Chapter 24

Visual art and the brain

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24.1. What is art?

Uniquely human, art, language, and music represent the highest forms of creativity of our species. Art, in contrast to language and music, has proven difficult to study and the neurological underpinnings of art appreciation and production are still poorly understood. Our prehistoric ancestors began to cover the walls of caves with pictures of animals as early as 40,000 years ago suggesting something very old, intrinsic, and universal about our capacity for art (Harth, 1999; Janson and Janson, 1997; Miller and Hou, 2004). Despite the fact that these paintings were produced by humans living in a very different cultural milieu, it is easy for even the most modern of humans to appreciate these early efforts at art.

What is art? While artistic preferences are steeped in culture, our discussion must begin with a common agreement about the core features of visual art. In the History of Art, Janson and Janson propose that the art begins with a mental image, be it either realistic or improbable, past or present (Janson and Janson, 1997). During the creative process, the artist manipulates materials to actualize this mental image. This aspect of ‘human intervention’ distinguishes natural objects such as flowers or landscape from art, unless they are purposefully exhibited as objects worthy of special consideration (e.g., found art). Manipulation of images occurs within the mind as well as with material. Furthermore, like language, art is a means of communication. Art delivers messages and impressions that cannot be expressed through words alone. Finally, art is original. The originality of the work is what separates art from craft—the latter can be mass produced. As truly original art only declares itself over time, this quality is often the most difficult feature to determine (Janson and Janson, 1997).

Chatterjee (2004) proposes a framework for understanding artwork, and by extension, how it changes. The first axis involves purpose and may be either descriptive or expressive. In any given work, an artist may choose to accurately represent the real world or communicate an internal state. Both are valid goals and have been more or less celebrated in art history. The entire brain participates in the production of an artistic piece, but research suggests that the process of copying an ‘accurate representation of the real world’ relies strongly on the nondominant parietal lobe, while pulling up internal images activates memory systems in the temporal areas. The second axis describes the content matter, which may be more perceptual or conceptual in scope. Perceptually based content includes more sensory information, including light, color, form, texture, faces, and scenes. Conceptually based content, on the other hand, may be abstracted, symbolic, and simplified. This division between perception and concept contrasts the strengths of the nondominant versus the dominant hemisphere.

In relation to the above definition of art, our goal is to articulate the state of the research on visuospatial perception, visual imagery, motor memory, and interest as it applies to the artistic process, through the lens of lesion studies and different categories of neurodegenerative illness. While the primary goal of this chapter is not to explain the cognitive basis of visual processing, it is important to discuss the visual systems used by artists as they conceptualize and then produce an artistic product.

24.2. The nature of research on art and the brain

The fields of neurology, psychology, psychiatry, and cognitive science lend diverse and complementary
perspectives on art and the brain. The bulk of our understanding rests upon case reports of artists and non-artists who suffer from localized brain injury. Some argue that following the natural history of established artists provides a richer understanding of the neurological substrate of art-making (Marsh and Philwin, 1978; Kaplan and Gardner, 1989). Indeed, pre- and postmortem comparisons can be more readily made in this cohort. With structural and functional imaging it is now possible to study brain activity and structure as it develops normally in an artist. Yet much of what we have learned about art and the brain still comes from the compelling stories of artists and non-artists who have had focal brain injuries that have influenced their visual creativity. Additionally, there have been numerous case reports of non-artists, usually with left frontal or temporally predominant brain degeneration, who demonstrate a newfound interest in the visual arts.

The case-based nature of the bulk of the research has certain limits. Perhaps most importantly, humans vary enormously regarding their premorbid ability to produce and understand art. This is particularly evident when trying to compare a talented artist to an individual who lacks visual artistic ability. Individual variability has made it difficult to produce standardized batteries that quantify art in the same way that aphasia batteries have been organized. Also, localization of specific brain regions to art is limited by the variations in human neuroanatomy. For example, V5 motion area varies by as much as three centimeters in location from one person to another. Furthermore, much variation in cerebrovascular territories exists (Watson et al., 1993). Finally, some degree of subjectivity in interpretation is inherent in research on art and the brain. For example, over 150 physicians and art historians have retrospectively diagnosed Vincent van Gogh (1853–1890) with temporal lobe epilepsy, Meniere’s disease, porphyria, depression, bipolar illness, and absinthe poisoning, to name a few (Arenberg et al. 1991; Morrant, 1993; Blumer, 2002).

24.3. How do artists differ from non-artists?

In distinguishing the novice from the expert artist, it may be helpful to describe what happens during art training. Just as learning syntax and grammar is essential to good writing, acquiring basic perceptual skills is foundational to making art. In fact, for art educators, one of the most persistent problems in teaching students how to draw is encouraging them to draw what they see instead of what they think they see. Edwards calls this challenge ‘overcoming the tenacious set of symbols or schemata that every person develops from the age of three and ten (Edwards, 1988).’ For example, most unskilled artists and children have a preconceived notion of a table: a rectangle with one leg attached to each of its four corners. Thus, the novice may draw a flat representation of the table, with little regard to foreshortening or perspective. However, trained artists not only have an abundance of schemas but have acquired a set of skills that allow them to draw more flexibly, even when faced with novel stimuli (Wapner et al., 1978).

Snyder and colleagues have suggested that the linguistic layering and labeling of objects in the world prevents non-artists from seeing the visual world as it is (Snyder and Thomas, 1997; Snyder et al., 2003). Paradoxically, learning how to become an artist requires the unlearning of these verbal and symbolic approaches to perception. Snyder’s theory may partially explain the emergence of visual creativity in the setting of semantic dementia, a degenerative disorder of the left anterior temporal lobe where semantic knowledge of the world disintegrates (Miller et al., 1996). Similarly, his theory yields insight into the behavior of artistic savants, who are prolific in visual expression but devastated in linguistic skills.

A basic assumption of neuroscience is that learning a skill leads to specific neuroanatomical and neurophysiological brain changes. An EEG study comparing professional artists and laymen showed significantly stronger delta band synchronization between frontal and temporo-occipital electrodes in the former group. Non-artists however, only showed enhancement in gamma band synchronization primarily in frontal regions. Together, these findings suggest that artists may display greater functional cooperation between cortical regions and that the prefrontal cortex plays an important role in creative tasks (Bhattacharya and Pattsche, 2005). Consistent with popular belief, strong right hemispheric dominance in terms of synchronization was also found among the artists (Bhattacharya and Pattsche, 2005).

24.4. Hemispheric contributions to art-making

Because of the limits of imaging at the time, early research could only make crude associations between lesion site and functional deficits. However, lesion and dementia studies from the 1970s to the present offer a valuable window into the relative hemispheric contribution to artistry, particularly the relationship between details versus form. As early as 1948, Alajouanine recognized the hemispheric specialization for linguistic, musical, and visual arts (Alajouanine, 1948). He described a writer (Valery Larbaud), a musician (Ravel), and an artist, each with devastating injury to the dominant (left) hemisphere. For the writer and musician, the dominant hemisphere injury had a devastating and permanent
effect, while for the artist the effect was minimal. Fifty-seven years later, Boller (2005) identified the artist as Paul-Elie Gernex and confirmed that the aphasia did not stop painting. However, poststroke work appeared less poetic and spontaneous. The story of hemispheric specializations for art is quite complex.

24.4.1. Details vs. form

Beginning with German neurologist Richard Jung’s collection of the work of four major German artists who suffered from right hemisphere injury (Jung, 1974), there have been several studies comparing patients with isolated hemispheric damage. Not surprisingly, patients with left-brain damage (LBD) produced drawings with a relative neglect of the (right) side of the canvas. Also, they tended to draw in a more simplistic and primitive manner. Contours were favored over details and their work was compared to children’s drawings. A preserved right hemisphere appears capable of maintaining the overall gestalt in drawing (Gardner, 1982; Kaplan and Gardner, 1989). In contrast, patients with right-brain damage (RBD) lost the overall contour of the subject matter but demonstrated fastidious attention to detail. Their drawings appeared more scattered, fragmented, and disorganized as a whole (Kaplan and Gardner, 1989; Gardner, 1982; Swindell et al., 1988). In another study of a visual artist with a right hemisphere stroke, the loss of the ability to draw and profound neglect was accompanied by the appearance of words onto pictures (Schnider et al., 1993).

Together, these studies support Kaplan’s theory that the left hemisphere attends to details while the right hemisphere perceives the overall form and composition of the subject matter (Kaplan, 1980). Furthermore, in a task calling subjects to categorize artwork, aphasic patients were better at grouping paintings by artistic style. On the other hand, right-sided injury patients tended to group by subject matter (Gardner, 1975). Of related interest, one longitudinal study found that the LBD group recovered more rapidly and completely than RBD patients, as evidenced by their steady improvement in drawing (Swindell et al., 1988).

Jung’s four German painters also demonstrated a definite shift in style with the onset of right-hemisphere damage (Jung, 1974; Gardner, 1982). As exemplified by the German painter Anton Räderscheidt’s (1892–1970) self portraits made before and after his right-sided stroke, paintings become more free and expressive. Critics noted a similar shift in style of another famous German painter and printer Lovis Corinth (1858–1925), but attributed the change to psychological reasons. More likely, the shift was due to the right-hemisphere stroke he sustained in 1911 (Jung, 1974; Gardner, 1982). Other examples of artists who demonstrated a shift in style include Reynold Brown, whose artwork was exhibited and discussed at an ‘Art and the Brain’ symposium in Chicago, 1994, and Loring Hughes (Heller, 1994). Gardner suggests such stylistic transformation may be due to ‘the release of an inhibitory mechanism’ (Gardner, 1982).

Color perception is discussed in more detail later in this chapter, but its relevance to hemispheric specialization is noted here. In a comprehensive study of color deficits following right versus left brain injury, De Renzi and Spinnler (1967) demonstrated that patients with right brain damage were more likely to demonstrate deficits in color perception (dyschromatopsia), while patients with left brain injury demonstrated more problems with color naming and with conjuring up an image of object’s colors. The influence of these primary deficits on the production of paintings remains unknown.

24.4.2. Symbolic art

The devastation of copying and realistic art with right hemisphere injury is well-established, but there is little research on the types of deficits that are seen when artists suffer left brain injury. In one study, Kaczmarek described a highly symbolic abstract artist who suffered a dominant hemisphere stroke (1991). This individual was able to successfully carry out accurate copies of visual scenes, but completely lost his ability to produce symbolic work. As will be discussed, patients with left anterior temporal or left frontal lobar degeneration lose symbolic components of language yet often produce elegant realistic or surrealistic art.

Additionally, several studies suggest that left hemisphere lesions may be associated with loss of primary visual functions that could impair the artistic process. Bay (1962), Gainotti et al. (1983), and Goldenberg et al. (2003) reported that aphasic patients had difficulty with drawing objects from memory.

24.4.3. Distribution of function between left and right hemispheres

In summary, lesion studies demonstrate that the left hemisphere attends to symbolic meaning in artwork, tends to appreciate art by its literal meaning or subject matter, and focuses on the detail of the subject matter. The right hemisphere, in contrast, perceives overall form and composition of the subject matter and responds to and generates the style of artwork.

However, there is some evidence for handedness affecting the distribution of function between hemispheres. In general, left-handers appear to be
24.4.4. The nature of neglect

Neglect following right hemisphere stroke, usually centered in the inferior parietal or superior temporal areas, is a fairly well-documented phenomenon (Vallar, 1993; Karnath et al., 2001; Bartolomeo and Chokron, 2002). One study cites unilateral neglect in over 80% of patients with acute right hemisphere stroke. Defined as failure to attend to objects in the left field of view, the disorder is usually associated with a poor prognosis (Roberson and Marshall, 1993; Halligan and Marshall, 1997). Furthermore, neglect may be person-centered or object-centered (Chatterjee, 1994; Ota et al., 2001). In person-centered neglect, the left side of the field of view in relation to the patient is relatively ignored, whereas in object-centered neglect, the left side of each object is overlooked.

The famous filmmaker Federico Fellini, also a distinguished painter and cartoonist, suffered a right parietal stroke which left him with a left-field visual neglect (Cantagallo and Della Sala, 1998). When given line-bisection drawing tasks, he demonstrated more stimulus-bounded neglect, whereas another patient with more anterior-medial damage demonstrated person-centered neglect (Ota et al., 2001). For example, he would always draw on the right side of the line (Fig. 24.1B). Unlike many of the other artists that Jung studied with right-hemisphere strokes, Fellini was unique in his awareness of his deficit. In fact, a few of his cartoons feature characters that cleverly demonstrate his insight (Fig. 24.1A and C). Fellini’s performance on visuospatial tasks and preserved insight suggest that his stroke left him with relative impairment of this visuospatial working memory but spared his long-term visual memory, suggesting that these two functions exist independently. However, another interpretation may be that he suffered from hemianopia, not hemineglect.

Other artists who have suffered right hemispheric strokes and exhibited left-sided field deficits include German realist painter Anton Räderscheidt, German painter and printer Lovis Corinth, German painter and draftsman Otto Dix, British painter and sculptor Tom Greenshields, and Italian painter Guglielmo Lusignoli. Lovis Corinth (1858–1925) for example, continued to paint portraits after his stroke, but with missing or displaced contours and details on the left side of the canvas (Chatterjee, 1994).

Halligan and Marshall (1997) report another 75-year-old painter and sculptor with a right hemisphere stroke and resulting left-sided neglect. Not only did he demonstrate space-based and object-based neglect in his drawing, but also in his sculpting (Fig. 24.2). In comparison to the high degree of representational likeness that the patient’s premorbid life sculptures demonstrated, his postmorbid sculptures revealed a clumsily articulated, poorly formed left side, even though he could rotate his work on a turnstile. His example demonstrates that neglect can occur in three-dimensional space as well (Chatterjee, 2004). Like Fellini, this artist was frustrated with his postmorbid work, revealing an awareness of his deficits. While there remained traces of the hemineglect in his later sculptures, the artist’s greatest deficits eventually resolved.

With these two exceptional case studies of artists demonstrating gradual improvement, one wonders whether the process of making art can facilitate recovery. There are no definitive studies to suggest that art therapy is an effective way to treat right or left brain injury. However, more formal controlled studies are underway.

There are a few case studies suggesting that representational and visuospatial neglect are two distinct deficits, presumably caused by two anatomically distinct lesions (Marshall and Halligan, 1993). In Bisiach and Luzzatti’s case study (1978), two Italian subjects with left unilateral neglect were asked to recall a familiar place, the Piazza del Duomo in Milan. First these subjects were asked to pretend that they were looking toward the Duomo. They enthusiastically and elaborately describe the shops and landmarks from the right side of the square, but not from the left side. When the subjects were asked to pretend that they were at the Duomo and looked toward the town, they described the side of the road (previously left but now right) that they had previously neglected and neglected the side that they had previously described.

Guariglia et al. report a 59-year-old right-handed man with a stroke in the right frontal area who demonstrated left-sided neglect when asked to perform an imagery task, but not when asked to perform visual tasks. Finally, a third case study reported a professional cartoonist who produced a whole image when drawing from memory, but neglected the left side when drawing from life (Halligan et al., 2003). Taken together, these studies suggest that the ability to imagine a scene exists separately from the ability to perceive a scene, such that hemineglect can affect the two independently.

Most case studies of neglect have been in right-brain damaged patients. Bartolomeo and colleagues’ quantitative studies of neglect concluded that most patients
experienced only isolated visuospatial neglect and that representational neglect tends to occur in only right-hemisphere injured patients (Bartolomeo et al., 1994). The severe left-sided neglect that RBD patients experience may explain Marr’s observation of these patients’ difficulty depicting items in three dimensions (Marr, 1982). Patients with left-hemisphere injury do not experience the same severity of neglect (Kaplan and Gardner, 1989). There is one case report of an artist with right-sided neglect, caused by a left-hemisphere stroke (Peru and Pinna, 1997). Furthermore, one study in humans suggests that the right superior temporal cortex is the key neuroanatomical site for spatial neglect, not the posterior parietal lobe (Karnath et al., 2001).

24.5. The neuroanatomy of visual imagery and color imagery

The cerebral processing of visual information occurs in two pathways. The first carries information from the
Fig. 24.2. Demonstrates the painter and sculptor described in Halligan and Marshall’s case study before (A) and after a right hemisphere stroke (B). The left side of the postmorbid sculpture, as seen by the patient and viewer, is less well-formed than the right side, and the entire work is a more crude representational style than the premorbid bust. (C) Drawing made after the same artist’s stroke. (Reprinted from Halligan and Marshall (1997), with permission from Elsevier.)
retina to the lateral geniculate nucleus and finally to the striate cortex (area V1), located in the calcarine fissure of the occipital lobes. Lesions in the optic tracts or the striate cortex produce predictable topographic deficits in the contralateral hemifield. The second pathway begins from the striate cortex and radiates out into multiple inter-related areas of the extrastriate cortex. Over 40 specialized extrastriate regions have been identified in the monkey. These regions are responsible for highly specific aspects of the visual experience—including color, shape, and face recognition (Barton, 2004).

Within the extrastriate cortex, intact visual perception requires the functioning of two visual streams: the ventral stream, responsible for recognizing ‘what’ is seen, and the dorsal stream, responsible for recognizing ‘where’ subjects are perceived (Ungerleider and Mishkin, 1982; Goodale, 1993; Goodale and Westwood, 2004). This separation of visual function suggests two anatomically distinct pathways of vision.

24.5.1. Ventral stream

The ventral stream projects from the striate to temporal cortex (Goodale and Westwood, 2004; Barton, 2004). This pathway encodes the enduring characteristics of objects, thereby permitting long-term identification and recognition (Goodale and Westwood, 2004). Whether an artist is drawing in representational fashion or is cul-
ing from the bank of images stored over a lifetime to pro-
duce abstract or symbolic work, an intact ventral stream is needed to perceive these subjects. Visual perception must be able to divorce the spatial placement and metric information from the essential characteristics of the object itself. Damage to the ventral stream produces problems such as agnosia and dyschromatopsia.

24.5.1.1. Damage to the ventral stream—agnosia

Visual agnosia is the inability to recognize an object by sight in the setting of relatively spared vision. Patients lose understanding of the seen object’s context or use (Barton, 2004). In contrast, these patients often identify objects presented to them in a tactile or auditory manner (Barton, 2004).

One 73-year-old left-handed male artist described by sustaining an occipital infarction in the 1970s developed a visual agnosia (Wapner et al., 1978). The deficits suggested by his presentation and initial imaging suggest a deficit mainly in the left occipitoparietal region, in the region of the left posterior cerebral artery and possibly the right posterior cerebral artery (Chatterjee, 2004). The patient was unable to recognize faces and approximately 75% of the inanimate objects presented to him. Without a sense of the meaning of the subject matter, he tended to focus on drawing its details instead of its defining features (Fig. 24.3). He often lost his place while drawing. To compensate, he would describe the object aloud to try and deduce the identity of the object. However, when asked to draw an object he recognized, he no longer maintained the same fastidious attention to detail. Interestingly, despite his stroke, his pre- and postmortem drawings retained the same style. He maintained the same techniques of perspective, shadowing, and texture to copy designs and objects with good accuracy. This patient’s course suggests that his visual agnosia was associated with deficits in visual imagery and visual memory. However, visuomotor and verbal pathways were preserved and activated as part of a compensatory process (Chatterjee, 2004).

There are a number of reports of a double dissociation between visual perception and imagery. One 34-year-old patient who suffered focal cortical damage in the ventral portion of the lateral occipital region (primarily in Brodmann’s areas 18 and 19), also exhibited extreme deficits in visuospatial perception but had relatively spared visual imagery (Servos and Goodale, 1995). She had difficulty recognizing objects when presented as line drawings, but could draw common objects and write the alphabet from memory. Furthermore, the patient reported vivid visual dreams with well-structured objects (Servos et al., 1993; Servos and Goodale, 1995). Another interesting dissociation was the patient’s preserved ability to use perception to make skilled grasping motions (i.e., adjusting her hand to the appropriate width and position).

In two remarkable case studies, Goldenberg and colleagues explored two patients with cortical blindness, one with loss of both visual imagery and visual knowledge (Goldenberg, 1992) and the other with complex and vivid visual imagery in whom visual loss was profound (Goldenberg et al., 1995). The second case strongly suggests that visual imagery can occur independent of an intact primary visual cortex.

Additionally, preservation of visual imagery and visuomotor memory lends theoretical support to the idea of the ventral and dorsal stream as the perception vs. action stream. Based on the relative functional deficits of the patient and her neuroanatomical lesions, Servos and Goodale (1995) suggest the occipitotemporal pathway’s central importance in generating visual images. One SPECT regional cerebral blood flow study lends evidence that visual imagery is associated with increased blood flow in the left inferior occipital and left thalamic regions (Goldenberg et al., 1991). From this case study and other research in monkeys, Servos and Goodale also suggest that the posterior parietal system, the ‘action stream,’ may be further divided into two functional regions. The superior parietal system may
be more responsible for visuomotor control, and the ventral regions more responsible for mental manipulation of objects (Servos and Goodale, 1995).

Taken together, the research suggests that the bank of visual imagery exists separately from visual perception. Theoretically, artists and patients with new deficits in their visual pathways may still produce art from mental imagery. New avenues of research might compare the breadth of visual imagery of people who are blinded at birth or during childhood to professional artists.

24.5.1.2. Damage to the ventral stream—dyschromatopsia

Oliver Sacks, the well known neurologist and writer, describes an artist who developed achromatopsia after brain trauma (Sacks, 1995). Patients with cerebral achromatopsia can suffer deficits in both hue and saturation, viewing the world in shades of gray. Other kinds of disturbance in color perception include dyschromatopsia, or a reduced ability to perceive hue. Some people report seeing the world through a colored filter or see color spilling beyond its object boundaries. Finally, hemiachromatopsia, or decreased color perception in the contralateral hemifield, is typically asymptomatic and therefore underdiagnosed (Zeki, 1990; Rizzo et al., 1993; Merigan et al., 1997).

A few case reports suggest that the ability to imagine color exists separately from the ability to perceive it (Shu-ren et al., 1996; Bartolomeo et al., 1997; 1998). One 63-year-old right-handed man with bilateral infarcts of the temporo-occipital region, affecting the lingual and fusiform gyri, developed a verbal and nonverbal amnesia as well as a significant deficit in color perception. However,
he did well on tasks that required him to name the color of objects with uncommon color associations (e.g., ‘Color of a US postal mailbox?’), compare verbal pairs of colors (e.g., ‘Which has more red in it, plum or eggplant?’), and distinguish the member in a verbal triad with dissimilar color (Shuren et al., 1996). Generally speaking, assessment of a patient’s color imagery, or memory for color, is difficult because common associations exist between certain objects and color (e.g., ‘apples are red’).

As in the story behind visual imagery, the research suggests the existence of both a top-down and bottom-up process for color imagery and perception. The two processes can be dissociated. In most cases, patients who develop achromatopsia are left with a permanent deficit, but most employ compensatory strategies in visual tasks.

### 24.5.2. Dorsal stream

The dorsal stream, running from the striate cortex to the occipitoparietal region, processes spatial relationships between objects (Goodale and Westwood, 2004; Barton, 2004). Because movement requires such visuospatial information, another name for this pathway is the ‘action’ stream. Damage to the dorsal stream produces defects such as akinetopsia (inability to perceive moving objects), despite ability to see stationary ones, optic ataxia (the inability to reach for an object despite being able to see it), oculomotor apraxia (inability to move one’s eyes toward an object despite possessing full range of eye movements and normal visual fields), and simultanagnosia (inability to recognize the whole despite perceiving the details), or a combination of the three, as seen in Bálint’s syndrome (Smith et al., 2003; Barton, 2004).

Artists may use information from the dorsal stream to think about composition, or the placement of an object on the page and its relationship to other objects on the page. Injury to the dorsal stream may decrease the artist’s ability to perceive relationships between objects within the field of view (Smith et al., 2003).

#### 24.5.2.1. Damage to the dorsal stream—simultanagnosia

Simultanagnosia is the inability to process a complex scene, despite being able to attend to individual elements. Neuroimaging suggests that simultanagnosia may be related to lesions in Brodmann’s areas 18 and 19 of the dorsal occipital lobes (Rizzo and Robin, 1990), although prefrontal damage has also been associated with an inability to interpret complex scenes.

In one case study, an 87-year-old artist sustaining a top-of-the-basilar artery embolic stroke, resulting in a posterior circulation defect, developed a simultanagnosia with no associated field deficits or hemineglect. In the immediate period following her stroke, her paintings and drawings of the same flowers-in-vase still life reveal a selective attention to parts of the still life, with less attention given to background. Two years after her stroke, she had made a full recovery and was painting in similar fashion to her premorbid state, incorporating the entire still life and rich background into her work (Smith et al., 2003).

### 24.6. Art in neurodegenerative disease, savants, and migraine

#### 24.6.1. Alzheimer’s disease

The most common form of dementia in the aging population, Alzheimer’s disease (AD), is characterized by deterioration in memory, language, and visuospatial ability (Cummings, 2004). The inability to recognize faces or to read an analog clock represent typical daily deficits that occur from loss of visuospatial function characteristic of AD. In a comparison of thirty AD patients with controls, Mendez and colleagues found that AD patients showed preserved visual acuity and color recognition, but decreased ability to visually recognize common objects and famous faces, make figure–ground distinctions, and evaluate complex figures (Mendez et al., 1990).

The deterioration of AD patients’ drawing abilities is common and has been well-documented (Henderson et al., 1989; Kirk and Kertesz, 1991). Case reports of artists with AD reveal a declining ability to represent subject matter in a representational fashion (Cummings and Zarit, 1987; Espinel, 1996; Crutch et al., 2001; Maurer and Prvulovic, 2004). Without necessarily diminishing in artistic quality, art becomes more abstract. Some of the painter Willem de Kooning’s (1904–1997) most celebrated works were made after the onset of his AD (Espinel, 1996). While difficult to quantify the effect that de Kooning’s illness had on his art, later paintings made during the advanced stages of his AD were composed of formless sheets of color and lines. One of our AD patients, a female artist with particularly prominent right parieto-occipital disease, noted to us, ‘I am no longer interested in form and shape, but colors now fascinate me.’ Artwork, shown in Fig. 24.4, demonstrates the abstract, formless nature characteristic of a patient with AD.

There are several case reports that describe individuals with AD in whom artistic changes, many in the positive direction, were noted. One consideration with these reports is that many of the individuals never had autopsy confirmation of the type of dementing disorder. Similarly, in several reports the dementia is described without consideration of the anatomical correlates of the brain degeneration. Therefore some of these patients
described below may have suffered from frontotemporal dementia or, perhaps, a highly asymmetric left frontally or temporally predominant form of AD.

The self-portraits of London-based professional artist William Utermohlen offer a rare and insightful perspective on the progression of his dementia. His large repertoire of paintings, his wife’s profession as an art historian, and longitudinal neuropsychological testing permit a veridical interpretation of his artistic evolution. Fig. 24.5A, as selected by his wife, represents the style and method characteristic of Utermohlen’s portraiture in his premorbid state. As shown in the series of portraits in Fig. 24.5, perhaps the most striking change was in his visuospatial skills. As most clearly seen in the progression from Fig 24.5A–D, the structure and relative positioning of the features on his face and head become increasingly distorted (Crutch et al., 2001). Such distortion was consistent with his declining

Fig. 24.4. These paintings made in 2002 by one of our female patients with AD demonstrates the abstract, relatively formless style characteristic of the artwork of patients with AD. The progression of AD has been associated with decreased visuospatial function. (Reproduced with permission.)
Fig. 24.5. Series of self-portraits of William Utermohlen as his Alzheimer’s disease progressed. A is typical of his premorbid portraiture style regarding his brushwork, color use, and expression. B and C showed increasing difficulty with spatial relationships, particularly with position of features on the face and head. As a result, his portraits look increasingly distorted. His later portraits become increasingly simplified and abstract, such that E and F carry very few features that permit identification of the subject. (Reprinted from Crutch et al. (2001), with permission from Elsevier.)
visuospatial testing performance and other drawings made at the time. In Fig. 24.6A, for example, a line drawing of a man reveals the awkward placement of two arms from behind the neck. It is of interest that the subject recognized a problem with the sketch, but could not identify what it was.

Stylistically, the subject’s brushwork becomes coarser and simplified through the course of his illness. As a result, his latest portrait Fig. 24.5E, is abstract, consistent with the style of paintings he was creating simultaneously (see Fig. 24.6B). Indeed, the last portrait has virtually no distinctive features helping the viewer to recognize his identity. While the trajectory of his work demonstrates a decline, color remains vivid in his late paintings. Crutch and colleagues also note the remarkable expressiveness of the portraits and the poignant depiction of emotions such as anger, sadness, and resignation (Crutch et al., 2001). Correlating changes in artistic expression with the mood change, agitation, and late psychosis characteristic of the course of the disease (Cummings, 2004) would represent another illuminating avenue of research.

Cummings and Zarit (1987) also report the course of an artist with AD over a 30-month period. Similar to Utermohlen, the patient’s work became more simplified and primitive. His color palette became increasingly restricted and techniques such as shading and perspective lost.

In summary, as these case studies suggest, disintegrating spatial relationships, regression, distortion, and stereotypy characterize the art of progressive AD (Maurer and Prvulovic, 2004). However, there has been one documented example to this rule. Danae Chambers, a British Columbian artist, demonstrated a remarkable preservation of her capacity to paint until very late in the course of her disease. A professional portraitist, she maintained her ability to paint people until eight months before her institutionalization, or when her MMSE score dropped to 8 points. Her preservation of visual working memory, recall, and perception suggest a relative preservation of the right temporoparietal

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**Fig. 24.6.** A selection of Utermohlen’s nonportrait paintings confirm his increasing difficulty with proper spatial relationships and progression toward abstraction. (Reprinted from Crutch et al. (2001), with permission from Elsevier.)
lobes, suggesting a highly asymmetric form of AD with relative sparing of the right hemisphere, or the possibility of frontotemporal dementia (Fornazzari, 2005).

24.6.2. Frontotemporal lobar degeneration

The anatomic subtypes of frontotemporal lobar degeneration (FTLD) provide a window into investigating the neurological basis of the artistic process. Previous case studies of left temporal-variant (semantic dementia) FTLD patients reveal a new preoccupation with art, greater attention to visual stimuli, and increased visual creativity during the early stages of their dementia. In contrast, patients with AD, which typically first affects the posterior parietal and medial temporal areas, show decreased visuoconstructive ability (Miller, et al., 1998; Miller and Hou, 2004). Of interest, creativity in FTLD has been observed in visual art, music, and visual invention, but not in writing or poetry (Miller et al., 2000; Mendez, 2004).

In one series of case studies, left-temporal variant FTLD patients exhibited a newfound interest in art and preferred making representational drawings of landscapes, animals, and people. Abstract or symbolic art was notably absent (Miller et al., 1998; Miller et al., 2000). In another account of a 57-year-old right-handed female artist, her left-sided frontal and temporal atrophy correlated with deteriorating language and social skills but increased creativity in her art-making. Unlike the prior case series, her painting evolved from more traditional landscapes and representational art to freer, more expressive, and abstract forms with the progression of her dementia. (Mell et al., 2003). Finally, a 56-year-old right-handed businessman with no previous interest in art begins painting for the first time with the onset of FTLD. He displayed heightened visual awareness to his environment, especially light and sound, even as his language and behavior deteriorated (Miller et al., 1996).

One of our FTLD patients, a man presenting with behavioral change and memory, language, and executive deficits, developed a newfound preoccupation in making art (Liu et al., in press). His artwork is characterized by the bizarre representation of faces and the resulting sense of disconnection between the subjects in his work (Fig. 24.7). A sense of disinhibition pervades his painting, either through the wild dress of his subject matter (Fig. 24.7A), suggestion of sexual relationships (Fig. 24.7B), or use of profanity in his artwork (not shown). His preoccupation with faces was associated with profound deficits in the ability to recognize emotions in faces and diminished empathy for people and animals. This patient parallels a cohort described by Mendez and Perryman (2003) in whom the face became gradually distorted and ‘alien’ in association with degeneration of the right temporal lobe. These patients with predominant involvement of the right anterior
temporal lobe and distortions of faces and facial emotions in their work demonstrate how the artists’ perceptions of the face translate into their work.

Given these remarkable stories, it should be noted that diminished creativity is more typical of patients with FTLD, suggesting that these case studies are the exception rather than the rule (Miller et al., 1998). Selective involvement of the temporal regions, with relative sparing of the frontal regions, may provide the anatomic rationale for this subset of patients (Miller et al., 2000).

The concept of paradoxical functional facilitation, a term coined by Kapur, explains how dysfunction in one sphere may allow the development of ability in another sphere (Kapur, 1996). For right-handed FTLD patients, the declining influence of the language center, increasing social disinhibition, and relative sparing of the visual systems may permit increased visual creativity (Miller et al., 1998; Mendez, 2004).

Furthermore, the compulsive behaviors commonly seen in FTLD may also play an important role in artistic production, causing patients to obsessively practice and even hone their artistic techniques (Miller et al., 2000). Our patient’s compulsive nature appears to have contributed to his artistic process. Indeed, he manifested compulsive behaviors in other realms, including water intake, eating rituals, and coin collecting. Especially in the later years, he repeatedly painted the same geometric designs on store-bought sculptures and objects twenty to thirty times. Arguably, his increasing compulsion, while causing him to be more prolific, limited the creativity of his artwork (Liu et al., in press).

24.6.3. Hallucinatory states: migraine headaches and dementia with Lewy bodies

Migraineurs have used associated hallucinatory experiences as an inspiration for creative output. Fuller and Gale originally proposed that migraine auras served as the inspiration for the Italian surrealist painter Georges de Chirico (1888–1978) (Fuller and Gale, 1988; Emery, 2004). Indeed, de Chirico’s compositions combine multiple places, reference several periods of history, and are filled with unrelated objects (Bogousslavsky, 2003). In a review of de Chirico’s autobiographical writings, Nicola and Podoll (2003; Podoll and Nicola, 2004) have found the artist’s experiences to be consistent with a history of migraineurs. While the artist reports that his hallucinations have directly influenced his painting, Blake and Landis (2003) argue that these altered states were caused by temporal lobe epilepsy, not migraines. Other painters reported to have suffered from migraines include Georgia O’Keeffe (1887–1986) and Salvador Dali (1904–1989).

Robinson and Podoll evaluated 562 migraineur paintings for body schema disturbances with migraine aura, either macrosomatognosia (enlarging) or microsomatognosia (shrinking) (Robinson and Podoll, 2000). Macrosomatognosia occurred more frequently and tended to affect segments of the body, particularly the head and upper extremities. Microsomatognosia was less common and tended to involve the whole body. Based on these patterns, the authors argue for the existence of an integrative neuronal network mediating whole body perception.

Similarly, hallucinations are a core feature of patients with dementia with Lewy bodies (DLB). There are scattered reports regarding the attempts of patients with DLB to capture the internal state on the canvas (Ebersbach, 2003), including Mervyn Peake (1911–1968), an English artist and writer (Sahlas, 2003). These studies emphasize that artists’ internal experiences are generated through a brain system that is organized to perceive and interpret the world. Release of these internal systems can provide the basis for artistic activity.

24.6.4. Artistic savants

In the 1970s and 1980s, psychologist Lorna Self searched widely for examples of extraordinary visual artistry. She discovered eleven children who demonstrated exceptional ability to render objects in a realistic manner from an early age. Most were mentally handicapped in some way, diagnosed as either autistic or autistic spectrum, and displayed stunted social and language development. One of her savant subjects, Nadia, drew with an extraordinarily sophisticated sense of perspective and manner of mark-making. In addition, while Nadia’s drawings were based on pictures, they were not reproduced in their exact form and could be drawn from memory. Self noticed that the autistic children start drawing objects realistically from a young age. They also called upon a wider range of subjects, tended to exclude humans as subjects, and were obsessive in their choice of subject matter (Howe, 1989).

In contrast to the drawings made by savant children, those by normal children were schematic, rigid, and contained mistakes. Because the ordinary child’s world is structured through language, their drawings are infused with conceptual knowledge. As Edwards claims, ‘The child is dominated not by what he sees but the relationship he or she knows’ (Edwards, 1988). The resulting drawings are more stereotyped. For example, a table drawn with four legs of equal length betrays an understanding of the furniture’s identity, but not its relationship to real space. Conversely, the social isolation that autistic children experience may nurture a direct connection with physical reality that permits them to represent their environment more veridically.
Savants’ focal strengths—in memory, drawing or music—have been emphasized by a few researchers (Treffert and Wallace, 2002; Hou et al., 2000). While still a rare occurrence, savants with artistic skill display exceptional visual memory, coordination, and copying ability. They exhibit a strong preference for a single art medium. Often, they restrict themselves to a narrow range of subjects; i.e., animals or insects but rarely human faces. Snyder and colleagues have attempted to induce savant-like ability by applying transcranial magnetic stimulation to the left frontotemporal brain region. In four of eleven subjects, artistic skills increased following this procedure (Snyder et al., 2003).

24.7. Principles of artistic aesthetics

V.S. Ramachandran has suggested that there are three key visual/physiological principles that drive the human artistic effort (Ramachandran and Hirstein, 1999). The first he calls the peak shift principle which represents the artist’s attempt to capture the visual essence of an object or principle through amplification. As an example he describes the exaggeration of the female form, poise and grace seen in many ancient and contemporary pictures of women. Similarly, the cartoonist will exaggerate unique facial features, thereby capturing more of the essence of the face than an exact copy would. The second principle relates to grouping or binding. Here Ramachandran describes the excitement and pleasure associated with linking disparate colors or shapes into a coherent whole. Here he notes the pleasure of seeing something novel emerge such as a Dalmatian dog initially seen as series of dots. In contrast, the third principle emphasizes using visual attention to isolate a single visual module. Here he emphasizes that a sketch using a few lines can be more aesthetically pleasing than a complete picture that captures every detail of a face or scene. The excessive details would distract from the key visual components, making less more.

The principles elucidated by Ramachandran represent an imaginative attempt to apply the rules of brain organization toward an understanding of art esthetics. In recent years, a field of art criticism has emerged that focuses upon relationships between neuroanatomy, neurophysiology, and artistic production and appreciation. It is evident that Raphael’s madonnas, perfect reproductions of the face and body, activate very different parts of the brain than the sheets of color in a painting by Mark Rothko. Interpretation of facial expression involves an inferior temporal system that projects to the amygdala in the anterior temporal lobe, while color recognition occurs in a posterior cortical visual system. In the case of facial and facial emotion recognition, the right hemisphere is dominant. Conversely, the Dada artist Duchamp intentionally engages the viewer to self-reflect, using strategies that are typical of the dominant hemisphere. He states, ‘All in all, the creative act is not performed by the artist alone; the spectator brings the work in contact with the external world by deciphering and interpreting its inner qualifications and thus adds his contribution to the creative act’ (Harth, 1999).

In addition to the way that the audience perceives an artistic work, there is much to be learned about the way that an artist approaches the creative act. The artist Jackson Pollock produced some of his greatest works in a physical fury, splashing paint onto a canvas while dancing around the canvas. Pollock’s pieces achieved success in part because of his extraordinary athleticism. It is tempting to speculate that Pollock’s motor systems, including his basal ganglia, played a major role in his artistic successes. A surrealistic artist employs images from dreams (or possibly migraines), while a portrait painter like Vermeer translates a static image onto the canvas. Analysis of the artistic process offers insights into the artist and the brain.

Largely neglected by the field of neurology, there has been a recent surge of interest in art and visual creativity. This has occurred along with a renaissance in neuroscience related to visual physiology. Indeed, the field of art and the brain is still in its infancy.

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