Neuroaesthetics, lecture 1, 18.01.13: Introduction to the course.

First of all, my name is Per Olav Folgerø. I am Associate professor at the University of Bergen Norway. I have the strange background of being neurobiologist and art historian, but this has led to the reason why I am here, namely to teach neuroaesthetics. I am very happy and grateful to be here in Saint Petersburg to present my lectures. They are a mini-version of the course that I have presented the last four years at the University of Bergen. The lectures are intended to provide insights into recent scientific works and methods in neuroaesthetics. (**next**)

The conception of ´Neuroaesthetics` was coded in 1999 by the neuroscientist Semir Zeki, who is a professor at the Wellcome Department of Imaging Neuroscience, University College, London. Hence, it is a relatively new discipline, (**next**) and lies at the intersection between cognitive psychology, neurobiology and art. (**next**) In neuroaesthetics, models mostly deriving from cognitive psychology and modern brain scanning techniques are used in studies on how the brain responds to aesthetic stimuli. (**next**)

Zeki's main interest is the primate visual brain system. From 1994 onwards, his studies also included the neural basis of aesthetic appreciation of art, and in 2001 he founded the Institute of Neuroesthetics, the first of its kind in the world, at University College London.

The aims of this institute are:

to study the creative process as a manifestation of the functions of the brain; (**next**)

to study the biological foundations of aesthetics; (**next**)

to provide a scientific forum for artists; (**next**)

to instill among neurobiologists the virtues of using the products of art to study the organization of the brain; (**next**)

to promote the importance of learning more about the brain when approaching topics such as art, morality, religion etc.

Zeki's research on which brain areas are activated by aesthetic stimuli will stand central in my presentations; in my lecture today I will give a brief sketch of it, and we will return to it in my third lecture that will take place on Monday. (**next**)

There is also another great neuroscientist who should be regarded as a founder of our discipline, namely Vilayanur Ramachandran, who is professor in neurobiology at the Center for Brain and Cognition, University of California, San Diego. (**next**) Together with William Hirstein, he has formulated what he calls "eight laws of aesthetics". We will not go through every eight of them in this lecture; we will return to this material in my fourth lecture; here shall only be presented one of the principles. (**next**)

According to Ramachandran and Hirstein, art will always tend to be a sort of exaggeration of the reality. As arguments in favor of their thesis, they draw on artifacts as diverse as the 28 000 years old so called (**next**) Venus of Willendorf, (**next**) Indian female temple sculptures from the 9th c. of our era showing exaggeration of female beauty, and modern caricatures, such as (**next**) this one of the American ex-president Nixon, which, as pointed out by Ramachandran, is more Nixon-like than the photo of the ex-President.

Ramachandran labels this exaggeration of form in art as (**next**) *the peak shift effect*. Interestingly, he finds the same mechanism in work in the animal world. There is, for instance, an (**next**) interesting experiment on seagulls feeding their chicks. The beak of the seagull, which is yellow, has a (**next**) red stripe on it, on which the chickens peck when they beg for food.

If you put a yellow stick with a (**next**) red stripe on it into the nest, the chicks will peck also at this stimulus. Now, if you put another stick with, say, (**next**) three red stripes into the nest, the chicken will pick even more vigorously. The stick with tree red stripes appears to be a ´Picasso in the world of chicks ‘says Ramachandran: (**next**) being trained to respond to one particular stimulus will lead to a preference for an exaggerated or *peak shifted*-version of the same stimulus. This is, of course, interesting also in an evolutionary perspective on art.

Ramachandran’s point is that art will always tend to exaggerate reality. We will return to Ramachandran’s remaining seven laws of aesthetics in my fourth lecture.

A most fundamental question in aesthetics is the following: (**next**) What is beauty? This question has been debated for at least 2.500 years and has been given a wide variety of answers. One can broadly distinguish three main positions: (**next**)

The *objectivist view*, which dates back to Plato, maintains that beauty is a property of an object that produces a pleasurable experience in any suitable perceiver. **(next)**

The *subjectivist view* dates back to the Sophists; it maintains that beauty is in the eye of the beholder, that is: taste cannot be debated. (**next**)

The *interactionist view* maintains that beauty is grounded in the processing experiences of the perceiver that emerge from the interaction of stimulus properties and the perceivers' cognitive and affective processes. Hence, this position appears as a golden middle between the objectivist and subjectivist positions. (**next**)

I. Among objectivist criteria for beauty we have, for instance, balance, contrast and clarity, symmetry, and proportions. (**next**) The first appearance of intended symmetry in hominid evolution, are the countless hand axes produced within the Acheulean stone industry, appearing at 1, 7 million years before present (BP) (**next**) and continuously produced until almost 200 000 years before our time, and within wide geographical locations.

They differ from the previous (**next**) Oldovan axes, first documented in Olduvai Gorge, Tanzania, by their conspicuous mirror symmetry along the (**next**) mid axis of the teardrop form. Moreover, as the symmetry of late Acheulean tools goes far beyond functional requirements (Wymer, 1982), it has been assumed that an increased cognitive sophistication of hominines must have taken place during this period (Hodgson, 2009). (**next**) At least it is

clear that ”symmetry became more detached from pure functional dictates in that an awareness toward the symmetry itself tended to come to the fore” (Hodgson 2011, p. 39).

At this point in my lecture I will lead our attention to some reflections on the appearance of symmetry, but also intended breaks with symmetry in art, and we will even rise the question whether symmetry may play a particular role in religious painting.

Throughout the history of art, we find that symmetry is one of the leading principles. One surprising example is found in portrait painting; (**next**) in portraits in 3/4 profile, the symmetry line, in majority of cases, passes through one of the eyes. I must restrict myself to give some few examples from different periods in the history of art (**next**…(**next) ..**Mother of God of Vladimir, painted in Constantinople A.D. 1131, (**next**) Mother of God, mosaic icon, 12th century, Constantinople, (**next**) Master of Flemalle, (**next: several portraits by Jan van Eyck**) Jan van Eyck, (**next**) Jan van Eyck, (**next**) Jan van Eyck, (**next**) Jan van Eyck, (**next**) Jan van Eyck, (**next**) Rogier van der Weyden, (**next**) Tizian, (**next**) Rafael, (**next**) Leonardo … .(**next**) This holds even for Picasso cubist paintings.

Talking about portraits, it is also remarkable to find that almost all 15th c. portraits are in profile, here represented by two self-portraits by the hand of Albrecht Dürer (**next**) (**next**), while all depictions of Christ, as the Holy Face, are *an face*. The (**next**) Holy Face has eyes gazing directly toward the beholder; hence, it has a perfect symmetry (**next**)…. (**next**).. (**next**)..

It is therefore very interesting that one of (**next**) Dürer's self-portraits is, in fact, an *an face* - the so called self-portrait as Christ. This will strongly indicate that *an face* and symmetry was the only acceptable way to represent Christ in this period of art history. (**next**)

The question can be raised, as indeed we do in a research project called "Symmetry in Art and Science", in which I cooperate:
Is a symmetric face associated with divinity, and is it so because of qualities that lie in the symmetric form itself? Hence, does our biologically determined preference for symmetry imply that holiness must be represented *an face*, i.e. in the most symmetric manner? (**next**) Or is it just a convention that determines that Christ shall be represented *an face*?

Our research is based on a survey questionnaire were subjects look at faces with different orientation and with different gaze directions. The conditions are: (**next**) *an face* and gaze on you, (**next**) *an face* with gaze to one side, (**next**) ¾ profile looking in same direction as head-orientation, and (**next**) ¾ profile gazing at you. Subjects are asked to read a list of adjectival allegations in the questionnaire and rate them from 0 to 10 according to how much they agree with them. As examples of adjectival statements can be listed the following **(next)**:

The person is authoritarian

The person is including

The person is monitoring

The person is caring

The person is trustworthy

The person is scaring

The person is harmonic

So far, our results will seem to demonstrate that(**next**)

The *an face* gazing at you is more authoritarian, but also more credible, more caring, more trustworthy, more harmonic, and more including. (**next**)

The profile looking at you is the more scaring and monitoring, not so when looking away.

It has, of course, never been any doubt that gaze direction is a significant factor. It is, however, not easy to give a precise estimate on the part played by the symmetry *per se* of the face. An *an face* gazing sideways is not perfectly symmetric, so it may well be that it is a preference for symmetry, as well as an arousing effect of *gaze on me* that, in combination, leads one to consider the perfectly symmetrical *an face* as more authoritarian, but also more credible, more caring, more trustworthy, more harmonic, and more including. We need a further development of our survey methods to try to find a solution how to mask the effect of gaze, if coming closer to an understanding of the contribution of symmetry alone.

The question about symmetry and asymmetry in representations of Christ is fascinating as much as it is complicated. The Holy Face of the Eastern icons, the Christ Pantocrator is asymmetrical, but in a very subtle manner, such as in (**next)** this mosaic from the gallery of Hagia Sophia, Istanbul. The (**next**) red lines marked on this slide show how the face of Christ had been *if* symmetrical. The nose is strictly vertical! Still, we can see much more of one side of the face than the other; in the Hagia Sophia Christ it is His l. side that is the most

prominent. The vertical nose and the prominence of one side of the face unquestionably show that the head is seen from at least two differing viewpoints: It is seen *an face* as well as from an *angle*! I am now preparing a study where the asymmetric Byzantine Christ the Pantocrator is included among the paintings represented in our survey.

Independent of this survey, it can, at least, be concluded that (**next**) the Byzantine iconographers did work out a sort of cubism *avant la lettre*, and that they were skilled in calculating how to move on the borders of the perceptually impossible, in a very impressive manner. (**next)** Interestingly, this is precisely what characterizes the Byzantine perspective in icon painting. A most convincing analysis of this perspective, from my point of view, is given by the Russian painter Lev Zhegin, published in 1970, one year after his death. He stresses that the Byzantine perspective is a synthesis of different viewing positions.

Quoting Zhegin, the Byzantine perspective is "directly connected with the dynamics of the viewing position: the form of reverse perspective is the result of the summarizing of the viewer's perception under the conditions of a multiplicity of viewpoints, that are themselves a result of the dynamics of the viewing position" end of quotation (Iazik zhivopisnogo proizvedeniia: uslovnost' drevnego iskusstva (The Language of the Work of Art: Conventionality of Ancient Art), Moscow 1970, p. 42.)

On next slide **(next)** you see a geometrical construction of the golden section; it shows that the nose of Christ is positioned almost in the golden mean. One may, in fact, ask whether this subtle movement of the face -about 10 degree - towards the line of the golden mean adds an extra level of beauty to it.

*

Sticking now to the question whether the golden beauty has a real and objective impact on the beholder, some modern research has significantly improved our knowledge. But let us start with a brief review of the first studies which took place in late 19th century, those of the German physiologist Gustav Theodor Fechner, published in the year 1876. (**next)** Fechner demonstrated that subjects rated geometrical figures with golden proportions as more beautiful than other figures. (**next**) Here it is the golden rectangle form that has been given the highest rating: 38% of the subjects, which were Fechner's students, rated the rectangle with golden proportions as the most beautiful. As you can see, the ratio between the length and the width of the rectangle is 0,618 .. , which is the golden ratio. We will soon come back to a figure that will make it clearer what we mean with the golden ratio.

It has, however, been strongly questioned (**next**) whether a biological and inherited mechanism alone can explain these features, or whether they are the result of the frequent appearance in our culture of forms with golden proportions, ranging from huge aesthetic monuments, those of art and architecture, to the golden rectangle form of the credit cards of modern daily life. (**next**)

In a recent brain scanning study, however, on the brain response to Classical and Renaissance sculptures, an Italian group at the University of Parma, leaded by Cinzia Di Dio (2007), demonstrate that subjects will *rate* (**next**) sculptures following the Greek canon of beauty higher than those that are digitally manipulated, those manipulated generally scored with a negative rating. Moreover, the canonical sculptures gives increased activation in distinct areas of the cerebral cortex. (**next**)

As we can see in this slide, showing the frontal page of Di Dio *et alii*'s article, the question is whether there are objective criteria for beauty, and whether the golden mean is such a criterion. (**next**) The studies were executed in a so called *functional magnetic resonance imagining scanner*, or simply fMRI scanner. The most striking finding is the activation of the *right insula* in those cases when the subjects in the scanner viewed sculptures following Polycleitos' mathematical canon, .This is important because the insula is a central structure in the emotional neural network of the brain, also called the limbic system. To observe the canonical sculptures will thus activate the emotional pathways as opposed to the cognitive ones, and <u>these mechanisms will seem to be biologically determined</u>!!!!.

In their scientific paper there is an illustration of the principal modifications of sculptures, (**next**) here of the *doryphoros*, the Spear Bearer, of Polykleitos. As you can see, the length of legs and thorax are manipulated, which results in great deviations from the proportions of canonical sculptures. In canonical sculptures, the golden mean (**next**) divides the sculpture at the level of the navel.

Two quantities are in the golden mean proportion if the ratio of the sum of the quantities to the larger quantity is equal to the ratio of the larger quantity to the smaller one. In our sculpture (**next**) the sum of quantities is equal to the height of the sculpture, the line AC. The (**next**) larger quantity, AB, is the length from feet to navel. The golden mean is thus

AC: AB = AB: BC = 1, 618 …. , the irrational number of the golden mean.

(**next**) Di Dio *et alii*'s results will seem to indicate that the golden beauty is an objective and biological parameter that elicits activity in particular regions of the brain. Let, therefore, Di Dio et alii's results illustrate what is meant by the *objectivist* view. This is, however, not to say that this Italian group of researchers are pure objectivists when it comes to the question of beauty. It just says that they have demonstrated how the golden mean acts on beholders, that it, seemingly, is universally, and biologically determined.

II. (**next**) So what is the *subjectivist* view then? As we have already seen, the *subjectivist view* maintains that beauty is in the eye of the beholder, which means that taste cannot be debated. (**next**)

Semir Zeki's group in London has recently (2011) documented that music and visual artworks, which by subjects in a test group is considered to be beautiful, in spite of the fact that what is beautiful for one person may be ugly for another, still will activate the same area in the brain, the area called the medial orbitofrontal cortex (mOFC). This has led the researchers to formulate a brain-based theory of beauty; I quote: (**next**) «Almost anything can be considered to be art, but only creations whose experience has, as a correlate, activity in mOFC would fall into the classification of beautiful art» - end of quotation (http://www.youtube.com/watch?v=NlzanAw0RP4). According to this definition of aesthetics, then, beauty is in the beholder's eye, which here actually means *the brain* of the beholder, within the structure of mOFC, localized frontal, in the midline, right above the eyes and the orbits. (**next**) In this slide we see the overlap between musical (red) and visual (green) stimuli in mOFC activation.

It is, however, not Zeki's position that there may be no objective criteria for beauty; what he says, however, is that if something is experienced as beautiful, the mOFC will be activated. This cortex is part of our nerve network for reward, and it is also a higher order cortex for smell and taste. This part of the brain is therefore a phylogenetic old structure, and it is particularly significant in the life of lower animals.

III. Added to the objectivist's and subjectivist's view of beauty, we have the so called (**next**) *interactionist* view, according to which beauty is grounded in the processing experiences of the perceiver that emerge from the interaction of stimulus properties and perceivers' cognitive and affective processes, in accordance with models deriving from gestalt psychology.

(**next**) Research has documented that the feeling of pleasure in a stimulus is greater if the stimulus is processed easily, i.e. when there is a so called *fluent processing* of the stimulus. (**next**)

Processing fluency is defined as the subjective experience of ease with which an incoming stimulus can be processed. (**next**)

What increases the processing speed?

(**next**) The processing fluency increases if the stimulus is symmetrical and if it has a high degree of contrast and clarity. (**next**)

Likewise, the processing fluency increases when we recognize the stimulus, i.e. if we have seen it before. We call it the mere exposure effect. (**next**)

The processing fluency will also be increased if the stimulus has been so frequently seen that it can be considered to be prototypical. (**next**) This article by Piotr Winkielman et alii stresses precisely that prototypes are attractive since they are *easy on the mind*; they are easily processed by our nervous system.

Let us, for the sake of simplicity, take an example from everyday life: our preference for a car model of long standing, here the (**next**) Volkswagen beetle (**next**), with its classical round forms. (**next**) This slide compares the newest model with an elder one; the two forms demonstrate fairly well what is meant by prototypicality. So when the Volkswagen, Fiat or other car industries with great success presents their retro models it is actually because we all have a preference for the prototypical, we want a car that resemble our bellowed prototype.

*

We will now leave this discussion about objectivist, subjectivist and interactionist positions, and face another question, which has been hotly debated in modern art history (**next**): Is art foremost a stimulus for our cognitive processes, a position dominating in art theory of the 20th century, for instance by Clement Greenberg's stressing of the cognitive and analytical content of the pure picture plain, or has it also a strong emotional impact? This question is among the subjects of the paper: (**next**): "Motion, Emotion and Empathy in Esthetic Experience", written by the art historian David Freedberg and the neurobiologist Vittorio Gallese.

An amazing discovery in neuroscience is the existence of the so called *mirror neurons*. These nerve cells link *sensory* and motoric parts of the brain in a very particular manner, and they are found in apes as well as in humans. They respond to the visual input by activation. (**next**) This slide illustrates an ape looking at a man executing a grasping movement. In the brain of the ape the mirror neurons are activated. The same neurons will also be activated ahead of a grasping movement done by the ape itself. The activation of the mirror neurons during pure observation of a movement will, however, not result in a real movement of the limb. What they do is to react "*as if*" in movement. A most significant implication of the discovery of mirroring mechanisms is that the simulation of action by the mirror neurons, the embodied activation, leads to our understanding of a movement executed by others.

The mirror neurons can even interpret the final intention behind a movement, even when the concluding stages of the movement are hidden from vision. Significantly, this motoric understanding also leads to an activation of our emotional nerve networks, leading to empathetic responses to what we see, whether it is an action taking place here and now, or in a photo, or in a work of art. (**next**)

Vittorio Gallese and David Freedberg propose that a crucial element of aesthetic response consists of the activation of embodied mechanisms within the brain that are *simulating* actions, leading to corporeal sensations as well as emotions, and that these mechanisms are universal. (**next**)

Embodied simulation in esthetic experience will also explain our empathy for pain. Freedberg and Gallese point, as one of their examples, to the etching of Goya, from *Los Desastres de la*

Guerra (Disasters of War: Biblioteque Nationale, Paris, France). The viewing of images of punctured or damaged body parts activates part of the same network of brain centers that are normally activated by our own sensation of pain. This accounts for the feeling of physical sensation and corresponding shock upon observation of pressure or damage to the skin and limbs of others, (**next**), as in this very dramatic art performance.

But they will also be activated when we watch movements, such those of a ballerina. (**next**)

The mirror mechanisms are localized in the so called *prefrontal cortex* and also in the *inferior parietal cortex*, as you can see on the brain to the right in this slide. (**next**) (**next**).

Can we mirror the movements of others, also when we just can see the traces of them, as, for instance, in the paintings of Jackson Pollock, which reflects the painters' dancing movements as he simulated Indian dance during the very act of painting? (**next**) (**next**)

Or, put it another way: *Do you feel the movement of brushstrokes in the final work?* (**next**)
Vittorio Gallese says, I quote: "We propose that even the artist's gestures in producing the artwork induce the empathetic engagement of the observer, by activating simulation of the motor program that corresponds to the gesture implied by the trace. (**next**) The marks on the painting or sculpture are the visible traces of goal-directed movements; hence, they are capable of activating the relevant motor areas in the observer's brain" –(**next**). Gallese stresses that "<u>despite the absence of published experiments on this issue, the mirror-neuron research offers sufficient empirical evidence to suggest that this is indeed the case</u>" (D. Freedberg, V. Gallese, 2007, p. 202).

This is, of course, particularly interesting when considering the expressionism in art. While Jackson Pollock belongs to the so called abstract expressionism, the Norwegian Edvard Munch was one of the ground pillars in what is labeled German expressionism. In 1886 his (**next**) *The sick child* was exhibited, describing his sister's sickness and death, as he remembered it from his childhood. He painted, scratched it away, painted anew, scratched, again and again to imprint his anxiety and grief when confronted with this memory. (**next**) According to the mirror neuron "doctrine" the brushstrokes can be bodily felt by the beholder!!! No wonder then that expressionism has such a great impact on many beholders.

And what about the pierced canvases of Lucio Fontana? (**next**)

According to the mirror neuron data collected from other experiments, it will, according to Gallese, seem reasonable that neurons in the mirror system is activated, as if they were part of the motoric act of cutting the canvas, in spite of the fact that the beholder stands still just looking at the artwork, not moving as much as a finger. (**next**)

And how does our brain react to the finger of Thomas piercing the breast of Christ in this painting by Caravaggio? The discovery of the mirror mechanisms in the brain tells us that we react physically, the mirror neurons mirrors the movements, those of Thomas, as well as the imagined reaction of Christ; moreover, the mirror mechanisms are not isolated. In the dynamics of the brain, the activation of the mirror neurons will also lead to activation of emotional centers. Hence, observed motion will lead to emotion, and empathy, as the title of Freedberg and Gallese's article tells us.

*

An extremely complicated subject is our ability of *mind reading*, the complexity of understanding other people's way of thinking in a particular situation. This goes from mirroring the others' motor acts, through the mirror neuron system, to a deeper understanding of the meaning of the other's motoric action:

Imaging that you are in a party together with your partner, when suddenly she lifts the arm, and starts tapping on her watch. What does it mean? Is this act intended to show how grateful she is for this Christmas gift from you? Your brain will mirror your partner's act; from this point onward, however, other mechanisms step in to tell you how to read her mind. This will involve complex networks of memory, reward mechanisms – what happened last when I saw the same movements, and which were the consequences of my decisions; was I rewarded or punished? I guess that the majority of you will interpret a wife pecking on the watch as a sign that we have to leave now, or we will lose our train, tram, ferry, you name it. But how do the different neural centers communicate with each other in such a way that we reach this logical conclusion? One of the basic mechanisms will surely have to do with the brain's mirroring mechanisms and their connections to memory structures.

*

In this lecture we have focused on different ways to define what beauty is, and discussed the objectivist view, the subjectivist view, and the standpoint in between, the so called interactionist view. Whether we believe in one of these views in opposition to the others, or we take an intermediate position, we will ultimately have to deal with the fact that the sense of beauty involves our neurons, neuron networks, rewarding mechanisms, mirroring

mechanisms etc. Moreover, each region communicates with other regions by means of neural connections, for instance those complex interactions linking the cognitive and the affective and emotional neural mechanisms of the brain.