is symmetry. It was shown by many studies that there is a preference for symmetry in human species, both in objects (Makin, Wilton, Pecchinenda, & Bertamini, 2012) and in human faces and bodies (Orgs, Hagura, & Haggard, 2013). Regarding the latter studies, the majority these studies were conducted using faces as stimuli, and usually, Caucasian faces. The focus on movement and dance has only recently been explored. It is not confirmed yet if this preference for symmetry in dance can be considered "cross-cultural", as studies has been done only using specific western dance styles (ballet) or known dance styles (tango or capoeira) in the western countries (Calvo-Merino, Grèzes, Glaser, Passingham, & Haggard, 2004; Calvo-Merino, Grèzes, Glaser, Passingham, & Haggard, 2006). As *Bharatanāṭyam* is also based strongly on symmetry especially in pure dance, we decided to see if a preference for symmetry could emerge also while observing this "foreign" dance style. As a question for future work proposed by Cross & Ticini was "(…) to explore whether when people watch different styles and forms of dance common patterns of brain activation emerge when viewing aesthetically pleasing dance, independent of dance style or staging context" (Cross & Ticini, 2011). In this context we did not study the neural correlates, even if it could be taken into account for future studies, but we conducted a subjective perception study on aesthetic judgment. For this purpose we selected four movements inspired by two main textbooks: the *Nāṭyaśāstra* and

the *Abhinayadarpana*. It is important to note that we are aware of the differences between the two textbooks. The *Nāṭyaśāstra* is the most ancient one and it describes postures and gestures in a way that yes, is similar to *Abhinayadarpana*, but sometimes also different, especially in the labels being used for dance postures. *Abhinayadarpana*, on the other hand, is the more recent one, and it is more focused on the body of the dancer (the static posture as well as the hand gestures), while *Nāṭyaśāstra* is about everything regarding the dramatic act and does not always go deeper in explaining some aspects of body posture (some body parts are considered less important).

With that being said, in our experiment we changed how the steps are combined. Normally the movements that are taught during dance practice, are taught so that the same movement is done firstly on the right side and then on the left side ("following-the-rule" movement). Usually the aim is to reach a perfect balance and symmetry in respect of a central vertical axis (called *Brahmasūtra*). We presented to participant movements that followed the codified practice, but also the manipulated ones. What we manipulated was the symmetry condition: some combination had a movement starting from left and the same movement then done on the right (asymmetry of *side*), some others had a movement starting from right but then a different movement done in the left side (asymmetry of *type* of movement). After watching the combinations, the participants had to give judgments about four aspects: if they liked that particular sequence of movements, if they thought it was "fluid", how much they felt it was expressive and, finally, if they thought it was a codified movement or an improvised one. We selected these questions based on literature (Orgs, Hagura, & Haggard, 2013) as they are variables linked to aesthetic experience. We predicted that the participants would prefer more the symmetrical movements (both of side and of type) and that this judgment would positively correlate with the liking judgment as well as the fluid and codified ones.

3.3 MATERIAL and METHODS

3.3.1 Subjects

As done in (Jola, et al., 2013), we enrolled naïve participants for this experiment. The aim of this experiment was to study aesthetic perception of movement, and, in particular, of symmetry of movement in *Bharatanāṭyam* dance. We tested 32 (15 females and 17 males) non-experts in this type of dance ranging from age 18 to age 63 (with a mean of 38). All the participants were people who have little or no direct knowledge with *Bharatanāṭyam* dance. Moreover, in this experiment we asked the participants to judge, as a self-report, if they had low, medium or high experience in art in general. The majority of the subjects reported to have low or medium level of expertise.

3.3.2 Stimuli

A set of simple dance movements of one of the eight classical Indian dance styles, called *Bharatanāṭyam*, was video recorded: the single dance movement is a combination of postures (of the single body parts) taken from the *Nāṭyaśāstra* and the *Abhinayadarpana*, the reference treatises that has been chosen for this experiment. We recorded the movement leaving the face visible unlike other studies (Calvo-Merino, Grèzes, Glaser, Passingham, & Haggard, 2004; Calvo-Merino, Grèzes, Glaser, Passingham, & Haggard, 2006), where the face of the dancers was blurred as to avoid an influence on the judgment of the subjects and on the neuroimaging measurements. Whereas, in this type of dance also the symmetry of the head and of the face muscles' movements are important and are part of the general movement. Even though *Nritta* is pure technical dance, the expressions in *Nritta* are as equally important as the ones in *Abhinaya*, because they contribute to the emerging of aesthetic experience. The fact that we choose non-experts is central for the aim of this study: is symmetry universally preferred even by looking at a "foreign" dance style (in which, by the way, the element of symmetry is crucial)? In all postures there is a symmetry along the vertical axis and the horizontal axis. Since it was shown (Orgs, Hagura, & Haggard, 2013) that a mere exposure effect is

not affecting the preference for symmetry in movement, we decide not to expose the participants to a training phase where also asymmetrical movements were presented. The subjects had to be 100% unaware of this dance form and they could not suspect our research question. Four different movements were chosen, and 16 couples of movements were created.

The first movement (Figure 17), that we called movement A, has *aramandi*. In *aramandi* position the posture of the legs as to form a sort of triangular shape. This position is also called, in the section of *maṇḍalabhedāḥ* ("forms of standing"), *āyatamaṇḍalam*, (*āyata* means "bent", *maṇḍalam*[48] means "standing") one of the ten positions of standing (*dashamaṇḍalam*) described in the *Abhinayadarpana* (Ramachandrasekhar, 2023). The translation from sanskrit describes *Āyata* posture as follow: "(…) standing with two feet, half a cubit apart from each other in a Caturastra posture and at the same time bending knees a little apart and placing one of them upon the other, will give rise to the *Āyata* posture" (Ghosh, 1975). Regarding the arms, they are in *natyarambam* (which means "beginning of dance"). The arms are stretched as to form a straight line from right to left, the elbows are slightly bent. Finally, the position of the hands is *tripatākahastaḥ* ("three parts of the flag"), the hand gesture that is typical of this dance form: the hand has to be stretched well and just the ring finger has to be 90 degrees bent, as well as the thumb. In this first movement the right leg, the right arm and the face should move at the same time on the side and this has to be repeated symmetrically on the lefts side.

[48] *Maṇḍalam* is described in the *Nāṭyaśāstra* as a posture (*sthāna*) that has "(…) two feet (…) four tala-s apart, chest sideways, hips and knees in line." P.94 *Tala* could be taken to be the length of the palm (from the wrist to the tip of the middle finger).

Figure 17 The first movement (A), also called "nattadavu", because of the use of natyarambe.

The second movement, movement B (Figure 18), consists in a torso bending: the hands are in *añjalihastaḥ* (both hands joined together) above the head and the legs are in the same *aramandi* position. Also here, the movement of the feet beating on the ground while the torso is bending on the side should be contemporary. The eyes follow the movement of the body, so they are also “bending” where the body is bending.

Figure 18 The second movement (B) with añjalihastaḥ on top of the head and the bending on the side.

The third movement, movement C (Figure 19), is in a different leg position called *sthānaka*, where the feet are joint together and the legs are straight. The literal meaning is exactly "standing position" which one of the three main positions in *Bharatanāṭyam* dance. The movement has the eye and neck movement called *attami*: the neck translates on the horizontal axis from side to side without moving the shoulders but keeping the head and the chest straight. The eyes follow the movement of the neck from side to side: *sācīdṛṣṭiḥ* (the movement of the eye on the side). While the hands are in *karṭākamukahastaḥ* (the half-closed fist) in front of the chest (trying to always form a symmetrical shape), the eyes together with the neck will move as an isolated movement firstly on the right and then on the left.

Figure 19 The third movement (C): hands in karṭākamukahastaḥ with only the movement of the eyes and neck.

Finally, the fourth movement, movement D (Figure 20), starts in *aramandi* position and while one foot is brought behind the leg as to form a *svastika* position (svastika means "cross"), the hand in *karṭākamukahastaḥ* will open in *alapadmahastaḥ* (the moving lotus) and the other arm will remain in *natyarambam*. Also here there is a slight bend of the torso while the hand and the foot are moving

together. When the hand and foot go back to the initial position the chest returns straight. The eyes are always following the movement of the hands.

Figure 20 The fourth movement (D) with the svastika position, the torso bending on the side and the hand opening in alapadmahastaḥ.

We decided to replicate the same movements and the same sequences, but with a different color shirt. That is for two reasons: one is because this non-relevant aspect of the stimuli could be a cue that can help maintain the attention (Calvo-Merino, Grèzes, Glaser, Passingham, & Haggard, 2006) of the participants and at the same time it won't make our research question obvious that is about the symmetry of movement itself. The sequence of how the movement should start (left or right) and which movement should go first was manipulated. There are some movements coupled as it should be in the tradition of this dance, so the same movement will be repeated firstly on the right and then on the left (symmetry of *side*). Whereas the asymmetrical conditions would be that in some cases the same movement will be repeated firstly on the left side and then on the right side (Figure 21) as one type of asymmetry. Whereas, in some other cases, the type of movement combination would change as compared to the sequence based on the textbooks. The "continuation" of the movements was manipulated. The "good" continuation (Orgs, Hagura, & Haggard, 2013) should be that the same movement is repeated first on the right and then on the left, while the "bad" continuation was created by coupling one movement with another one different from the first one. As this could lead to a lot

of combinations, we decided to do restrict the number of possible couples, by matching couples only between two precise movements and not between all four movements between each other. So, the first movement is combined with the second one and the third movement with the fourth one. There are no other combinations, like for example the second movement combined with the fourth one. This for practicality into building the experiment: too many combinations could lead to a possible dissipation of attention from the experiment.

Figure 21 On top an example of asymmetry of side: the same movement is repeated firstly on the left side instead of right. Below an example of asymmetry of type: in this case movement A is done on the right side, but then movement B is done on the left.

3.3.3 Procedure

The experiment did not consider an initial exposure and a subsequent test phase in order to avoid the mere exposure effect that could influence the aesthetic perception of the couple of movements. The experiment is done online but also keeping the contact with the participant. With a zoom call or a normal video-call we stayed in contact with the subjects in order to accompany them into the initial phase of the experiment and to be there if some clarifications were needed. All the experiment has to be done on computer. After the compilation of the consensus form, the participant has to fill the personal data as well as specifying how much he or she consider him or herself an "expert" in art in general. We asked this self-rated question to be sure that the majority of people were not too much into the artistic world generally speaking and to see if there would be some correlation also with the degree of expertise. After this initial phase, the presentation of the videos began. We presented sequences of couples (each couple will be lasting approximately 8 to 10 seconds) of movements: the sequence of the two couples has to be randomized, so there could be two couples of movements starting from left paired together. At the end of each couple, the participants have to judge the movement by giving four judgments that seems to be important components of aesthetic perception (Orgs, Hagura, & Haggard, 2013). The participants will judge the movement by sliding a bar with the mouse from one extreme to the other. The elements will be: the *pleasantness*, as how much the movement is liked. The *fluidity*: how fluid the movement is perceived, that is how much they thought the sequence had a "good" continuation (Orgs, Hagura, & Haggard, 2013). "Good" continuation means that successive postures always followed the most continuous trajectory possible (in this case first on the right and then the same on the left side, in this order) without changing the movement or path reversals. The *expressiveness*: how much the movement is judged to be expressive, in terms of conveying some kind of emotion or telling a story. As the eyes and gaze are a fundamental aspect of *Bharatanāṭyam* dance, we decide not to blur the face of the dancer like (Calvo-Merino, Grèzes, Glaser, Passingham, & Haggard, 2004) because, even if the face expression was neutral, it could

contribute to the aesthetic perception as whole. The *codification*: how much the participant perceives the sequence as codified (by a certain manual) or if it is perceived as manipulated or improvised. It is crucial that the participants should not be informed that movement sequences followed a certain structure (so that one is considered "good" continuation and another one "bad"). Any influence of compositional structure on aesthetic judgments therefore will occur spontaneously. The participants had to give their judgments by sliding a bar on the screen going from one extreme of the judgment to the opposite extreme. For example, to the question "how much you liked the dance you saw?" the participant could slide the bar with the mouse from the "very little" to "very much". The scale was a continuous scale from 0 to 100. After watching all the videos, we asked the participant to answer a multiple-choice question regarding the similarity of this dance form with other styles. We asked: "how much this dance style reminded you of other dance styles which maybe you are aware of?". The choice could be between "ethnic", "classical", "contemporary", "popular" and "none of the above".

3.4 Data analysis

We conducted a within subject experiment, where the independent variables were three: *symmetry* (with two levels present or absent), the *type* of movement (type 1 for movements A and B and type 2 for movements C and D) and the *direction* of the movement (if it starts from left or right). The dependent variables were the four judgments given by the participants. Ideally the data that have two or more independent variables with dependent groups are analyzed using a repeated measure ANOVA, which refers to a symmetric distribution around a mean. In this case, however, the results were asymmetrical on the left side or on the right side around the mean. For this reason, we decided to conduct an ANOVA not based on means, but on medians, by transforming the data in ranks so they would be more uniform. We used ARTool (Wobbrock, Findlater, Gergle, & Higgins, 2011), where ART stands for *Aligned Rank Transform*. ARTool is a non-parametric analysis of variance on

factorial models. With this method, the results are aligned and ranked so that, unlike when using the regular rank transform (RT), using an aligned rank transform (ART) ensures that main effects and interactions have appropriate Type I error rates and suitable power. We then conducted post-hoc tests for significant interactions. The post-hocs were pairwise comparisons corrected using FDR (*false discovery rate*) to avoid Type I error.

3.3.4 Results

The hypothesis behind this study was to test the universality of the symmetric principle, specifically regarding the human body that is moving. If symmetry really is a universal principle (Ramachandran & Hirstein, 1999) and, for this reason, a prevailing aesthetic aspect when it comes to the judgment of objects or people, then it does not matter if a moving body is executing ballet or an unknown dance form. Our results confirmed this hypothesis, at least for the subjects who judge themselves as having high expertise in art. In the analysis we made sure that no responses were given casually. Overall, we found out that there was a main effect between symmetry and level of expertise. As Figure 22 shows, for all the four variables of interest (*pleasantness*, *expressiveness*, *fluidity* and *improvisation*) there is a bigger difference in the judgments between non-experts as compared to experts: the pattern of preference is the opposite for non-expert compared to our hypothesis. That is, non-experts preferred in general asymmetric movements compared to experts. The movements for non-expert subjects were liked more and judged as more expressive, more fluid and more improvised. The pattern of the non-experts is the same for the medium-expert subjects, but the difference with non-experts is less strong. There is a change in the pattern for the experts, except for the judgment of *improvisation*. In all the other three judgments, experts liked more the symmetric movement and perceived it as more expressive and fluid. In particular, the judgment of *expressiveness* seems to be more significant compared to the judgments of "fluidity" and *pleasantness*, where the inversion of pattern is not much significant. In general, it is possible to see that the difference in the perception of symmetric and asymmetric movements is bigger between non-experts and experts.

Starting from the *pleasantness* judgment (Figure 22, top left) the repeated measure analysis of variables shows three statistically significant relationships: the main effect of *type* (the type of movement) is statistically significant and small (F (1,971) = 5.22, p = 0.023; Eta2 (partial) = 5.34e-03, 95% CI [3.93e-04, 1.00]). The main effect of *symmetry* (the relationship between symmetry and pleasantness) is statistically significant and small (F (1,971) = 7.71, p = 0.006; Eta2 (partial) = 7.88e-03, 95% CI [1.31e-03, 1.00]). The interaction between *symmetry* and *expertise* is statistically significant and small (F (2,971) = 4.65, p = 0.010; Eta2 (partial) = 9.48e-03, 95% CI [1.30e-03, 1.00]). We then analyze more in depth the interaction between *symmetry* and *expertise* by running a t-test. The main effect of symmetry and asymmetry (*Table 1*) for non-experts is statistically significant and small (estimate = 69.5, se = 27.4, (t) = 2.54, p = 0.023,) as compared to intermediate experts (estimate = -12.6, se = 16.6, (t) = -0.76, p = 0.45,) and experts (estimate = -44.6, se = 29.6, (t) = -1.51, p = 0.20,). Regarding the pairwise comparison, the two statistically significant interactions were between non-experts and intermediate experts (estimate = 82.1, se = 32, (t) = 2.56, p = 0.022), and between non-experts and experts (estimate = 114.1, se = 40, (t) = 2.83, p = 0.022,). The difference between intermediate experts and experts was not statistically significant (estimate = 32.0, se = 33.9, (t) = 0.94, p = 0.41).

Also for the *expressiveness* judgment (Figure 22, top right) the repeated measure analysis of variables shows a statistically significant effect for the *type* of movement (F (1,971) = 42.14, p < .001; Eta2 (partial) = 0.04, 95% CI [0.02, 1.00]) and for *symmetry* (F (1,971) = 6.49, p = 0.011; Eta2 (partial) = 6.64e-03, 95% CI [8.26e-04, 1.00]). Moreover, like for the previous judgments, the interaction between *symmetry* and *experts* is statistically significant (F (2,971) = 6.53, p = 0.002; Eta2 (partial) = 0.01, 95% CI [3.19e-03, 1.00]). In the T-test (*Table 3*) of the interaction between symmetry and expertise the difference between symmetry and asymmetry for non-experts is statistically significant (estimate = 74.23, se = 26.9, (t) = 2.76, p = 0.02,) as compared to intermediate experts (estimate = -7.96, se = 16.4, (t) = -0.79, p = 0.63,) and experts (estimate = -66.57, se = 29.1, (t) = -2.23, p = 0.03,). Regarding the pairwise comparison, the two statistically significant interactions were

between non-experts and intermediate experts (estimate = 82.20, se = 31.5, (t) = 2.61, p = 0.018,) and between non-experts and experts (estimate = 140.81, se = 39.7, (t) = 3.55, p = 0.002,). The difference between intermediate experts and experts was not statistically significant (estimate = 58.61, se = 33.4, (t) = 1.76, p = 0.09).

As for the *fluidity* judgment (Figure 22, bottom left) the repeated measure analysis of variables does not show a statistically significant effect for the *type* of movement, whereas *symmetry* (F(1,971) = 21.56, p < .001; Eta2 (partial) = 0.02, 95% CI [9.11e-03, 1.00]) and, again, the interaction between *symmetry* and *experts* (F(2,971) = 6.90, p = 0.001; Eta2 (partial) = 0.01, 95% CI [3.60e-03, 1.00]) are statistically significant and small. In the T-test (*Table 2*) of the interaction between *symmetry* and *expertise* the main effect of symmetry and asymmetry for non-experts is statistically significant and small (estimate = 80.07, se = 27.1, (t) = 2.95, p = 0.009,) as compared to intermediate experts (estimate = 0.70, se = 16.5, (t) = -0.38, p = 0.45) and experts (estimate = -65.06, se = 29.3, (t) = -2.22, p = 0.04,). Regarding the pairwise comparison, the two statistically significant interactions were between non-experts and intermediate experts (estimate = 86.4, se = 31.7, (t) = 2.72, p = 0.013,) and between non-experts and experts (estimate = 145.1, se = 39.9, (t) = 3.64, p = 0.002). The difference between intermediate experts and experts was not statistically significant (estimate = 58.7. se = 33.6, (t) = 1.75, p = 0.09,).

Unlike the other three judgments, for the *improvisation* one (Figure 22, bottom right) the repeated measure analysis of variables shows a statistically significant effect only for *symmetry* (F (1,971) = 19.36, p < .001; Eta2 (partial) = 0.02, 95% CI [7.70e-03, 1.00]) and not for the interaction between *symmetry* and *expertise*. In the T-test (*Table 4*) for the interaction between *symmetry* and *expertise* there are no significant values: the difference in the perception of symmetry or asymmetry is still bigger for non-experts (estimate = -3.57, se = 27.3, (t) = -0.13, p = 0.89,) than experts (estimate = -65.04, se = 29.4, (t) = -2.21, p = 0.16,) or intermediate experts (estimate = -14.31, se = 16.5, (t) = -0.86, p = 0.58,). In the comparison between levels of expertise, the pattern for experts is not changing

as compared to non-experts: for this judgment also for the experts the symmetric movement is perceived as more improvised as compared to the asymmetric one.

Table 1: Pleasantness

expert	symmetry pairwise	expert pairwise	estimate	SE	t-ratio	p-value
Non-Expert	Asymmetric - Symmetric	.	69.5	27.4	2.538	0.0226
Intermediate Expert	Asymmetric - Symmetric	.	-12.6	16.6	-0.760	0.4475
Expert	Asymmetric - Symmetric	.	-44.6	29.6	-1.509	0.1974
.	Asymmetric - Symmetric	Non-Expert - Intermediate Expert	82.1	32.0	2.564	0.0226
.	Asymmetric - Symmetric	Non-Expert - Expert	114.1	40.3	2.832	0.0226
.	Asymmetric - Symmetric	Intermediate Expert - Expert	32.0	33.9	0.943	0.4149

Table 2: Fluidity

expert	symmetry pairwise	expert pairwise	estimate	SE	t-ratio	p-value
Non-Expert	Asymmetric - Symmetric	.	80.07	27.1	2.954	0.0096
Intermediate Expert	Asymmetric - Symmetric	.	-6.32	16.5	-0.384	0.7008
Expert	Asymmetric - Symmetric	.	-65.06	29.3	-2.222	0.0397
.	Asymmetric - Symmetric	Non-Expert - Intermediate Expert	86.40	31.7	2.725	0.0131
.	Asymmetric - Symmetric	Non-Expert - Expert	145.13	39.9	3.638	0.0017
.	Asymmetric - Symmetric	Intermediate Expert - Expert	58.73	33.6	1.749	0.0967

Table 3: Expressiveness

expert	symmetry pairwise	expert pairwise	estimate	SE	t-ratio	p-value
Non-Expert	Asymmetric - Symmetric	.	74.23	26.9	2.756	0.0179
Intermediate Expert	Asymmetric - Symmetric	.	-7.96	16.4	-0.487	0.6263
Expert	Asymmetric - Symmetric	.	-66.57	29.1	-2.288	0.0335
.	Asymmetric - Symmetric	Non-Expert - Intermediate Expert	82.20	31.5	2.608	0.0185
.	Asymmetric - Symmetric	Non-Expert - Expert	140.81	39.7	3.551	0.0024
.	Asymmetric - Symmetric	Intermediate Expert - Expert	58.61	33.4	1.756	0.0953

Table 4: Improvisation

expert	symmetry pairwise	expert pairwise	estimate	SE	t-ratio	p-value
Non-Expert	Asymmetric - Symmetric	.	-3.57	27.3	-0.131	0.8958
Intermediate Expert	Asymmetric - Symmetric	.	-14.31	16.5	-0.865	0.5808
Expert	Asymmetric - Symmetric	.	-65.04	29.4	-2.210	0.1642
.	Asymmetric - Symmetric	Non-Expert - Intermediate Expert	10.74	31.9	0.337	0.8836
.	Asymmetric - Symmetric	Non-Expert - Expert	61.47	40.1	1.532	0.2666
.	Asymmetric - Symmetric	Intermediate Expert - Expert	50.73	33.8	1.503	0.2666

Results are averaged over some or all of the levels of: direction, type

P value adjustment: fdr method for 6 tests, df:971

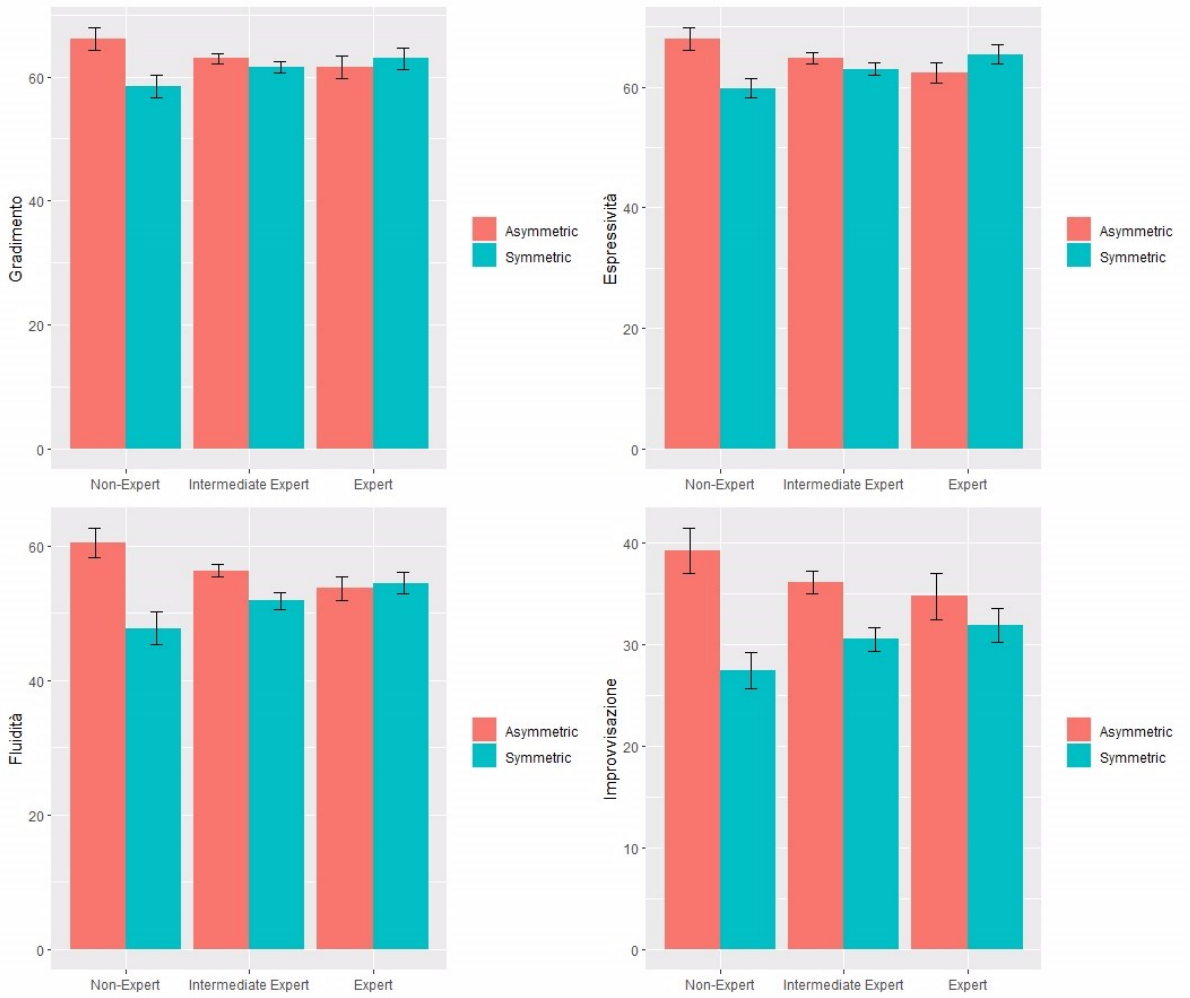


Figure 22 Summary table representing the main effect of symmetry and level of expertise for each of the variables of interest. On the x-axis is shown the level of expertise, on the y-axis the four judgments. In red the asymmetric movements and in blue the symmetric ones.

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As outlined before, only for some variables, an effect linked to the *type* of movement that has been executed is present. Overall, by looking at Figure 23 the movement that was preferred was type 2, which contains the all the combinations of movement C and D. However, not for all the four variables the preference was the same. For the *pleasantness* judgment there was no significant difference in the preference between the two types of movements among the different levels of expertise. For the *fluidity* judgment only for experts and intermediate experts the perception of fluidity was stronger for type 2 movements. As for *expressiveness*, is possible to see the strongest difference between the two types of movements which is present for all levels of expertise: every level judged more expressive the type 2 movement. Finally, for the last variable, the *improvisation* one, only the

non-experts participants judged as more improvised the type two movement, whereas for the other levels is the opposite. It is important to note that in the *fluidity* and *expressiveness* conditions the values looked non statistically significant by watching only at the graph but seemed to be significant as reported by the repeated measure analysis. This difference is due to the difference between analysis and graphics. The analysis is based on rankings and repeated measures that the graphic does not show because it shows only the mean values.

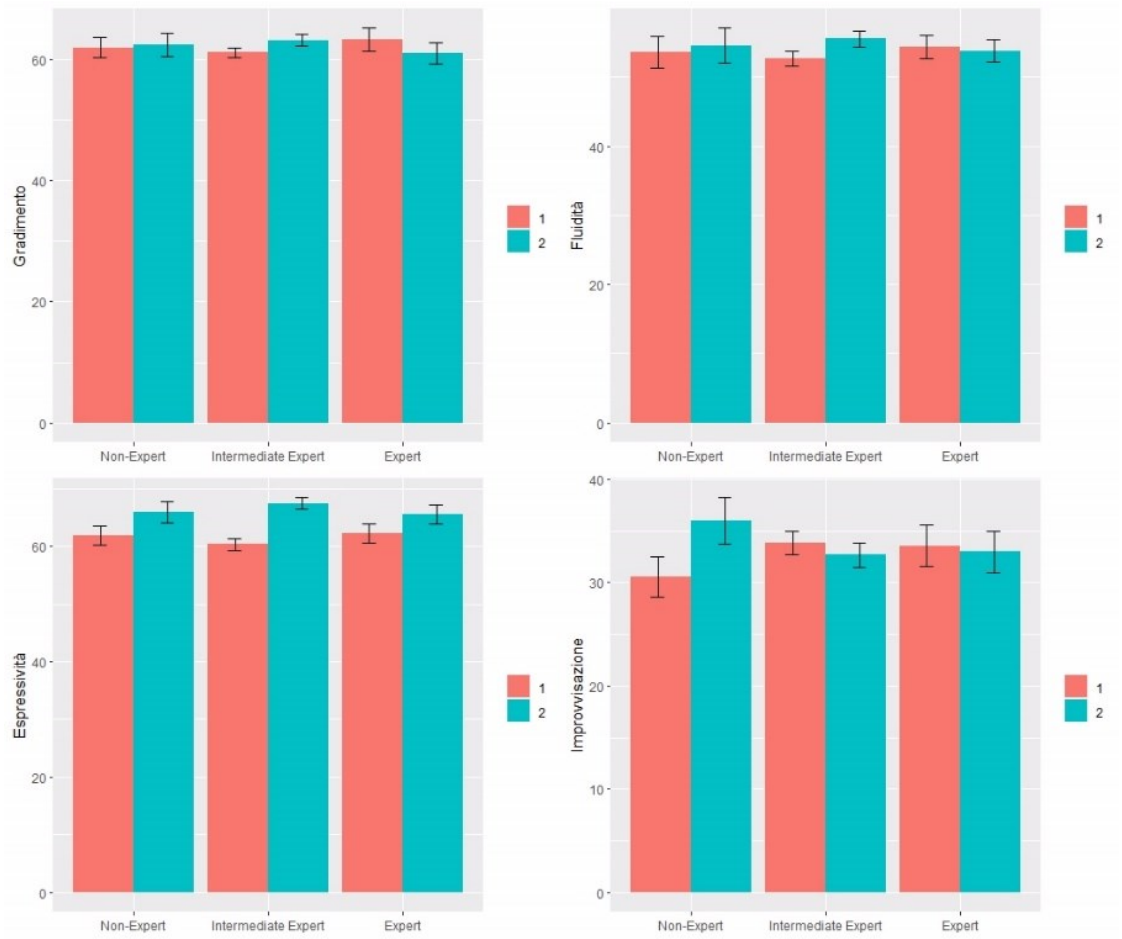

Figure 23 Summary table showing how each movement is judged by the participants at different levels of expertise. On the x-axis is shown the level of expertise, on the y-axis the four judgments. 1 corresponds to type one movement (movements A and B) and 2 corresponds to type 2 movements (movements C and D).

To analyze the correlation between judgments, we run a Spearman correlation for the same reason of using ARTool: there are multiple correlations that are non-parametric. Figure 24 shows the pairwise correlations between judgments. As the graphics and the Spearman correlations highlight, there is a significative and positive correlation between the judgment of *fluidity* and *pleasantness*,

that is, the more a movement is fluid and the more is liked. A positive and stronger correlation is present between *expressiveness* and *pleasantness*, so that the more a movement is perceived as expressive and the more is liked.

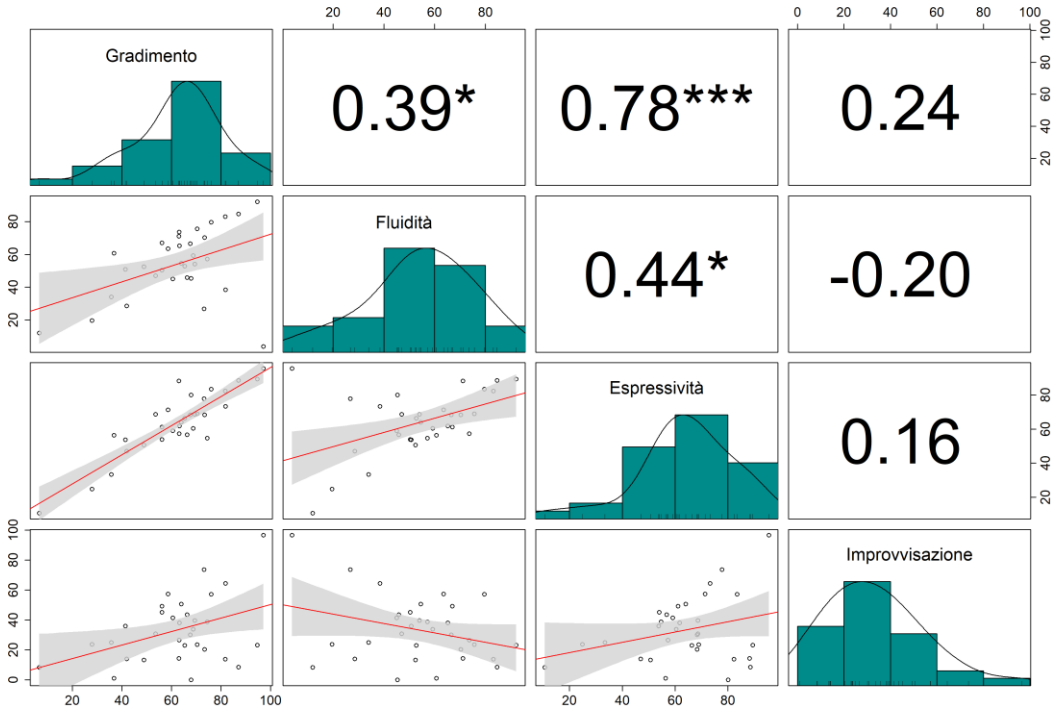

Figure 24 The matrix shows all the variables related to each other. On the top of the diagonal there is the value of the Spearman correlation (rho). On the diagonal the distribution of each variable. On the bottom of the diagonal the bivariate scatter plots of the mean values for each participant.

A less strong correlation but still significative emerges between *expressiveness* and *fluidity* (the more fluid the movement, the more expressive is perceived). Lastly, regarding the *improvisation* variable, the results show a non-significant correlation with *improvisation* and, respectively, *pleasantness* and *expressiveness*, even if these correlations are small, they are present and not that small to be ignored. Finally, there is a negative correlation between the *improvisation* condition and the *fluidity* one: the more a movement is fluid the more is considered "coded" and not improvised. After the all the video presentation, we asked the participants one last question: how they would classify this type of dance (Figure 25). The majority of them perceived *Bharatanāṭyam* dance as more similar to a "classical" or "popular" dance style.

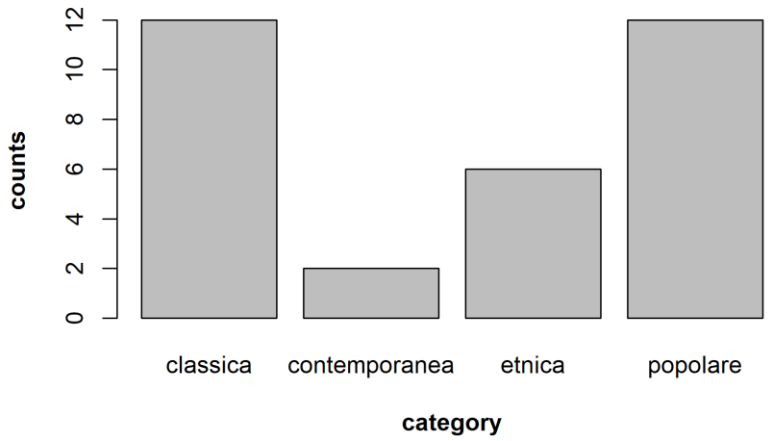

Figure 25 Histogram representing the classifications of the movements seen by participants. On the x-axis the categories we selected for the participant to choose and on the y-axis the number of participants who choose each of the categories.

3.5 Discussion

In this study we presented a study that aims to investigate if the perception of symmetry in a body in movement is still predominant as aesthetic preference. Is the preference for symmetry still present even if the body is moving (and not static) and even if the dance is not a well-known dance? With this study we tried to see if the hypothesis of symmetry as a universal principle would find a confirmation. In the following we will discuss our findings.

3.3.5 Symmetry and expertise

Aesthetic perception of body postures is related to spatial geometry and involves both visual and sensorimotor processing (Calvo-Merino, Urgesi, Orgs, Aglioti, & Haggard, 2010). In line with these findings, only the minority of the participants in our study preferred symmetric body movement, the ones who considered themselves as experts in art. Whereas, the majority of subjects (non-experts and intermediate experts) overall preferred asymmetric movements and this was not due to a prior exposure of asymmetric movements (Orgs, Hagura, & Haggard, 2013). This is in contrast with our hypothesis that naïve people in dance, and *Bharatanāṭyam* dance specifically, should prefer by default

symmetric movement, demonstrating that probably expertise play an important role in the appreciation of symmetric movements as the results show a statistically significant interaction between *symmetry* and *expertise*. Our findings are more in line with the studies done by Calvo-Merino et al. on dance experts: even if in our case we did not investigate the brain responses, that study showed that there is a greater response in the motor areas (as well as visual areas) when dance experts viewed a dancer doing a movement of their own repertoire (Calvo-Merino, Grèzes, Glaser, Passingham, & Haggard, 2006). Probably, despite the fact that *Bharatanāṭyam* is not a known dance style, people who perceived themselves as "experts" in art have a greater sensibility to aesthetic perception and therefore are able to seize directly the geometric lines created by the body in space. This may mean that symmetry is not necessarily representing an innate preference, but a reinforcing one along with other aspects that are predominant when it comes to aesthetic judgment, like the artistic experience of each subject. Not by chance, the participants who perceived themselves as experts were also the ones who had previous experiences regarding art: from music to theatre to singing or watching dance performances.

3.3.6 Which movement makes the difference?

The preference for type two movement is interesting because, in terms of implied effort and complexity, the two movements are opposite: movement C is a standing position and nothing is moving except for the neck and the eyes, so it could be considered a simple movement (Orgs, Hagura, & Haggard, 2013). While movement D is more dynamic and complex in its structure: the legs are bent and one is crossing behind the other and at the same time the hand in front is rotating together with chest and eyes. Probably these combinations, exactly for the fact that they are opposite to each other, created an element of novelty and "surprise" or uncertainty (Cupchik & Berlyne, 1979) that was liked more. Another curious result is that they were perceived as more fluid. This demonstrate that the sequence of movement does not necessarily need to be symmetric in order to be preferred.

All of these considerations follow the line of literature that go against the idea that the preference for a certain element (a movement or a sequence of movements) is preferred because is simple (and easier for the brain to elaborate) and familiar. Not by chance the asymmetric movements were considered also more improvised and probably for this reason, more interesting. Most likely there was the element of familiarity (with classical dance or ballet) because the majority of participants classified *Bharatanāṭyam* dance as classic, but presumably, the random mixing and the unpredictability prevailed over the "regular" and schematic symmetry. Participants in our study were never directly informed about the presence of a sequential symmetry rule, yet sequence structure clearly influenced aesthetic judgement, maybe more than symmetry itself. The element of novelty, starting from the *Bharatanāṭyam* dance itself that was unknown for the participants, could represent a limit at the same time. For a complete naïve person, whatever dance movement could represent a new element and create an awe reaction and to be preferred for this reason. This aspect could be study more deeply in future studies maybe by creating some trials before the actual test phase as to reduce the novelty effect. Moreover, the element of expressivity could have biased the judgment. Even if the face expression was neutral, the fact alone the face was visible, unlike (Calvo-Merino), could have influenced the aesthetic perception of the movement in particular the movement C, where the eyes play an important role.

3.6 CONCLUSION

To summarize, we decided to investigate the predominancy of symmetry in aesthetic perception. The stimuli chosen were movements taken from reference textbooks of *Bharatanāṭyam* dance, an indian classical dance style. Symmetry is an important principle in human perception, to the point to be considered a universal principle by some researchers. If it is universal the preference for symmetry in human body should prevail over other aspects and there should be also a cross-cultural preference. With our experiment we tried to understand better if non-experts participants would prefer symmetric

movements of an unknown dance style. The results seemed to have disconfirmed our hypothesis: the minority of subjects (the experts) confirmed the hypothesis, but the majority of subjects (intermediate experts and non-experts) tended to prefer asymmetric movements over symmetric ones. This probably is because, despite the similarity with dance styles known in western countries (like classical dance) and the fact that symmetric movements and sequence of movements are easier to process, the way in which the movement were combined and the level of complexity of the movement themselves had priority on the aesthetic perception. However, this is just the beginning in the exploration of the aesthetic perception of dance and, given the cultural complexity of *Bharatanāṭyam* dance, more studies could be done in the future that could also enrich the young field of Aesthetics and Neuroaesthetics.

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5 REFERENCES

Altmann, I. (2023). Gustav Theodor Fechner as natural scientist. *Chem Text*.

Aristotele. (2000). *Metafisica.* (G. Reale, Ed.) Milano: Bompiani.

Boccali, G. (2021, Giugno 3). Bharatanāṭyam and Aesthetics. *Conference on Bharatanāṭyam and Aesthetics*. Accademia Sangam.

Boccali, G. (2021, Ottobre 10). Kāvya and Rasa. *Conference on Kāvya and Rasa* . Accademia Sangam.

Bode C., H. M. (2017). A cross-cultural comparison for preference for symmetry: comparing British and Egyptians non-experts. *PSIHOLOGIJA*, 383-402.

Bornstein, M. H., Ferdinandsen, K., & Gross, C. G. (1981). Perception of symmetry in infancy. *Developmental Psychology*, 82-86.

Bressan, P. (2007). *Il colore della luna.* Laterza.

Calvo-Merino, B., Grèzes, J., Glaser, D., Passingham, R. E., & Haggard, P. (2004). Action observation and acquired motor skills: an fMRI study with expert dancers. *Cerebral Cortex*.

Calvo-Merino, B., Grèzes, J., Glaser, D., Passingham, R. E., & Haggard, P. (2006). Seeing or Doing? Influence of Visual and Motor Familiarity in Action Observation. *Current Biology*, 1905-1910.

Calvo-Merino, B., Urgesi, C., Orgs, G., Aglioti, S. M., & Haggard, P. (2010). Extrastriate body area underlines aesthetic evaluation of body stimuli. *Springer-Verlag*, 447-456.

Carrère, E. (2021). *Yoga.* Adelphi Edizioni.

Changeux, J. P. (2013). *The beautiful, the good, the true. Un nuovo approccio neuronale.* Milano: Raffaello Cortina Editore.

Chatterjee, A. (2014). *The Aesthetic Brain.* Oxford: Oxford University Press.

Cross, S. E., & Kirsch, P. L. (2015). Additive routes to action learning: layering experience shapes engagement of the action observation network. *Oxford University Press*, 4799-4811.

Cross, S. E., & Ticini, F. L. (2011). Neuroaesthetic and beyond: new horizons in applying the science of the brain on the art of dance. *Springer - Dance Neuroaesthetic*, 3-4.

Csikszentmihalyi, M., & Csikszentmihalyi, I. S. (2006). *A life worth living: COntributions to positive psychology.* New York: Oxford University Press.

Cupchik, C. G., & Berlyne, E. D. (1979). The perception of collative properties. *Scandinavian Journal of Psychology*, 93-104.

De Beni, R., Carretti, B., Moè, A., & Pazzaglia, F. (2014). *Psicologia della personalità e delle differenze individuali.* Bologna: Il Mulino.

Di Nuovo, S. (2021-2022, Dicembre-Maggio). Arte e Neuroscienze tra funzioni cerebrali e mente sociale. *Psicologia Contemporanea*, pp. 106-107.

Fechner, T. G. (1907). *Elemente der Psychophysik (Elements of psychophysics).* Leipzig: Breitkopf & Hartel.

Ferigo, C. (2021, settembre). The poetry of movement - How human being tells himself through Dance Therapy and Abhinaya. Verona: Università degli Studi di Padova.

Fink, B., Neave, N., Manning, T. J., & Grammer, K. (2006). Facial symmetry and judgments of attractiveness, health and personality. *Personality and Individual Differences*, 491-499.

Fink, B., Weege, B., Flügge, J., Rörder, S., Neave, N., & McCarty, K. (2012). Men's personality and women's perception of their dance quality. *Elsevier* , 232-235.

Gallese, V., Benuzzi, F., Lui, F., Ardizzi, M., Ambrosecchia, M., Ballotta, D., . . . Porro, A. C. (2018). Pain Mirrors: Neural Correlates of Observing Self or Others' Facial Expressions of Pain. *Frontiers of Psychology*.

Ghosh, M. (1975). *Nandikesvara Abhinayadarpanam.* Calcutta: Impression Printers & Printers.

Goren, C. C., Sarty, M., & Wu, P. M. (1975). Visual following and pattern discrimination of face-like stimuli by newborns infants. *Pediatrics*, 544-549.

Grassi, E., & Palumbo, P. (2021-2022, Dicembre-maggio). Un approccio neuroestetico alla bellezza. *Psicologia contemporanea*, pp. 62-63.

Griffey, A. F., & Little, C. (2014). Infant's visual preferences for facial traits associated with adult attractiveness judgments: Data from eye-tracking. *INfant Behavior & Development*, 268-275.

Higgins, E. T., Roney, C., Crowe, E., & Hymes, C. (1994). Ideals versus ought predilections for approach and avoidance: Distinct self-regulatory systems. *Journal of Personality and Social Psychology*, 276-286.

Höge, H. (1995). Fechner's experimental aesthetics and the golden scetion hypothesis today. *Empirical Studies of the Arts*, 131-148.

Huang, Y., Lyu, J., Kue, X., & Peng. (2020). Cognitive basis for the development of aesthetic preference: Findings from symmetry preference. *PLoS ONE*.

Ishizu, T., & Zeki, S. (2011). Towards a Brain-Based Theory of Beauty. *PLOS ONE*.

Jacobsen, T., Schubotz, I. R., Höfel, L., & Cramon, Y. (2006). Brain correlates of aesthetic judgment of beauty. *Elsevier, NeuroImage*, 276-285.

Jayakumar, S. (2020, novembre 11). Cultural History of South India. Saraswatham Association.

Jola, C., McAleer, P., Grosbras, M.-H., Love, S. A., Morison, G., & Pollick, F. E. (2013). Uni- and multisensory brain areas are synchronised across spectators when watching unedited dance recordings. *i-Perception*, 265-284.

Kant, I. (2005). *Critique to Pure Reason.* (G. Gentile, & L. G. Radice, Eds.) Roma: Laterza.

Little, C. A., & Jones, C. B. (2003). Evidence against perceptual bias views for symmetry preferences in human faces. *The royal society*, 1759-1763.

Machilsen, B., Pauwels, M., & Wagemans, J. (2009). The role of vertical mirror symmetry in visual shape detection. *Journal of Vision*.

Makin, D. J., Wilton, M. M., Pecchinenda, A., & Bertamini, M. (2012). Symmetry perception and affective responses: A combined EEG/EMG study. *Elsevier - Meuropsychologia*, 3250-3261.

Maniscotti, L. (2021, settembre 11 giugno). Śiva Nāṭarāja dall'iconografia alla rappresentazione danzata. *Quaderni Asiatici*, pp. 18-19.

Maslow, A. H. (1968). *Toward a psychology of being.* (V. Nostrand, Ed.) New York: Astrolabio.

Mather, G. (2014). *The Psychology of Visual Art.* UK: Cambridge University Press.

Mercadini, R. (2022). *L'ingegno e le tenebre.* (F. Martini Di Giorgio, Trans.) Milano: Rizzoli Editore.

Noor, F., & Evans, D. (2003). The effect of facial symmetry on perceptions of personality and attractiveness. *Journal of Research in Personality*, 339-347.

Orgs, G., Hagura, N., & Haggard, P. (2013). Learning to like it: Aesthetic perception of bodies, movements and choreographic structure. *Consciousness and Cognition* , 603-612.

Ornaghi, S. (2003). Un cervello e due emisferi. *Yoga Journal*, 49.

Policardi, C. (2020). *Divino, femminile, animale. Yogini teriantropiche nell'India antica e medioevale.* Alessandria: Edizioni dell'Orso.

Pollock, S. (2016). *A Rasa Reader.* New York: Columbia University Press.

Ramachandran, S. V. (2009). The power of symmetry. *Scientific American Mind*, 20-22.

Ramachandran, V. S., & Hirstein, W. (1999). The Science of Art - A Neurological Theory of Aesthetic Experience. *Journal of Consciousness Studies*, 17-18.

Ramachandrasekhar, P. (2023). *Dance Gestures (mirror of expressions). With english translation of Abhinayadarpana.* Chennai: Giri Trading Agency Private Limited.

Raman, J. (2015). *Bharatanāṭyam Dance of India - Grammar and Technique.* USA: RASIKA.

Rangacharya, A. (2010). *Nāṭyaśāstra.* New Delhi: Munshirnsm Manoharlal Publishers.

Rao, S. (n.d.). *The texts of the Indian Dance traditions – Part Eight.* Retrieved from Sreenivasarao's blog: https://sreenivasaraos.com/tag/texts-of-the-indian-dancing-traditions/

Shabout, N. (2018). *Comprendere l'Estetica Islamica*. Retrieved from Cultor College: http://www.cultor.org/islam/A.html

Siviniski, J., & Burk, T. (1989). Reproductive and Mating Behavior in fruit flies: their biology, natural enemies, and control. *Elsevier*, 343.

Sri Aurobindo Institute of Research in Social Science. (n.d.). *Aalap, A Discovery of Indian Classical Music.* Times Music, Mumbay: Sri Aurobindo Society, Pondicherry.

Swaddle, P. J., Judy, P. K., & Clelland, E. R. (2004). Symmetry preference as a cognitive by-product in starlings. *Behavior*, 469-478.

Tosato, A. (2021, April 29). Dance and Sculptures. *Cicle of conferences on Dance and Sculptures*. Accademia Sangam.

Treccani. (n.d.). *http://www.treccani.it/vocabolario/).*

Vianello, R., Gini, G., & Lanfranchi, S. (2015). *Psicologia dello Sviluppo.* Torino: De Agostini Scuola.

Wardle, S. G., Taubert, J., Teichmann, L., & Baker, I. C. (2020). Rapid and dynamic processing of face pareidolia. *Nature Communication*, 9-10. Retrieved from https://doi.org/10.1038/s41467-020-18325-8

Wobbrock, J. O., Findlater, L., Gergle, D., & Higgins, J. J. (2011, May 7-12). *The Aligned Rank Transform for Nonparametrics Factorial Analyses Using Only ANOVA Procedures. Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI 2011).* doi:10.1145/1978942.1878963

Yalom, I. (2005). *The Schopenhauer Cure.* Vicenza: Neri Pozza Editore.