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NEUROSCIENCE AND VISUAL ART; MOVING THROUGH EMPATHY TO THE INEFFABLE

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SUMMARY

In this article we wish to discuss recent work on neurobiology and visual arts, with impact on human pleasure, wellbeing and improved mental health. We wish to discuss briefly our model of the Human Person and apply it to Visual Art, and we wish to discuss our view of how empathy has been suggested as an important factor in how visual art can impact the human person, with its links with neuroscience and anthropology, and thus how Visual Art can put Human Beings in touch with their deepest feelings and even with the ineffable.

Key words: *art – neuroscience - Thomistic model of the person - empathy - mirror neurons - embodied cognition*

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INTRODUCTION

Art has been an important part of the everyday lives of human beings for thousands of years. It is a means of self-expression and communication. Art is able to transport human beings to the distant past or to remote lands. It is able to cause strong emotions and deep thoughts. Its brilliance can have great impact on the watcher. When it is used to express deep meaning and concepts such as supplicating, thanking (e.g ex-voto paintings) and illustrating the presence of a power greater than that of humanity itself, it can be used to represent that power. Individual Persons have different and unique reactions to art, but its ability to impact us is clear. In this article we intend to show that this impact is because of the strong effect art can have on the human brain.

Viewing, analyzing, and creating art can stimulate the brain in substantial and long-lasting ways. This is why the cultural and intellectual benefits of art can serve as a powerful tool that can be used to achieve personal fulfilment. Both viewing and making art do have positive impacts on the brain.

HOW THE BRAIN PROCESSES ART

Freedberg has described a study in which ten subjects were asked to examine the wrist detail from Michelangelo's *Expulsion from Paradise*, a fresco panel on the ceiling of the Sistine Chapel. In this, the fallen-from-grace Adam wards off a sword-wielding angel, his eyes averted from the blade and his wrist bent back defensively. The aim of the study was to find out what it was that triggers the viewer's aesthetic response, that is, the sense of the observer being with Adam in the painting, acting to fend off the blows. The study used trans-cranial magnetic stimulation (TMS) to monitor the functioning of the subjects' brains. What was found was that observing the image excited areas in the primary motor cortex that controlled the observers' own wrists (Freedberg 2007, 2009).

Freedberg's study belongs to the field of neuro-aesthetics, which explores how the brain processes a work of art (Freedberg 2007, 2009). It was reported that seeing the raised wrist causes an activation of the muscle. Similarly, viewers of Degas' ballerinas have sometimes reported that they experience the sensation of dancing. Thus, the brain mirrors actions depicted on the canvas.

In another study (Di Dio 2007) the reaction of the brains of observers to classical sculpture was monitored. The body proportions of the sculpture were then changed, and it was observed how the viewer's response changed. This was done using fMRI. The most important result was that the observation of original sculptures, compared to the modified ones, produced activation of the right insula as well as of some lateral and medial cortical areas (lateral occipital gyrus, precuneus and prefrontal areas). When volunteers were required to give an overt aesthetic judgment, the images judged as beautiful selectively activated the right amygdala, compared to those judged as ugly. It was concluded that the sense of beauty is mediated by two non-mutually exclusive processes: one based on a joint activation of sets of cortical neurons, triggered by parameters intrinsic to the stimuli, *and* the insula (objective beauty); the other based on the activation of the amygdala, driven by the observer's own emotional experiences (subjective beauty) (Di Dio 2007).

The context of viewing artwork has been studied by Kirk (2009). The question which he addressed was whether a viewer would react in the same way if he saw the same picture in a famous gallery and in a less important setting. Kirk showed subjects a series of images - some, he explained, were fine artwork; others were created by Photoshop. (Kirk 2009). In fact, none of the images had been generated by Photoshop. It was found that different areas of viewers' brains were activated when the image was said to be "art." The study used fMRI. Subjects' aesthetic ratings (that is, their perception of beauty) were significantly higher for

stimuli viewed in the 'gallery' (that is, images known to be from a gallery) than 'computer' contexts (Kirk 2009). This modulation according to context correlated with activity in the medial orbitofrontal cortex and prefrontal cortex, while the context, independent of aesthetic value, correlated with bilateral activations of temporal pole and bilateral entorhinal cortex. This shows that the prefrontal and orbitofrontal cortices involved in aesthetic judgments are significantly biased by the subjects' prior expectations about the likely hedonic (pleasure) value of the stimuli according to their source (Kirk 2009).

BENEFIT TO THE BRAIN OF LOOKING AT ART

Apart from the emotional and societal aspects of art creation and appreciation, does observing visual art give any benefit to the brain?

It appears that looking at art helps persons improve the processing of information.

The experience of art is a complex one. It emerges from the interaction of multiple cognitive and affective processes. Neuropsychological and neuroimaging studies reveal the broadly distributed network of brain regions upon which the experience of art relies. This network is divided into three functional components: (i) prefrontal, parietal, and temporal cortical regions which support evaluative judgment, attentional processing, and memory retrieval; (ii) the reward circuit, including cortical, subcortical regions, and some of its regulators, which is involved in the generation of pleasurable feelings and emotions, as well as the valuation and anticipation of reward; and (iii) attentional modulation of activity in low-, mid-, and high-level cortical sensory regions which enhance the perceptual processing of certain features, relations, locations, or objects. We have yet to understand how these regions act together to produce unique and moving art experiences. Research is still ongoing regarding the impact of personal and cultural meaning and context on this network (Nadal 2013).

Creative thinking involves both hemispheres of the brain communicating with each other(Kirk 2009). Art enhances problem-solving skills and attention to details. Data supports the view that art appreciation is independent of the artists' intent or original interpretation and is related to the individual message that viewers (creatively) themselves provide to each piece of art (Herrera-Arcos 2017).Recent data suggests that active perception of the images with sustained cognitive attention in parietal and central areas caused the generation of the judgment about their aesthetic appreciation in frontal areas (Maglione 2017).

ART AND THE REWARD MECHANISM

One important result of looking at art is stimulation of the reward mechanism. Lay persons experience the increase of positive feelings which are brought about by looking at certain pieces of art. It has been shown that brain regions associated with vision, pleasure and emotions are consistently triggered by looking at pieces of art.

Looking at art causes a response by the reward mechanism. Thus, viewing the works of famous painters like Claude Monet, Vincent Van Gogh and other artists more strongly activates the brain's "reward system" compared to the brain activity that happens when looking at photographs of similar subjects.

In a study, four male volunteers and four females were asked to view paintings made by famous and unknown artists and photographs with the same subject as of the paintings. Imaging technology revealed that when an individual viewed a painting, the ventral striatum (part of the reward system) was more strongly activated, compared to just looking at the photograph version. Furthermore, not only did art viewing stimulate the ventral striatum, but it also activated the hypothalamus which is the part of the brain that is associated with appetite regulation and the orbitofrontal cortex, which is responsible for calculating risk, impulse control and detection of social rules.

Zeki et al. (Kawabata 2004, Ishizu 2011) carried out studies where MRI scans were taken as people looked at 30 works of art. Each piece of art was placed by the research team on a spectrum of conventionally 'beautiful' (John Constable, Jean-Auguste-Dominique Ingres, Guido Reni) to 'ugly' (Hieronymus Bosch, Honore Damier, Quinten Massys).They found that "when you look at art – whether it is a landscape, a still life, an abstract or a portrait – there is strong activity in that part of the brain related to pleasure. The blood flow to the brain increased for a beautiful painting just as it increases when you look at somebody you love. It tells us art induces a feel good sensation direct to the brain." In other words, the reward mechanism is stimulated by looking at art. There is a surge of the feel-good chemical, dopamine, into the orbito-frontal cortex of the brain, from the Nucleus Accumbens) resulting in feelings of intense pleasure. Dopamine and the orbitofrontal cortex are both known to be involved in desire and affection and in invoking pleasurable feelings in the brain. Both romantic love and illicit drug taking are similarly associated with dopamine. The interior insula, which is connected to pleasant emotions, and the putamen, an area that has ties to the experience of reward, are two parts of the brain which are also stimulated by viewing art.

In a series of fMRI brain-mapping experiments, Zeki et al., scanned the brains of volunteers as they looked at 28 pictures. They included The Birth of Venus by Sandro Botticelli, Bathing at La Grenouillere by Claude Monet and Constable's Salisbury Cathedral. Prof Zeki found that blood flow increased in the areas of the brain usually associated with romantic love (Kawabata 2004). Hence, when things considered to be beautiful are looked at, there is increased activity in the pleasure reward centres of the brain(Kawabata 2004). In the

study, paintings by John Constable, Ingres, the French neoclassical painter, and Guido Reni, the 17th century Italian artist, produced the most powerful 'pleasure' response in those taking part in the experiment (Kawabata 2004). This reaction was immediate. The increase in blood flow on fMRI was in proportion to how much the painting was liked. This demonstrated that art induces a 'feel good sensation' by affecting the reward centers of the brain" (Kawabata 2004).

IMPROVING OUR PERCEPTION SKILLS

Vessel et al. (2013, 2012, 2010, Yue 2007) studied patterns in people's reactions to 109 different works of art. Personal opinions are highly subjective, and the brain was able to choose whether it likes or dislikes a piece of art extremely rapidly. It is reported that "The most powerfully engaging works of art appeared to trigger brain regions in the frontal cortex that are involved in introspective thought, as well as nearby regions usually directed at more outward matters. These two areas usually do not activate simultaneously" (Vessel 2013, 2012, 2010). Thus art can involve multiple perception skills at once.

In 2013, Vessel reported 'In a task of rating images of artworks in an fMRI scanner, regions in the medial prefrontal cortex ,known to be part of the default mode network (DMN) were positively activated on the highest-rated trials. This is surprising given the DMN's original characterization as this set of brain regions that show greater fMRI activity during rest periods than during performance of tasks requiring focus on external stimuli (Vessel 2013). However, further research showed that DMN regions could be positively activated also in structured tasks, if those tasks involved self-referential thought or self-relevant information' (Vessel 2013). The experimental design emphasized the personal aspects of aesthetic experience, and observers based their ratings on how much each artwork "moved" them (Vessel 2013). Each artwork was rated highly by some observers and poorly by others. Thus the ratings related to the aesthetic experience itself (Vessel 2013). Thus the DMN activity suggested that certain artworks, may be so well-matched to an individual's unique makeup that they obtain access to the neural substrates concerned with the self-access which other external stimuli normally do not get (Vessel 2013). This mediates a sense of being "moved," or "touched from within" (Vessel 2013). This account is consistent with the modern notion that individuals' taste in art is linked with their sense of identity, and suggests that DMN activity may serve to signal "self-relevance" (Vessel 2013). Thus, not only does it appear that our brain may be 'hardwired' to appreciate and process art, but it may be that observing art might enable a person to access deep experiences of identity, self-relevance and a feeling of being "moved," or "touched from within".

HELPING OUR BODIES TO RE-BALANCE

Art has been shown to enable persons to de-stress. It can also improve physical wellbeing. A study links looking at art with normalising heart rate, blood pressure and cortisol levels. A study on workers in Westminster showed that participants' stress levels decreased after a lunchtime visit to an art gallery. Participants self-reported their stress levels before entering the gallery and then spent 35 minutes exploring the space in any way they wanted. When they left the gallery, they expressed being less stressed. Furthermore, they also had lower concentrations of cortisol, which is a hormone linked with stress (Clow 2006).

This is important because of the link between stress and depression via stress and BDNF (Krzak 2017).

REWARD AND EMOTION

Vartanian and Goel demonstrated on fMRI that both the areas of the brain involved in processing emotion and those that activate pleasure and reward systems are engaged when looking at art (Vartanian 2004). They attempted to determine the neuroanatomical correlates of aesthetic preference for paintings using fMRI. Participants were shown a series of artwork pictures and asked to rate them according to preference (Vartanian 2004). Activation in right caudate nucleus decreased in response to decreasing preference, and that activation in bilateral occipital gyri, left cingulate sulcus, and bilateral fusiform gyri increased in response to increasing preference (Vartanian 2004). This showed that parts of the brain linked with emotion and those linked with reward were both involved in the brain's response to looking at art (Vartanian 2004).

Many of these studies used fMRIs to look at neural systems while responding to paintings.

It is expected that the brain will recognize faces and process scenes when a person looks at art. But parts of the brain linked to emotions also show activity in the process. Hence both perception and emotion is involved. Lines, patterns, and drawing on canvas are interpreted by the brain into a face, person, or other object. The brain is remarkably adept at discerning familiarity and meaning from patterns, abstract forms, and incomplete information. Whenever a piece of art is observed, the brain acts to interpret the visual information it is receiving (Maglione 2017).

EMBODIED COGNITION

When viewing art, there is a tendency of the observer to attempt to place himself into the artwork. This placement occurs through a process known as embodied cognition (Caramazza 2014) in which mirror neurons in the brain turn elements such as action, movement, and energy seen in art into actual emotions which can be

felt. Embodied cognition starts with looking at a piece of art (Mahon 2015). The more the piece is analyzed, the more there is a tendency for the viewer to place himself within the scene and actually feel the quality of the works (Trentini 2015).

EMPATHY AND ARTISTIC EXPERIENCE

Recently, Agius and Mckeever had hypothesized (Agius 2017) that empathy was important in the perception of the beauty and meaning of visual art and could lead to deep moving feelings and even to experiencing the ineffable. Recent papers have born out the role of empathy in experiencing art.

Thus, (Brinck 2018) argues as follows; A recent version of the view that aesthetic experience is based in empathy as inner imitation explains aesthetic experience as the automatic simulation of actions, emotions, and bodily sensations depicted in an artwork by motor neurons in the brain (Brinck 2018). Aesthetic experience is enacted and skilful, based on the recognition of others' experiences as distinct from one's own (Brinck 2018). An explanation of the aesthetic experience is the reciprocal interaction between viewer and artwork (Brinck 2018). The viewer achieves the aesthetic experience by participating in making sense of the work, while movement is a means for creating meaning (Brinck 2018). Aesthetic engagement is coupling to an artwork and provides the context for exploration, and eventually for moving, seeing, and feeling with art (Brinck 2018). Aesthetic experience emerges from bodily and emotional engagement with works of art through complementary perception-action and motion-emotion loops (Brinck 2018). Perception-action involves the embodied visual exploration of an artwork in physical space, and progressively structures and organizes visual experience by way of perceptual feedback from body movements made in response to the artwork (Brinck 2018). Motion-emotion concerns the movement qualities and shapes of implicit and explicit bodily responses to an artwork that cue emotion and thereby modulate over-all affect and attitude (Brinck 2018). The two processes cause the viewer to bodily and emotionally move with and be moved by individual works of art, and consequently to recognize another psychological orientation than her own (Brinck 2018). Thus, art can cause feelings of insight or awe and disclose aspects of life that are unfamiliar or novel to the viewer (Brinck 2018). Similar Accounts are given by Stamatopoulou (2018) and Gernot et al. (2018). It has been suggested that looking at traces of actions used in creating artwork (e.g. brush marks) is associated with a simulation of these actions in the observer's sensorimotor-cortex (Hoenen 2017). This was demonstrated by recent data and thence it has been suggested that individuals scoring high in emotional empathy feature a particularly responsive mirror neuron system (Hoenen 2017).

These concepts linking mirror - neurons, empathy, and also the previously described ‘experiences of to access deep experiences of identity, self-relevance and a feeling of being "moved," or "touched from within"’ could come together to explain how art can be used to enable an experience of deep , ineffable experiences.

CONCLUSION

Some neuroscientists are concerned that neuroscience offers a reductionist perspective on the human person and his/her relationship with art.

In previous papers (Agius 2017, 2014) we have argued that a model of man based on Augustine and Thomas Aquinas , in that man is an embodied spirit , and so every function of man is represented by a bodily function, is more acceptable to modern neuroscience than Decartes’ dualist model. In the papers which we had reviewed previously (Agius 2017), we identified many levels of function where this was true, from gross observable functioning to molecular levels. This point is essential when relating neuroscience to art and any part of human activity, since the model we use- of Man as an embodied spirit- is consonant with both our observations of neurobiology and of the necessity of recognising the fundamental dignity of the Human being, without reducing Man to biology alone, however we recognise that this is simply a model, all be it one which fits with the natural observations.

Therefore, based on our present review, we suggest that our review of how we perceive art is entirely consonant with a Thomistic model of the human person, where every one of our thoughts and actions is represented in our bodies, in the case of art, in our brain. We suggest that it is because of the mechanisms that we have described above that art can be used, not only to describe landscapes and persons, but also abstract concepts, including religious ones.

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