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The Neuropsychology of Visual Art

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The Neuropsychology of Visual Art

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The neuropsychology of visual art

Anjan Chatterjee

17.1 Introduction

Katherine Sherwood was 44 years old when she had a massive left hemisphere stroke. This catastrophic event left her with an aphasia and right-sided weakness. She was (and is, as at the time of writing this chapter) an artist and a professor. After recovering from the psychological impact and some of the neurological deficits from her stroke, she began to paint again using her left hand. She laid canvasses horizontally, and moved around them in a mobile chair. She also noticed a curious thing. The style and content of her painting changed (Waldman 2000). She previously regarded herself as a particularly cerebral painter, approaching her work in an over-intellectual manner. After her stroke, she felt that images flowed from her more easily and expressively (Sherwood 2012) (Figure 17.1). Something changed about her process of making art (Chatterjee 2008). What had changed?

More generally, cases like Professor Sherwood raise questions about what we can learn from the neuropsychology of art. Neuropsychology has been critical to advancing our knowledge of various cognitive systems, including perception, memory, and language, as shown by other chapters in this book. However, its impact on the study of aesthetics has been limited. Why? Certainly, an important factor is that as a domain of inquiry neuroaesthetics is relatively immature (Chatterjee 2004b, 2011). The data from which one might draw inferences are sparse. Beyond the constraints of limited data, fundamental questions about proper methods remain. It is easy to be seduced by the striking phenomenology and to construct interesting “just so” stories to account for these observations. Cognitive neurology and neuropsychology has had a long tradition of starting with careful clinical observations before applying rigorous quantitative methods to the phenomena under consideration. The neuropsychology of art is at this threshold and seems poised to make the quantitative shift (Chatterjee 2009).

One could speculate that artists, by virtue of their developed visuo-motor skills, might be relatively protected from the visuo-motor deficits associated commonly with brain damage. Such speculation appears not to be true when we consider the effects of brain damage on artistic production (Bogousslavsky and Boller 2005; Chatterjee 2004a, 2004b; Rose 2006; Zaidel 2005). Unilateral spatial neglect is a disorder in which patients are unaware of one side of space (Chatterjee 2003; Heilman et al. 1993). Artists with unilateral spatial neglect demonstrate neglect in their artwork (Jung 1974). Visual agnosia is the inability to perceive or recognize objects visually. Artists with visual agnosias have difficulty depicting objects in their art (Wapner et al. 1978). Achromatopsia is the inability to apprehend color.

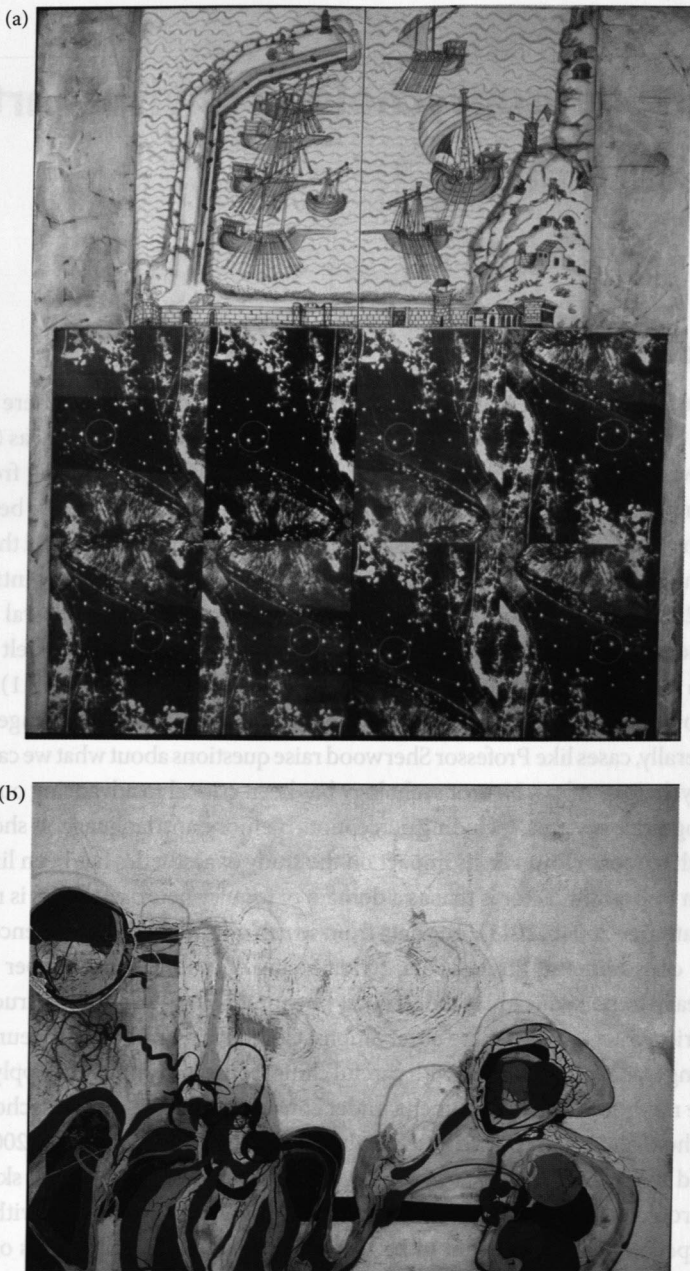


Figure 17.1 Examples of Katherine Sherwood's paintings. Permission obtained from Katherine Sherwood. (a) *Test Sites*, painted before her stroke. (b) *The Cart Before the Horse*, painted after her stroke. This material was originally published as Visual Art by Anjan Chatterjee in *The Roots of Cognitive Neuroscience: Behavioural Neurology and Neuropsychology*, edited by Anjan Chatterjee and H. Branch Coslett and has been reproduced by permission of Oxford University Press <<http://ukcatalogue.oup.com/product/9780195395549.do>>. For permission to reuse this material, please visit <<http://www.oup.co.uk/academic/rights/permissions>>.

Artists with achromatopsia may be unable to use color properly in their images (Sacks 1995a). In these cases, the artwork illustrates the nature of neuropsychological deficits. While the depictions may be beautiful and captivating, they do not offer insight into the nature of artistic production itself.

In this chapter, I focus on two aspects of the neuropsychology of art. First, I will examine situations in which brain damage produces a paradoxical facilitation (Kapur 1996) of artistic output. The effects of brain damage on the ability to produce visual art stand in sharp contrast to virtually all other complex human abilities. Diseases of the brain can impair our ability to communicate, coordinate movements, recognize objects, apprehend emotions, and make rational decisions. By contrast, while diseases of the brain often alter the ability to produce art, the alterations are sometimes interesting and occasionally even regarded as improvements (Chatterjee 2006), but they can still be regarded as not impeding an individual's ability to create artworks. Second, I will discuss the issue of measurement in the experience of viewing art. One might approach the idea of measuring aesthetic experiences with some trepidation. The fear is that quantifying these experiences robs them of that which is fundamental to them. However, if neuropsychology of art is to advance as a science, it must incorporate some form of quantification in its methods (Chatterjee et al. 2009). I will describe our attempts to do so.

17.2 The paradoxical facilitation of visual art

Implicit in a discussion of this paradoxical facilitation of art is the view that there is no single "art center" in the brain. Nor does one hemisphere play a privileged role in art production per se. Rather, the production of art is highly complex with different components mediated by different parts of the brain. The final artistic output emerges from a coordination of these different components. Brain damage alters the available parts of the brain dedicated to the overall artistic output that becomes the product of a different coordination of components. By analogy, we might think of these neural systems like a suspended mobile. The mobile rests still in the equilibrium of its weights. If a particular weight is removed, the entire configuration might collapse. However, the configuration might also find itself in a new resting state that is different from the original but which is also appealing. Similarly, brain damage may render an artist incapable of continuing to work, or it may create a new equilibrium in which the individual's artistic work proceeds in new and interesting configurations.

There are four ways in which neurological disorders might change and sometimes improve art production (Chatterjee 2006). These are the (1) disposition to produce visual art, (2) provision of a unique visual vocabulary, (3) aids to descriptive accuracy, and (4) changes in expressive powers.

17.2.1 Disposition to produce art

Fronto-temporal dementias (FTD) are a group of degenerative neurological diseases which cause people to undergo profound changes in their social interactions. They can become disinhibited and disorganized. They can have problems with language, attention span, and the ability to make decisions. In addition to these alterations in personality and

cognition, a few people with FTD develop a propensity to produce art for the first time. Miller and colleagues (Miller et al. 1998) note that these people's art is realistic, not abstract or symbolic. It is highly detailed and has an obsessive quality. The patients themselves seem intensely preoccupied with their work. The artistic output of people with FTD appears to be a consequence of changes in their personalities. The acquired obsessive-compulsive traits find graphic expression and they produce striking visual images as a part of their repetition and attention to detail.

Several other examples show that obsessive-compulsive traits rendered by neurological diseases can predispose people to produce art. Sacks (1995b) described the Italian painter, Franco Magnani, living in San Francisco. Magnani painted hundreds of realistic scenes of an Italian town, Pontito, where he grew up. At the age of 31, Magnani probably had an encephalitic illness. Following that illness he painted compulsively. Pontito preoccupied his thoughts and conversations. Sacks speculated that he had partial complex seizures and was in part demonstrating an obsessive "sticky" personality sometimes associated with temporal lobe epilepsy (Waxman and Geschwind 1975). Such patients are also sometimes "hypergraphic," meaning they write incessantly. Magnani's hypergraphia was being expressed visually rather than verbally.

Lythgoe and colleagues (Lythgoe et al. 2005) reported the case of a builder with a sub-arachnoid hemorrhage. He also had no interest in art premorbidly but became an obsessive artist after recovery from the initial injury. After the hemorrhage, he had a normal verbal and performance IQ and exhibited behavioral patterns except for some degree of verbal disinhibition. He did well on most neuropsychological tasks except for those that involved mental flexibility. He also began to draw hundreds of sketches, mostly of faces. He then moved to large-scale drawings sometimes covering entire rooms, while confining his art to a few themes.

Finally, about 10 per cent of children with autism develop savant-like abilities (Rimland and Fein 1988). A sub-set of these children produce striking visual images (Sacks 1995c). The most detailed description of such a case was Nadia, reported by Selfe (1977). As a baby, Nadia did not respond to her mother and as she got older she lacked social empathy. As a child, she was obsessively concerned with the presence of other children without forming any substantial bonds with them. Her acquisition of language was delayed. Despite these developmental abnormalities, she was remarkable skilled at drawing. By the age of three years she was drawing life-like horses. She drew intensively for a few moments at a time, always copying images. She also focused on specific images, like horses, of which she drew hundreds of examples. While Nadia's abilities were striking, she was not unique. Autistic children with these striking drawing skills seem to focus on specific subjects and draw them repeatedly.

Thus, neurological disorders that produce obsessive-compulsive traits can also dispose people to produce art. These artists produce realistic images and focus on a narrow range of themes. While the neural basis for obsessive-compulsive disorders is not completely understood, dopamine and alterations of reward circuits are probably involved. We reported a patient with Parkinson's disease who produced art obsessively after being placed on dopamine agonists (Chatterjee et al. 2006). Interestingly, despite profound impairments in his motor control, which were evident when he wrote, he could make graceful sinuous

movements when drawing. Obsessive–compulsive traits are also associated with dysfunction of the orbito-frontal and medial temporal cortices and fronto-striatal circuits (Kwon et al. 2003; Saxena et al. 1999; Ursu et al. 2003). Notably, in cases such as those described in this section, these regions may have been damaged, leaving posterior occipito-temporal cortices intact. The preservation of posterior cortices ensures that the neural substrate that represents faces, places, and objects are preserved and are available as the focus of these patients' obsessions.

17.2.2 Visual vocabulary

Neurological disorders such as migraine and epilepsy are associated with productive visual phenomena. Of over 200 entries submitted to the first National Art Competition sponsored by the British Migraine Association and WB Pharmaceuticals, 70 per cent showed spectral appearances, 48 per cent showed fortifications, 16 per cent showed areas of visual loss, and 2.5 per cent showed mosaic visions (Wilkinson and Robinson 1985).

The artist, Ignatius Brennan, (Podoll and Robinson 2000) eloquently expressed how migraineous auras inspired his art. His migraines, beginning at the age of 11 years, were experienced as frightening episodes of visual loss, often with a zigzag cloud obscuring much of his visual field. As he got older, he saw triangles and rounded forms as well as mosaics. He also experienced visual distortions of things getting larger or smaller. He recounts the effects of migraines on his art as follows:

I started with pictures of my migraine experiences unconsciously rather than deliberately, when I was in art school. I used to do a lot of drawings of landscapes at that time and often found that I would be drawing clouds not just in the sky, but everywhere, which I think was a reference to the visual voids experienced during visual loss. I also used serrated zigzag shapes in my drawings, symbolizing the experience of a whole being broken up. . . . Clouds, zigzags and other imagery are part of my own personal visual vocabulary, but which certainly has come out of migraine experiences. I'm absolutely sure. I don't tend to do that deliberately, but when it suits a particular subject, e.g. to represent a feeling or an emotion, I make use of these images in different ways. . . .

Such patients offer insights into how artists generally have a visual vocabulary at their disposal. Greater analyses of these cases may inform us about how artists develop this visual vocabulary and how they develop a visual grammar in concatenating this visual vocabulary.

17.2.3 Descriptive accuracy

For centuries visual artists have been preoccupied with rendering objects and their surroundings accurately. Underlying the problem of descriptive accuracy in drawing and painting is the role of knowledge. Visual agnosias are a class of disorders in which patients have difficulty recognizing objects (Farah 1990). Since Lissauer's classic descriptions of visual agnosias, object recognition deficits are known to lie on a continuum between perceptual and conceptual deficits (Lissauer 1890). Perceptually based agnosias, called *apperceptive agnosias*, impair the ability to process the visual information into a coherent

object. Conceptually based agnosias, called associative agnosias, involve impairments of semantic knowledge of the object (Farah 1990).

Wapner, Judd, and Gardner (1978) described an artist with an apperceptive agnosia who had difficulty copying images despite being able to convey depth and shading in drawings that were otherwise fragmented. His preserved semantic system did not help guide his artistic production. Thus, when asked to draw a telephone, he constructed images by reasoning, "It needs a base for it to stand on, a place to speak into, something to hear with a wire to plug in for communication and a place to dial." This verbal strategy was not effective in rendering accurate images. Semantic knowledge by itself does not help render objects accurately.

This patient contrasts with two people with associative agnosias (Franklin et al. 1992; Schwartz and Chawluck 1990). In both cases, when asked to draw objects from verbal labels these people drew crude, simplified images similar to those drawn by a young child. However, when drawing from complex visual images, the results were strikingly different. For example, one of these people could copy a portrait originally painted by Botticelli or draw a beautiful portrait of a staff worker (Franklin et al. 1992). People are thus able to render objects accurately and beautifully without semantic knowledge.

The case of a Polish aphasic artist also informs us about the relationships between semantics and art (Kaczmarek 1991). Profoundly influenced by the events of the Second World War, his premorbid paintings were anti-war statements. They often included numbers, letters, and ideograms. Following his stroke, he could only produce a few words. At its core, our semantic system functions to abstract and generalize. The use of abstracted symbols could be considered a marker for a preserved semantic system. Although testing of his semantic system was not reported, from the descriptions of his aphasia one might infer that it was impoverished. His inability to make use of verbal symbols extended to his artwork. He was no longer able to produce paintings in his previous style of using symbols to communicate his anti-war sentiments. However, he was still able to draw realistic landscapes and portraits well, despite having lost his ability to manipulate symbols!

Does semantic knowledge of an object hinder artistic production? The art historian Ernst Gombrich (1960) observed that even trained artists impose knowledge of what they are looking at in their depictions in a way that can compromise their accuracy. Thus, impaired knowledge, provided visual-motor systems are intact, might aid in the ability to depict objects and scenes accurately. Perhaps such impaired knowledge accounts for cases of autistic children with savant-like artistic abilities.

Autistic artists need only to look at an object for a few minutes before being able to draw them rapidly and accurately (Sacks 1995c; Selfe 1977). Nadia's abilities were not an accelerated version of other children's drawing development. She did not first pass through a phase of drawing simple schematic images before learning to draw realistically. Rather her skills developed very early and did not change much over time. Nadia initially drew horses deftly and without hesitation. Two observations suggest that she treated horses as visual patterns rather than as objects. First, she would start drawing anywhere on the page. Rather than trying to squeeze the whole horse into a page, she would stop drawing when

she came to the paper's edge even if it meant only drawing part of the horse. Secondly, most people draw horses by starting at the head. Nadia could start her drawing at the neck and seemed unaffected by critical features associated with a specific object, such as the head of a horse. Her remarkable skill at drawing horses, and later pelicans, was not hindered by semantic associations that interfere with the ability to "see" the visual object. As Nadia eventually acquired language her drawings became more prosaic. Presumably, the acquisition of language indicated development of a richer semantic system and detracted from her artistic skills.

17.2.4 Changed expressivity

Visual art is of course not restricted to rendering objects and scenes accurately. Perhaps driven by the advent of photography, visual art diverged into many forms of expression. Among the most intriguing effects of brain damage on artists are a class of phenomena in which the inability to make accurate depictions results in surprisingly appealing stylistic changes. These changes can occur in the use of color and form and in the content of images.

Sacks (1995a) described an artist with an acquired achromatopsia following a traumatic brain injury. His earlier paintings were colorful and abstract. After the accident everything appeared "dirt gray" to him. His initial attempts to use color did not work and he resigned himself to painting in black and white. Eventually he incorporated a limited set of colors in his paintings. After an initial sense of helplessness, he considered his new way of seeing as a strange gift. He thought he saw the world as pure form, uncluttered by color, and endowed with a new range of expressions.

Right hemisphere damage can produce left spatial neglect and artists with neglect omit the left side of images that they draw or paint (Blanke et al. 2003; Cantagallo and Sala 1998; Halligan and Marshall 1997; Jung 1974; Marsh and Philwin 1987; Schnider et al. 1993). As they recover from their neglect, their use of line may still be altered. Two examples show how this change in the use of line can produce art that is highly regarded. Lovis Corinth, an important German artist, had a right hemisphere stroke in 1911. As he recovered, he resumed painting. His self-portraits and those of his wife showed clear changes in style, with details on the left sometimes omitted and textures on the left blending with the background. Alfred Kuhn characterized this work as follows (quoted in Gardner 1975):

He [Corinth] had become prescient for the hidden facets of appearance. . . . The contours disappear, the bodies are often as ript asunder, deformed, disappeared into textures. . . . also the faithfulness of portraits had ceased almost entirely. . . . With wide stripes the person is captured in essence. Characterization is now exaggerated, indeed, often to caricature. . . . Corinth always seems to be painting a picture behind the picture, one which he alone sees. . . . at this point Corinth shifted from the ranks of the great painters into the circle of the great artists.

Heller (1994) reported the experience of the artist Loring Hughes, who after a right hemisphere stroke had difficulty coordinating the spatial relationship between lines. This forced her to abandon her premorbid style of accuracy in realistic depiction. Instead she turned to her own imagination and emotions. Initially, she was too ashamed to display

her paintings, but she began to show publicly once she became comfortable with her new style. The artistic community responded well to these distorted images. The critic Eileen Watkins described her work as now delivering “an emotional wallop” that was not present previously.

When they occur as a result of left brain damage, stylistic changes might be different from those observed stemming from right brain damage. The specific changes reported are the introduction of more vivid colors and a change in content. These changes are exemplified in the Bulgarian painter, Zlatio Boiyadjiev, the Californian artist Katherine Sherwood who was mentioned in the introduction, and a Swiss painter reported by Annoni and colleagues.

Boiyadjiev’s premorbid artistic style was natural and pictorial and he tended to use earth tones in his paintings. Following the onset of his aphasia, Boiyadjiev’s paintings have been described as richer, more colorful, and containing more fluid and energetic lines (Brown 1977; Zaimov et al. 1969). The imagery in his work became more inventive and at times even bizarre and fantastical. Similarly, Katherine Sherwood suffered a left hemisphere hemorrhagic stroke that left her with an aphasia and right-sided weakness (Waldman 2000). She trained herself to paint with her left hand, and since then her career has flourished. Premorbidly, her images were described as “highly cerebral” incorporating a range of esoteric images such as cross-dressers, medieval seals, and spy photos. After her stroke she felt that she could not produce these images even if she tried. Her new style is described as “raw” and “intuitive,” with large irregular circular movements. She says her left hand enjoys an ease and a grace with the brush that her right hand never had, and describes it as “unburdened” (Sherwood 2012). Finally, Annoni and colleagues (2004) recently described a Swiss landscape painter whose art was described as being “figurative–impressionist.” He had a small stroke in the left thalamus. His wife thought he had mild emotional dysfunction after his stroke. He felt that he was more sensitive to the hidden beauty of images and used bolder colors. He switched from realistic to more impressionistic images. He thought that he was less likely to use lines, contours, and perspective clearly and felt that he was more creative.

A final stylistic change rendered by brain damage is a move towards simplicity. Annoni and colleagues (2004) described a person with a left occipital lesion. A month after his stroke he resumed drawing and painting. His new artwork was simplified, stylized, increasingly abstract, and confined to a limited use of colors. It is not known if damage to visual association cortices would consistently result in simplification and abstraction. A few artists with Alzheimer’s disease have continued to paint (Crutch et al. 2001; Maurer and Prvulovic 2004; Miller and Hou 2004) and demonstrate a similar pattern. William Utermohlen painted a series of self-portraits several years into the course of his illness. As these portraits became increasingly simplified and distorted, they appear as haunting psychological self-expressions.

Willem de Kooning is probably the best-known artist who continued to paint after the onset of Alzheimer’s (Storr 1995). De Kooning’s ex-wife and students provided the structure for him to continue to work. They stretched his canvases and mixed his colors. Experts

think this late period represents a new and coherent style. His paintings were simpler and he confined his palette to primary colors. Traces of shapes from earlier works are evident, but are pared down. Gary Garrels (1995), the senior curator at the San Francisco Museum of Modern Art, thought “the vocabulary of forms was retained, but clarified. . . . the results are paintings of an openness and freedom not seen before, paintings that are extraordinarily lyrical, immediately sensual, and exhilarating.”

17.3 Quantification in the neuropsychology of art

Despite the fascinating observations recounted here, much needs to be done if neuropsychology is to make substantive contributions to empirical aesthetics. For the field to mature, it must move beyond recounting interesting anecdotes. Methodologically it is critical to quantify features of artwork in order to assess change. Most of the cases reported are devoid of measurement. Claims about changes in art after brain damage are usually post-hoc comments supported by a few illustrative examples of artwork.

We need an instrument to assess art quantitatively. Such an instrument should have at least two characteristics. First, it should assess artwork via a comprehensive set of attributes which would include formal properties (use of line, color, composition, etc.) and content properties (abstract, realism, etc.). Second, it should distinguish between descriptive and evaluative judgments. With such an instrument one could begin to impose quantitative structure on otherwise casual observations about works of art.

With these considerations in mind, we developed the Assessment of Art Attributes (AAA) (Chatterjee et al. 2010). The AAA assesses 12 descriptive attributes that would apply to any piece of visual art. Six attributes refer to formal/perceptual properties and six to content/conceptual properties. The six formal/perceptual attributes are: *Balance*, *Color Saturation*, *Color Temperature*, *Depth*, *Complexity*, and *Stroke Style*. The six content/conceptual attributes are: *Abstractness*, *Animacy*, *Emotionality*, *Realism*, *Representational Accuracy*, and *Symbolism*. The stimuli in the AAA consist of 24 paintings from the Western canon. These are paintings by well-known artists, but not their most famous works and encompass a range in the six formal/perceptual and six content/conceptual attributes of interest. The paintings are also evaluated for preference or liking and their level of interest for the viewer.

17.4 Art production

We have used the AAA to examine changes in art production as well as art perception following brain damage. For art production, we examined the work of three artists that have already been mentioned (Chatterjee et al. 2011). These are Sherwood and Boiyadjiev, both with left brain damage, and Corinth with right brain damage. In each case we sampled several paintings completed before and after the stroke occurred. Average ratings on each attribute were obtained for each painting. Then the average ratings for all the pre- and post-morbid paintings were obtained for each participant for each artist.

We examined Sherwood and Boiyadjiev’s work to determine if left brain damage produces consistent changes in art. Sherwood describes her approach to her work premorbidly

as over-intellectualized (Chatterjee 2008). Post-morbidly, her work has been described as raw and more expressive, and less forced (Sherwood 2012). In concordance with these descriptions, raters found her work following brain injury to be more abstract, more symbolic, more distorted, more vibrant, less realistic, and depicted with looser strokes. Raters also found her work to be flatter and to contain warmer colors, changes not mentioned previously by critics describing her work. Boiyadjiev's work has been described as becoming fantastic and sometimes bizarre with richer, more colorful forms, and having fluid, energetic lines (Brown 1977). Consistent with these descriptions, raters found his work to be more abstract, more symbolic, less realistic, more distorted as well as having a looser stroke style. They also found his work to be flatter and less animated, changes also not mentioned by critics before.

Could motor deficits for Sherwood and Boiyadjiev have caused these changes? Both were right-handed artists who began to paint with their left hands after their strokes. From these data, it is not clear if some pictorial aspects of the artwork, such as the coarser brushstrokes, changed because of hemispheric brain damage or because they began to use their left hand. However, a shift to the left hand is unlikely to explain the use of increasingly vibrant colors or changes in conceptual attributes of their artwork, such as greater symbolism or abstraction.

A priori, one could be pessimistic about the prospects of identifying systematic effects of brain damage on art production. After all, artistic styles and content vary so much across different artists that one might be comparing changes in qualitatively different kinds of objects. Our observations of Sherwood and Boiyadjiev's paintings suggest that this pessimism might not be warranted. Sherwood and Boiyadjiev's artistic styles are quite different from each other. For example, Sherwood's paintings started out being substantially flatter than Boiyadjiev's. Critically, both artists' paintings were judged as becoming flatter following their strokes, despite the fact that Sherwood's paintings executed *before* her stroke were more similar to Boiyadjiev's paintings made *after* his stroke in depicting depth. Thus, it would be a mistake to think that people with left brain damage produce a *prototypic style* of painting. Rather, it appears that left brain damage produces a *prototypic shift* in style of painting.

Sherwood and Boiyadjiev's paintings became more abstract, symbolic, and distorted as well as less realistic, and they were painted with looser strokes, more vibrant colors, and less depth (Chatterjee et al. 2011). Examining Corinth's work would test the specificity of these changes. Corinth's paintings after his stroke were described as "deformed," and attempts at producing faithful portraits "ceased almost entirely". Blanke (2006) describes a broadening of brushstrokes, a lack of depth, less spatial detail, and several deformities depicted on the left side of his self-portrait paintings. Researchers found Corinth's paintings to be more abstract, more distorted, less realistic, and also to exhibit looser strokes and a flatter perspective.

When Sherwood, Boiyadjiev, and Corinth's paintings are considered together, the following changes were found in all three artists' works. Their paintings became more abstract and distorted and less realistic and accurate. They were also rendered with looser

strokes, less depth, and with more vibrant colors. Thus, none of these changes can be ascribed to laterality of brain functions. Also, their paintings did not change in complexity or the level of emotion being conveyed. It remains to be seen whether these attributes would be susceptible to change with other kinds of neurological illness. For example, we might expect the artworks of people with Alzheimer's disease to become less complex over time.

All the changes observed in Corinth's paintings were also observed in works by both Sherwood and Boiyadjiev (Chatterjee et al. 2011). Thus, chronic right hemisphere damage does not appear to produce specific patterns of change in artistic production. By contrast, both Sherwood and Boiyadjiev's subjects became more symbolic. This could mean that artists with left brain damage, because of an unfettered right hemisphere, engage meaning more loosely, specifically in the use of symbolism. These data show that the popular idea that right hemisphere is the artistic hemisphere is wrong. Clearly, both hemispheres participate in artistic production as shown by the fact that these artists' paintings changed regardless of which hemisphere was damaged. If anything, damage to the left hemisphere produced more significant alterations in artistic production than did damage to the right hemisphere.

We have also used the AAA to assess gradual changes in artistic styles in two patients with Alzheimer's disease (AD). Investigating artists with AD allows us to look for gradual changes in art production rather than sudden changes brought about by a stroke.

William Utermohlen was diagnosed with AD after a long, successful painting career (Crutch et al. 2001). He was born in Philadelphia and studied at the Pennsylvania Academy of Fine Arts from 1951 to 1957. He moved to England in 1957 where he enrolled at the Ruskin School of Art in Oxford before settling in London. His early work was characterized by linear expressionism, with frequent inclusion of Pop imagery and styles, including a use of strong colors. His earliest symptoms began four years before diagnosis, and involved difficulties with tying a necktie, calculating household finances, and memory of day-to-day events. Formal neuropsychological examination revealed a moderate degree of global cognitive deterioration, while MRI indicated generalized cerebral atrophy. Following the initial diagnosis at the age of 61, regular clinical assessments documented the expected gradual decline in cognitive function (Crutch and Rossor 2006). We looked at five self-portraits executed by William Utermohlen in the four-year period following his diagnosis.

The second artist, Lester Potts, was diagnosed with Alzheimer's disease around age 70. He had worked in a rural Alabama sawmill during the Great Depression. He served in the Korean War and was regarded as a dependable civic leader. He had not painted before his enrolment at an adult day-care center. At the center he was taught to use watercolors by a retired artist as part of a community outreach program. By the time he died at age 78 Lester Potts had painted over 100 original watercolors.

Using the AAA, we found that both artists' paintings became more abstract and more symbolic, less realistic and less accurate in depicting figurative detail. Potts' paintings also showed more color saturation, shifts in hues, less complexity, and less emotion as his disease progressed. Notably, changes were not seen with balance, depth, or stroke quality in either person's paintings.

Our observations were in general accord with other observations of the relationship between AD and artistic production and offered greater detail in the nature of change observed. For example, Fornazzari (2005) describe changes in the portraiture of a woman who suffered from AD. These changes include trends toward “unusual figure fond, loss of proportion in the facial features, and loss of proportionality. . . .” The changes mentioned might parallel those observed in Utermohlen and Potts. “Unusual figure fond” and “loss of proportionality” might correspond to a decline in depictive accuracy. However, it is not clear if loss of proportionality could refer to loss of balance, which we did not see in either person. This uncertainty highlights one of our points, which is that clear operational definitions of art attributes are needed if we are to compare results across studies.

Our findings also validate anecdotal observations of changes in abstraction and increased symbolism among artists with AD (Crutch et al. 2001; Cummings and Zarit 1987; Rankin et al. 2007; Chatterjee 2004a). For example, art historians describe a heightened trend towards abstraction in paintings executed by Willem de Kooning during the progression of his AD (Garrels 1995). Maurer and Prvulovic (2004) thought that in the later works of the painter Carolus Horn, “ornamental symbols and mythical creatures appeared, which were derived from a conjunction of different species.” Cummings and Zarit (1987) reported that an artist with AD over a period of two-and-a-half years moved towards simplicity and distortion. Miller and Hou (2004) observed AD artists to produce works with less precision and attention to spatial relationships.

17.5 Art perception

We know virtually nothing about the neuropsychology of the perception of art. One might expect that sensitivity to different attributes within a work of art would be affected by different kinds of brain damage. Recently, we used the AAA to examine the effects of brain damage on art perception (Bromberger et al. 2011). Our investigation focused on the role of the right hemisphere. The right hemisphere participates prominently in visuospatial attention and representation (Chatterjee 2003; Heilman et al. 1993). As a first step, we wished to avoid confounding language comprehension with perceptual judgments in our study. For example, if a participant does not understand what the word “symbolic” means, it would not be difficult to assess their perception of symbolism in any painting. We also use contemporary lesion analysis methods in our study. Voxel-based lesion-symptom mapping (VLSM) techniques allow us formally to assess the way in which damage to a brain area correlates with behavioral scores (Bates et al. 2003; Kimberg et al. 2007; Wu et al. 2007) with the advantage that one does not have to establish a deficit cut-off. Rather, behavior in VLSM considered a continuous variable.

In this study, the judgments of 20 people with right brain damage were compared to 30 healthy age-matched control participants. Of all the content/conceptual qualities, damage to the right frontal lobe was associated with differences in judgments of abstractness, realism, animacy, and symbolism in visual art. In addition, damage to the right parietal lobe was related to deviations in judgments of animacy and symbolism. There were no

brain–behavior relationships for differences in evaluative judgments, those of preference or level of interest for the viewer.

Any aesthetic experience is built upon at least three components (Chatterjee 2004b; Chatterjee 2011). These components are the experience of sensory qualities, the associated sets of meanings, and the emotional responses evoked by the aesthetic object. Broadly, one might regard the formal-perceptual attributes of the AAA as probing the sensory experience, the content-conceptual attributes as probing the meaning, and the evaluative questions as probing the emotional response to these paintings. The data from this study suggests that these three components of visual aesthetic experiences might segregate broadly in the organization of the brain. Most of our participants had damage in the distribution of the right middle cerebral artery. This distribution of brain damage involving lateral frontal-parietal and temporal cortices was more likely to affect judgments of conceptual attributes. We would predict that damage in the posterior cerebral artery distribution affecting ventral occipital and temporal cortices might be more likely to affect the perceptual attributes. Furthermore, given the extensive data implicating the ventral striatum and orbitofrontal cortex in subjective rewards (Kable and Glimcher 2009), damage to ventro-medial prefrontal cortices is plausibly more likely to affect people's evaluation of paintings.

These recent results demonstrate the feasibility of conducting systematic quantitative studies in the neuropsychology of art. This point by no means implies that theoretical analyses or qualitative approaches to art are not useful. It does mean that if the neuropsychology of art is to mature *as a science*, it needs to incorporate quantitative approaches, and formal tests of hypotheses as part of its research program.

17.6 Conclusion

In reviewing the literature of the neuropsychology of art production, I emphasized the possible enhancing effects of brain damage on artistic production. Of course, these observations are based on selected artists. It is likely that many more artists are devastated by their brain injury and these cases are not reported. We simply do not know the base rate of facilitation effects. Yet, the examples of changed and possibly improved art following brain damage point to the multifaceted nature of art. In my view, exploring the mechanisms underlying the alterations and gaining insights into these facets is one way that neuropsychology can advance neuroaesthetics. Looking forward, unless the neuropsychology of art can incorporate the basic rigors of any experimental science, we will not get past the description of seductive artistic phenomenology under consideration. We are in a position to augment qualitative insights with quantitative approaches. The observations from patients can also serve to generate hypotheses to be tested using functional imaging techniques. For example, the hypothesis that the perception of art dissociates from the evaluation of art is amenable to functional imaging methods. We can be guardedly optimistic that the neuropsychology of art may mature and serve as a fundamental anchor in the new field of neuroaesthetics.

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