Dementia as a window to the neurology of art

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Summary  Art is an expression of neurological function and how it organizes and interprets perception. Recent reports of changes in art performance among patients with frontotemporal dementia have provided an unexpected window to the neurology of art. They confirm that visual art is predominantly in the right hemisphere and suggest a neuroanatomical schema for artistic creativity. The right parietal region is critical for the visuospatial prerequisites of art, and the right temporal lobe integrates and interprets these percepts. The right temporal lobe appears necessary for extracting and exaggerating the essential features of an artistic composition. In contrast, the left parietal region and the left temporal lobe have inhibitory effects on artistic expression through attention to visuospatial detail and semantic labeling, respectively. Frontal-executive functions are also required for artistic expression, particularly right dorsolateral frontal initiation of a network for novelty-seeking behavior. Further study of art in dementia can profitably evaluate this proposed schema for the mechanisms of art in the brain.

Introduction and hypothesis

Brain diseases such as dementia can alter artistic expression. In evaluating the effects of brain disease on art, investigators can discover changes in universal neurological principles of perception and cognitive organization. Neurologists have described a series of patients with frontotemporal dementia (FTD) who manifested alterations in artistic expression in early stages of their dementing illness [1–3]. FTD patients with predominant left temporal involvement have had increased artistic activity, suggesting that a loss of function in the linguistic side of the brain results in an enhancement of visual processing in the intact right hemisphere [2]. In contrast, FTD patients with predominant right temporal involvement have had an alteration in extracting the essential aspects of art [3]. These observations, along with changes in frontal novelty-seeking behavior, suggest an organization for art in the brain and a proposed framework for further investigations.

Neurological impairment and art

Neurological disturbances can alter the quality of art produced by artists. It is well known that famous painters, such as Vincent Van Gogh, have had psychopathology, such as manic-depressive illness and a compulsive focus on their art [4]. It is less well known that some have had neurological diseases. After Willem de Kooning developed...
Alzheimer's disease (AD), his art lost its coherence and became simplified versions of earlier, more complex works [5]. After an illness that caused disorientation with loss of vision and hearing, Francisco de Goya created dark and pessimistic paintings [5]. Goya may have had Vogt–Koyanagi–Harada disease, lead toxicity from his lead-based paint, or a meningitis or encephalitis [6]. The art of Giorgio de Chirico became perseverative and rigid with repetitive copying of very similar paintings or of his own work [7]. De Chirico may have suffered from migraine or, more likely, temporal lobe epilepsy. After Mervyn Peake developed dementia with parkinsonian, his art became geometric and abstract-like with an apparent loss of empathy in his caricature-like portraits [8]. Similarly, brain disease can alter the expression of music. Maurice Ravel, the French composer, developed an FTD-spectrum disorder that disproportionately affected his left hemisphere and language function [9]. Some authors interpret his masterpiece, Bolero, and a later work, Concerto for the Left Hand, as suggesting that music originates from the right hemisphere.

Intriguing information on art and the brain comes from artistic savants [10]. The savant syndrome is the prototype for heightened artistic expression in the presence of neurological impairment. The savant syndrome occurs most commonly in those with autism but it may occur in others with mental retardation or even those who acquire left hemisphere damage early in life. The skills that savants have are based on the right hemisphere and are visual, auditory, or mathematical in nature. Injury to the left hemisphere with language loss may cause the right hemisphere to compensate for this loss, and improvement in their language skills may cause some savants to lose their artistic skills. Savant skills are also based on a remarkable memory, with implicit, procedural learning, and a focused intensity in a restricted set of interests.

Strokes and focal brain lesions can differentially impair artistic expression. Left hemisphere injury, which oversimplifies drawings while maintaining overall spatial organization, does not usually impair artistic skills [11]. Right hemisphere injury, however, impairs the visuospatial arrangement between the parts of the image and devastates the ability to copy, draw, or paint [12]. When asked to draw an object, patients with right hemisphere injury create a reasonable likeness, with all the required details but without the essence of the object or the composition. In the famous Gobin tapestry, Masters of the Spirit, the 68-year-old artist had a right cerebral hemorrhage half-way through the completion of this 16 × 11 foot tapes-

try [13]. Working from left to right, his right-sided figures, drawn after his stroke, became distorted and somewhat bizarre.

Dementia and art

Dementing diseases usually result in a deterioration of artistic productions. AD is the most common form of dementia and, early in the course, predominantly affects the parietal and mesotemporal regions [14]. There is a subgroup of patients with AD who have major complex visual difficulties from posterior cortical involvement [15]. AD results in an abandonment of previous artistic productions in favor of copying previous efforts [5,16]. The art of patients with AD may show abnormal spatial relations between visual features [17]. An apparent reversion to more abstract representations most likely reflects the distortion of the global visuospatial aspects of the image from right parietal involvement. Among other dementing diseases, a patient with corticobasal degeneration with right hemisphere involvement has shown altered art with less realistic, distorted depictions and a loss of the subtle aspects characteristic of his premorbid work [18] (see Fig. 1).

Among the dementias, FTD may be a disorder that can affect the brain in just the right ways to illustrate mechanisms of artistic expression. FTD is a neurodegenerative disease that usually presents in the 50’s with prominent personality changes such as decreased social skills and disinhibition [19,20]. These patients have circumscribed and progressive atrophy of frontal lobes, anterior temporal lobes, or both associated with microvascular changes in superficial layers and astrocytic gliosis [19–23]. Previously described as “Pick’s Disease,” clinicians now refer to this disorder as FTD, because only about 20% have the pathognomonic Pick bodies on autopsy [24]. Converging evidence suggests that FTD is often a “taupathy” from tau protein abnormalities in the brain, sometimes associated with mutations in the tau gene on chromosome 17 [25–28].

Neuroanatomic subtypes of FTD occur early in the disease, when FTD is more localized and asymmetric. There are frontal or temporal and left hemispheric or right hemispheric patterns of degeneration with different constellation of symptoms. About 20% of FTD patients have a “temporal-variant” with predominant involvement of the anterior temporal poles and inferolateral temporal lobes and some orbitofrontal changes [29–31]. Patients with left temporal lobe FTD usually present
with impaired naming, word comprehension, and semantics. Patients with right temporal FTD usually present with socially inept, unempathic, and, occasionally, sociopathic behavior [29].

A number of FTD patients have developed creative activities in early stages of left temporal FTD [1,2]. In one case, a 56-year-old businessman developed a new passion for painting leading to art awards and acknowledgements. In another case, a 51-year-old housewife began painting rivers and rural scenes remembered from her childhood. A 53-year-old man with no prior interest in art developed intense artistic activity, ultimately painting churches and haciendas remembered from his childhood. One FTD patient became a meticulous photographer with the perfectionistic compulsion to “get the angle just right.” An established artist with progressive aphasia associated with FTD developed a freer, emotional, and more impressionistic art style [32]. Creativity in FTD has emerged in other forms of expression including music, mechanics, and mathematics but, notably, not in verbal areas such as writing and poetry.

Some patients with right temporal lobe FTD have manifested a completely different change in artistic expression [3]. Alterations in the facial drawings of these artists suggest a perception of others as less human and more alien. Similar to the later work of Mervyn Peake, these patients have demonstrated a lack of empathy for persons in caricature-like drawings [8]. These changes indicate a qualitative alteration in the derivation or interpretation of the essential features and essential “humanness” of their drawings and caricatures [3].

Figure 1  Caricatures of others made by a patient with probable right temporal predominant frontotemporal dementia. His premorbid caricatures (1a) were less menacing and more representative than those made at least two years into his illness (1b).
Visual processes in art

These subsets of temporal-variant FTD patients offer a unique opportunity for clarifying the neuroanatomical and neuropsychological schema for artistic creativity. Normally, the brain reassembles separate visual features beginning in the visual cortex [33]. These features, which include the appreciation of shapes, forms, colors, contours, contrasts, and movements, must be spatially organized into prerequisites necessary for the appreciation of art. Visuospatial organization relies heavily on the parietal cortex or “dorsal visual stream” involved in figure-ground discrimination and Gestalt principles such as proximity, similarity, continuation, and closure. The parietal region also participates in the temporal integration of the image through exploratory eye movements and scanpaths.

The next step in visual processing requires integration and interpretation of the visual image. The visual elements must be organized into coherent and meaningful scenes, a process that differentially occurs in the right temporal lobe [34]. Visual artists must have the ability to interpret perspective, brightness and other constancies, and the influence of context. Art appreciation especially demands a sense of balance, proportion, symmetry, and an estimation of the center of gravity of a picture. Artistic sense also includes visual rhythm and movement, the order of the image, and other kinetic aspects [35]. Some of the higher interpretative aspects involve visual illusions, visual metaphors, and perceptual problem solving [36,37]. The schema proposed here suggests that temporal lobe functions predominate in these interpretive, as well as integrative, processes.

An essential aspect of artistic expression is a process that sums up the essence of a composition and exaggerates its features [37,38]. There is an active search for constants as we evaluate the salient and most pronounced features with the goal of abstracting visual constructs and visual order. This process results in the storages of idealized representations or prototypes of visual objects or scenes. In isolating the key aspects or essence of a composition, however, we inevitably distort the image [33]. As in caricature, there is an enhancement of features that deviate from some sense of normality or average “anchor point” [37,38]. Our preconceptions of how things should appear and be organized heavily influence this process. Ultimately, this process forms part of a “recognition network” in the midtemporal and temporopolar cortices which is particularly lateralized on the right [39,40].

Interhemispheric effects on art

Much data indicates that the intuitive artistic sense is in the right hemisphere. The right hemisphere is oriented to visuospatial abilities, geometric patterns, mental rotation and imagery, familiar faces and places, and realistic art. The left hemisphere is oriented to language, analytic thought, and the assignment of meaning to visual scenes, especially when the obvious meaning appears absent as in surrealistic art [41]. In directed attention tasks, attention to the overall global picture activates the right lingual gyrus whereas locally directed attention to focal details of a scene activates the left inferior occipital cortex [42]. The right parietal lobe processes these global features of a complex stimulus array and its relative spatial relations, and the left parietal lobe performs a detailed visual analysis [43]. Moreover, the right frontal lobe is involved in novelty-seeking and spontaneous non-verbal productions, whereas the left frontal lobe exerts control over verbal analysis [44,45].

Cognitive and behavioral studies support the concept of a predominant right hemisphere role in artistic abilities. Disturbances in the perceptual integration of scenes occurs from right lingual area injury [34], and creative subjects have significantly more right than left parietotemporal electroencephalographic activity [46]. On personality measures, creativity is associated with a preference for broad, global ideas and unusual perceptual experiences, attributes generally lateralized to the right hemisphere [47–49].

Functions in the left hemisphere may inhibit or override the artistic abilities of the right hemisphere. In normal subjects, inhibitory and excitatory mechanisms probably interact in a complex harmony reflecting a “paradoxical functional facilitation” [50]. In “split-brain” or corpus callosotomy patients, Bogen and Bogen observed that a major obstacle to high creativity was left hemisphere inhibition of right hemisphere functions [51]. In addition, decreasing left hemisphere semantics or meaning enhances drawings, as exemplified by the improved copying of portraits when they are presented upside-down [52]. The gradual loss of semantics for words and objects may promote alternative expressions through the search for the essential features and order in visual art. For example, a left frontotemporal epileptic focus has resulted in the impulsive initiation of drawing as electrical depression affected language functions in the left hemisphere [53].
Most FTD patients with enhanced creativity have had asymmetrical left anterior temporal dysfunction and poor verbal skills [54]. With left temporal FTD, semantic memory is impaired [55,56], and basic perception, such as the intensity of visual images, may be increased [1]. Among FTD patients, predominant degeneration in the left anterior temporal lobe appears to enhance critical right hemisphere functions causing heightened activity in right temporal areas of the brain.

Some right temporal FTD patients, on the other hand, have had a distortion of extraction of the essence of a drawing [3]. Their caricatures are a reflection of what they see as the essential or emphasized features of a face [37]. The drawings of artists with right temporal FTD have evolved to focus on menacing, morphed, or skeleton-like features. The essential, emphasized features of the faces grew more bizarre or "alien" as their disease progressed, consistent with a qualitative distortion in determining the essence of the individual being portrayed.

Other cognitive functions

The expression of art necessitates the preservation of memory and select frontal-executive abilities. Sparing of working memory [57] and episodic memory [55] characterize the temporal-variant of FTD, and the relatively intact frontal lobes, responsible for complex thought and planning, allow patients to plan and execute their art. High creativity is correlated with high cerebral blood flow in prefrontal regions [44]. Cognitive mobility, tolerance of ambiguity, and capacity to easily change set are other prefrontal functions that are required for creative art.

The frontal lobes are involved in a network responsible for novelty-seeking and detection [58–60]. Fundamental to creativity are "novelty functions" such as the ability to think unconventionally, use divergent thinking in open-ended situations, and be open to new experiences and innovation [47,61]. The dorsolateral frontal region initiates a distributed neural network that is engaged in novelty detection and recruits posterior cortical areas for processing of novel events. Orbitofrontal cortex, hippocampus, and parahippocampal gyrus are involved in this novelty network, and the anterior cingulate gyrus is involved in monitoring novelty detection. If the novel event is sufficiently engaging, posterior cortical and temporal regions are recruited for further processing. Novelty may be managed by the right frontal lobe [62], and a disproportionate functional prevalence of the right over the left frontal lobe, as in left temporal FTD, could lead to a "release" of novelty-seeking in art.

Compulsive features of FTD can contribute to emergent creativity [2]. In general, a rigid focus, as well as perseverance and meticulousness, are features of artistic creativity [61]. Compulsive-like behaviors are common presenting symptoms among FTD patients and include repetitive motor routines, counting, checking, collecting and hoarding objects, and rituals involving singing the same songs, oral behaviors, unusual toileting behavior, and others [63,64]. Compulsive-like behaviors can manifest as repetitive artistic behavior [63]. In a well-characterized case report of an artist with FTD, an obsessive interest with frequent repetition of the creative activity was a definite factor in the development of her art [2,32].

Conclusions

A subset of patients with FTD and emergent creativity offer a unique opportunity for unraveling the underlying neurological basis of artistic ability. Art does not represent objects as they appear to the eye but, rather, reflects basic neurocognitive mechanisms and interpretations. An evaluation of temporal-variant FTD patients implicates a release of right hemisphere artistic abilities associated with the loss of left hemisphere semantic abilities. These patients also suggest that the extraction and exaggeration of the essence of art occurs in the right temporal lobe. Additional unique features, such as disinhibited novelty-seeking and rigid compulsivity may contribute to the expression of artistic creativity. Further investigations of this proposed schema could help clarify whether, ultimately, we are all latent savants, kept in check by the constant analytic labeling and attention to visual detail imposed by our left hemispheres.

References


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