The brain, biology and evolution in art and its communication

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Abstract: Both art and language are referential and symbolic, but while quite a bit is known about language localisation in the brain, scant little is known about art in that regard. In neurology and neuropsychology, studies of patients with localised brain damage for over 100 years has helped chart the neuroanatomical underpinning of numerous types of cognition. Insight into the neuroanatomical underpinning of aspects of art can be obtained from professional artists who have suffered localised or diffuse brain damage. Similarly, artists with brain damage from birth, known as autistic savants, can provide further help in shedding light into brain and art. The origin of art practice in Homo sapiens existence is important in any discussion of brain and art, as is the relevance of biological motivation shared by animals and humans. These issues are discussed in this article.

Keywords: aesthetics and brain; artists and brain; brain damage and art; language and art.

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1 Introduction

The neurological basis of the arts has long been a source of interest and debate. One of the outstanding mysteries surrounding art is why humans produce art and are attracted to viewing it, despite its seeming lack of functionality or utility. Philosophers and scholars have argued about the purpose and function of the arts since the days of Plato and Aristotle, holding, in the case of Plato, a negative approach to the role of artists in society (Murdoch, 1978). Viewing art's value as a communicative system, one of several practiced by humans, its biological roots, and early beginnings in the life of the Homo sapiens can help explain its function and utility in human life. Multiple messages are communicated in art's contents and aesthetics. The neurology and neuropsychology of artists with various kinds of brain damage can potentially shed light on the link between art and its neural underpinnings, through reviewing what has gone awry and what has remained intact in their art following the damage. The issues associated with the neural basis of art along with its biological and evolutionary background will be discussed in this article.

Art, as language, is grounded in symbolic and abstract cognition which are supported by the unique neural wiring of the human brain. Such cognition is central to human communication, whether through the arts, spoken language, body language or facial expressions, all because of the access to many forms of mentally stored meanings and knowledge. The more abstract a notion becomes, the more it can incorporate into it different dimensions of concepts, details and categories (Liberman and Trope, 2008). Abstract symbols condense levels of meanings and details derived from life's experiences into efficient mental conceptual conglomerates. Thus, symbolic thinking is a powerful source for myriad of interpretations, associations, innovations and creativity and it is one of the hallmarks of the human mind.

2 Art vs. language

Art can be regarded as a communication medium expressing the artist's thoughts, experiences, concepts, values, fears and so on. Artists articulate all of these using the skills and techniques available for this expression. Both art and language are used for communication and both share symbolic cognition supported by the human brain, while they differ in their obvious mode of expression as well as in the nature of the basic meaningful units that comprise them. The meaningful units of language, the words, have a meaning all their own even before they become part of a sentence. The vocabulary of language consists of words with more or less fixed meaning that together are combined through syntax to form additional meanings. The units of art are neither fully defined nor do they have a fixed meaning. Seen in isolation, outside of the art, they mean nothing special, unlike words. Take the case of a brush stroke: a brush stroke building up to a cloud in a painting is meaningful only in the context of the whole painting, but not when seen in isolation. A dab of turquoise placed in the right eye of the 'Girl in a Red Hat' painting by Johannes Vermeer signifies a piece of reflected blue skies, but seen in an otherwise clear canvas, could signify something entirely different. All the hues, shades, brush strokes, and outlines that together make up 'The Mona Lisa' by Leonardo Da Vinci add up to a meaningful whole in the context of the painting as a whole entity, not as millions of separate component parts. Moreover, art works contain more ambiguities than language, thereby promoting intellectual discourse, multiple interpretations and varied emotional responses. In this sense, the relative lack of precision in the symbolic nature of art renders it a powerful communicative system.

Unlike the words of a language, the 'language' of art is complex and is not easily reducible to definable component parts, and this is what makes it difficult to localise its neural basis in the brain. Looking to the brain, language localisation in specialised brain regions has begun at least 150 years ago with the studies of Paul Broca, the French neurologist, who zeroed in on the inferior posterior region of the left frontal lobe as the principle neural site for the control of speech (Geschwind, 1979; Finger, 2000) and the German neurologist, Carl Wernicke, helped localise the language meaning comprehension region in the left hemisphere, as well, in the superior temporal lobe. Since then, many other specialised regions within the left hemisphere have been linked to aspects of language, spoken, comprehended, read and written. Loss of certain aspects of language following damage to specific neural regions has helped map its neural underpinnings. Some neurolinguistics researchers suggest a role for right hemisphere involvement in aspects of language (Code, 1987). However, based on rich sources of data from brain damaged patients, neuroimaging studies and physiological responses, the current understanding of language and the brain is that the principle language centres are specialised in the left cerebral hemisphere.

3 Brain underpinnings of art

Because of the definition issues of the units of art, we cannot pinpoint to specific linking of neural regions for art. We can, however, discuss the consequences of brain damage in professional artists and look for alterations in aspects of their art. The particular meaningful alterations concern the genre, artistic skills, productivity and creativity (genre here refers to art school or art movement, as in abstract, realistic, impressionistic and so on). While non-artists with brain damage are common in the neurological literature, established artists are relatively rare. Reviewing the individual cases of approximately 15 artists with unilateral (left or right) brain damage revealed that genre was unaltered, and skills, productivity and creativity remained unchanged (Zaidel, 2005). A few additional artists have been described in other publications (Rose, 2004; Bogousslavsky and Boller, 2005), and a review of their cases does not disclose significant artistic alterations following damage. Established artists who develop slow progressive dementing diseases such as Alzheimer's Disease or fronto-temporal dementia do not lose their artistic skills, talent or creativity even as diffuse neuronal damage becomes extensive throughout the brain and cognitive and physical deficits are present (Zaidel, 2005, 2009). They do, however, lose these skills toward the end of their illness when many cognitive, motoric and memory functions become severely and irreversibly compromised. Collectively, this adds up to general artistic elements not being localised in specific brain regions.

There are specific brain regions that control features of pictorial art that are not unique to art. They are functional in both artists and non-artists alike and could undergo alterations following brain damage. Depiction of 3D space to create illusion of space is sometimes important for the message communicated by the artist. Drawing convergent perspective is one example. In the brain, the right parietal lobe critically controls the ability to depict 3D space on a 2D surface. Damage results in distorted spatial perception problems as well as loss of knowledge of the topography (De Renzi, 1982). The ability to derive the meaning of the entire picture, usually a scene, depends on the integrity of the left angular gyrus. Damage sometimes leads to a condition known as simultanagnosia, the inability to provide the theme of a pictorial scene (Levine, 1978). Segmenting, disembedding units, finding hidden objects in a complex scene are linked to the integrity of the left hemisphere (see summary in, Zaidel (2005), and this is related to the perceptual mechanism of figure-ground relationships and global–local mechanisms

(Hubner and Studer, 2008). All of these functions although important in art, are not defining features of art.

Furthermore, no research data are available on the extent of deficits specifically in artists in the functions described in the foregoing; as a group they might be ‘resistant’ to extensive deficits exhibited by non-artists. Artists who generally spend a lifetime observing details and global configurations in their environment develop a trained ‘eye’. The years of practice could contribute to such resistance. Consequently, we should expect redundancy in functional representation in their brains, one that transcends hemispheric or regional specialisation.

Artistic talent in the visual arts can be distinguished from creativity and innovation by considering unusual artists known as autistic savants. They possess extraordinary artistic abilities even as their brain damage compromises their cognitive and social interactions (Sacks, 1995, 2004; Selfe, 1995; Treffert and Wallace, 2002; Mottron, Limoges and Jelenic, 2003). It should be mentioned that precious few of individuals with autism are savants. These special artists can create spatially realistic drawings and paintings, in both grey scale and full colour from memory alone or from direct observations. Despite the correct proportionality of 2D representations of scenes and objects as well as attention to details, the artwork lacks creativity or innovation (Sacks, 1995). Most have begun displaying graphic skills from a very early age and attempts to receive art instructions with an eye toward improvement have been made. Little artistic growth has been observed. All of this suggests the following conclusions: first, artistic talent survives extensive brain damage (even when the damage reflects congenital anomalies). Second, talent is dissociable from creativity, innovation and conceptual thinking. Third, visuo-constructive and visuo-spatial abilities, both functions of the mind that are specialised by the right cerebral hemisphere, cannot be generalised to creative and innovative art (Zaidel, 2005).

Further insights can be gleaned from artists with dementia which represents a disease in which cognitive, motor and memory decline result from diffuse atrophy (caused by neuronal loss) of extensive regions of the brain. There are several types of dementias, each with its own course of cognitive and behavioural decline. Alzheimer’s disease, fronto-temporal dementia, and late stage Parkinson’s disease are but few examples. Individual artists suffering from such conditions have been described in the neurological literature (Zaidel, 2005). Their cases demonstrate the remarkable resilience of artistic skills in the face of extensive cognitive loss and brain atrophy.

In some dementia cases, however, where art was not the main means of earning a living and where art was not practiced, art creation nevertheless began after disease onset (Miller et al., 1996, 1998). What can account for such behaviour? One brain process that has been suggested to explain this phenomenon involves the frontal lobes and its neural connections to the rest of the brain. Specifically, deterioration of these connections is known to lead to behavioural disinhibition (Zamboni et al., 2008), and in the present context this would include a sort of release of pent up desires to create art (Miller et al., 1996, 1998). However, it is not clear that this can be the sole interpretation. First, we should note that the implication is that the capacity to conceptualise and rely on symbolic cognitions is spared for a substantial period into the dementia disease, a time when cognition, memory and social behaviour all deteriorate substantially. Second, in such individuals there is no proof that artistic skills in fact did not exist prior to the disease’s onset, albeit not practiced or displayed. Third, given the large number of individuals throughout the world who develop dementia relative to those miniscule few with the disease who do exhibit artist skills after onset, we would expect a vast number of individuals with the disease to display artistic skills. Fourth, what could explain the appearance of art production in those select few cases is that somehow the neural degeneration process in the brain facilitated the expression of pre-existing talent and artistic skills, possibly through the disinhibition process.

One of the communicative powers of art lies in its aesthetics. Issues in aesthetics and preference for certain visual forms are informative to the art–brain link. Research has shown that oblique lines as opposed to non-sloping horizontal and vertical lines are not as aesthetically appealing (Appelle, 1972; Latto, 2004). One explanation is the early visual exposure to structures in the environment and the plasticity of the visual system. There is greater prevalence of horizontal and vertical content in the environment than of oblique content, and consequently, the experiential visual events sculpt the visual system to be more sensitive to horizontal and vertical orientations. Latto has found that orientation of lines in paintings contributes greatly to aesthetic preference (Latto, 2004). Mondrian and the Dutch art school of De Stijl adopted the use of horizontal and vertical lines and promoted aesthetic reactions to their works (White, 2003). Perception scholars have argued that the appeal in those orientations reflects a close match with what the visual and perceptual systems are tuned to detect. However, as Washburn (Washburn, 2000) points out, simple forms and shapes are liked as well, independently of whether they represent horizontal or vertical lines. In all, we should consider that the visual system reacts to components of visual form that reflect a match between what is seen and the visually tuned neurons in the brain, and the match partially explains reactions to art.

4 Biology and the underpinnings of art

The neural basis of art might reach back to a biological component shared by humans and animals. Art is meant for display and therein might lay its connection to a biological motivation associated with procreation. Animals display their bodies to potential mates in order to reveal their current fitness and genetic quality. During mate selection seasons, feathers, tails, furs, wings, voice boxes, sounds, clever acrobatics and more are exhibited for the purpose of attraction and procreation. Scholars have suggested a link between such displays and art (Zahavi, 1978; Miller, 2000, 2001). According to this view, artists display their genetic quality as well; the more attention their work receives, the higher the selling price, the longer they are held in high regard and these are all qualities that reflect excellent cognition, skill, talent and creativity.

For humans, art is tied to the judgment of the other. In the biological sense, it is used to assess others' fitness. In nature, the display that gets to be chosen for mating or the one that leads, represents quality genes. Ideally, if those are passed on to the offspring they will enhance and promote the offspring's survival, and the species line will continue. Art creation is a more peaceful way of attracting judgment than head-on, physical, aggressive fights. It is also less energy consuming than that generally expanded by animals in courtship rituals, when violence is not involved. In humans, redirecting biological aggressive drives in order to be aesthetically gratified is consistent particularly with Freud's ego defence mechanism known as sublimation.

A wide range of courtship displays has evolved in nature, from peaceful strategies to very aggressive fights (Gould and Gould, 1989). They have all presumably evolved to adapt to the brain of the beholder, to ensure the details of the display and rituals are processed to the potential mate. Humans viewing the display of a male bird of paradise would observe only acrobatics and colourful plumage whereas a female bird of paradise would perceive infinitely more numerous details because those would be pertinent to her species' survival. The same notion is true of art's display; it is meant for the brain of the human beholder. Humans have evolved a cognitive apparatus equipped to handle the display, its symbolic nature, its message and contents.

One outstanding example of what some scholars consider to be art in nature is that created by the bowerbird (Miller, 2000). It is an exception in the animal world worth considering, particularly in the context of courtship strategies. This bird is found mainly in Australia and New Guinea (Diamond, 1982). Several species have been identified. To attract a mate, the male bowerbird builds constructions, the bowers, in the forest from building materials that come from the environment, close and far. Once the basic frame is built from well placed twigs and branches the male bird decorates it with various precious fruits, vegetables, mushrooms, leaves, dead bugs and much more. The range of bower complexity varies with the bowerbird species, ranging from relatively simple to highly elaborate. Within the species, however, each individual male bird builds a distinct structure. The idea behind the energy and effort put into the bower is to attract females for mating and procreation. Female bowerbirds inspect individual bowers and if they like what they see, go off with the male builder into the forest and mate there. The bower is used only for attraction, not for mating or raising the young. The bower is a display of fitness, capability and genetic quality of the male. Indeed, upon viewing some of the bowers one is hard put to deny an artistic capacity (Madden, 2008).

5 Homo sapiens and the early appearance of art

When did anatomically modern humans initiate the practice of art and for what purpose? Archaeological findings indicate that consistent art practice gained momentum around 45,000–35,000 years ago, and the great majority of the artefacts are associated with Western Europe. Since art is linked to symbolic and abstract cognition and since anatomically modern Homo sapiens emerged some 200,000–150,000 years ago in Africa, scholars have pondered the time gap as well as the locale with respect to abundant art practice. As stated above, the hallmark of human cognition is the heavy reliance on symbolic thought, which is also the underlying source of sophisticated combinatorial language that allows transformation of vocabulary and syntax into meaning, as well as of art and other non-verbal communicative systems. Although non-human primates, birds and other animals possess some symbolic cognition and communication systems, they do not produce art. Together, these are the issues that confound and puzzle scholars of brain and art.

Some six million years ago, the Homo line split from chimpanzees and several archaic forms of human ancestors evolved afterwards. By now, Homo sapiens have replaced all those forms throughout the world. Having originated in Africa, based on both genetic and fossil evidence, they first migrated to Europe and Asia about 100,000 years ago. Then, another group left Africa about 60,000 years ago and spread throughout the world (Mellars, 2006; Behar et al., 2008). Archaeological evidence has revealed use of red ochre pigments and shell ornaments with both the first and second migrations. The usage of both implies symbolic cognition. But it is the brain of the people of the second migration that some scholars suggest might be crucial to the abundant expression of art that was practiced later on in Western Europe (Jacobs et al., 2008). The argument is that the Homo sapiens who remained in Africa after the first migration underwent further social and crucial neurochemical and neuroanatomical brain changes. We do not yet know yet the precise nature of those alterations. They underwent adaptive changes as survival strategies in the face of a long-standing draught in Africa, one that lasted for over 100,000 years and has led to changes in the environment and food sources. The theory is that the adaptive response of human groups to the climatic changes has contributed to technological innovations and improvements in tools as well as behavioural changes, particularly in relation to social grouping. Whether DNA alterations occurred at that time as well remains to be determined. The confluence of these factors could have shaped cognition in the direction of symbolic and abstract thought, leading eventually to the practice of art. So the people of the second migration out of Africa brought with them the kind of cognition that shaped the art-related cognition behind the eventual appearance of abundant art production, a practice that went unabated to this date.

It is not yet clear yet why consistent art practice appeared in Western Europe and not in other parts of the world reached by the people of the second migration out of Africa. We may speculate that there was increase in hierarchical stratification within human groups in the European part of the world and those belonging to a specific societal level had to be identified with ornamentation, decoration and artistic production (Lewis-Williams, 2002). There may also have been increased control over the environment and thus increased time that could be devoted to artistic production, particularly by recognising talent in specific individuals (Dissanayake, 1995). The latter recognition could have evolved especially quickly in Western Europe for reasons not entirely known at this point. Future archaeological findings would most likely shed further light on the early use of art in human society.

6 Future research

The further breakdown of the effects of brain damage on established artists would benefit from the use of digital methodology, particularly in the form of systematic comparison of works produced before vs. after the damage. Countless of subtle differences could potentially be detected with digital technology. Gauging colour intensity, brush strokes pressure and width, overall configuration and many more features of art can help categorise, catalogue and explain the role of disease etiology, hemispheric laterality of damage, and localisation of damage on art production, and ultimately elucidate the link between art and brain.

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