Brain, Behaviour and Cognition Series

NEUROPSYCHOLOGY OF ART

NEUROLOGICAL, COGNITIVE, AND EVOLUTIONARY PERSPECTIVES

SECOND EDITION

DAHLIA W. ZAIDEL

A **Psychology Press** Book

ROUTLEDGE

NEUROPSYCHOLOGY OF ART

Fully updated, the second edition of *Neuropsychology of Art* offers a fascinating exploration of the brain regions and neuronal systems that support artistic creativity, talent, and appreciation. This landmark book is the first to draw upon neurological, evolutionary, and cognitive perspectives, and provides an extensive compilation of neurological case studies of professional painters, composers, and musicians.

The book presents evidence from the latest brain research, and develops a multidisciplinary approach, drawing upon theories of brain evolution, biology of art, art trends, archaeology, and anthropology. It considers the consequences of brain damage to the creation of art and the brain's control of art. The author delves into a variety of neurological conditions in established artists, including unilateral stroke, dementia, Alzheimer's disease, Parkinson's disease, and evidence from savants with autism.

Written by a leading neuropsychologist, *Neuropsychology of Art* will be of great interest to students and researchers in neuropsychology, cognitive psychology, neuroscience, and neurology, and also to clinicians in art therapy.

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Neuropsychology of Art: Neurological, Cognitive, and Evolutionary Perspectives, Second edition
Dahlia W. Zaidel

NEUROPSYCHOLOGY OF ART

Neurological, Cognitive, and Evolutionary Perspectives

Second edition

Dahlia W. Zaidel

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Dedicated to the memory of Roger W. Sperry, Nobel Laureate, scientist, and artist

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BRAIN, BEHAVIOUR AND COGNITION

From being an area primarily on the periphery of mainstream behavioural and cognitive science, neuropsychology has developed in recent years into an area of central concern for a range of disciplines. We are witnessing not only a revolution in the way in which brain-behaviour-cognition relationships are viewed, but also a widening of interest concerning developments in neuropsychology on the part of a range of workers in a variety of fields. Major advances in brain imaging techniques and the cognitive modelling of the impairments following brain injury promise a wider understanding of the nature of the representation of cognition and behaviour in the damaged and undamaged brain.

Neuropsychology is now centrally important for those working with brain-damaged people, but the very rate of expansion in the area makes it difficult to keep up with findings from the current research. The aim of the Brain, Behaviour and Cognition series is to publish a wide range of books that present comprehensive and up-to-date overviews of current developments in specific areas of interest.

These books will be of particular interest to those working with the brain-damaged. It is the editors' intention that undergraduates, postgraduates, clinicians and researchers in psychology, speech pathology and medicine will find this series a useful source of information on important current developments. The authors and editors of the books in the series are experts in their respective fields, working at the forefront of contemporary research. They have produced texts that are accessible and scholarly. We thank them for their contribution and their hard work in fulfilling the aims of the series.

Chris Code and Glyn W. Humphreys
University of Exeter, UK, and University of Birmingham, UK
Series Editors

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PREFACE TO THE FIRST EDITION

The artist's studio, regardless of its location and time in history, is a natural laboratory for neuropsychology and neuroscience. Unlike the deliberate theory-driven stimuli created in scientific laboratories for the purpose of deriving models of behavior and the mind, artists often create their works spontaneously, their productions reflecting the mind in the brain in a natural setting. Art expression is by and large unique to humans and, basically, no different from language expression in the sense that both represent diverse communication forms each with potentially infinite combinations. At the same time, neuropsychological evidence from artists with brain damage suggests that the two forms are not necessarily related, that is, language can become severely affected in a given artist following damage while art expression is only minimally or not at all affected. This in turn raises the possibility that at the dawn of human brain evolution, language and art were not that closely intertwined. In the absence of fossil and archaeological evidence to the contrary, this still remains an open question, and one that will always be difficult to resolve. In the evolutionary scheme of things art could have developed earlier than language, preceding it not because of its non-verbal format, but because of its symbolic, abstract, and communicative value; alternatively, art making and language could have emerged slowly, and in parallel, in the same evolutionary window. The emergence of both modes of communication likely relied on pre-existing biological mechanisms and neuroanatomical arrangements that supported cognitive abstraction, something that probably took millions of years to evolve.

This book is intended for neuropsychologists, neuroscientists, neurologists, psychologists, anthropologists, archaeologists, artists—advanced students, clinicians, researchers—anyone working with or who is interested in the human brain, brain damage, and the relationship between art and brain. It discusses both visual and musical arts.

There are no specific neuropsychological tests that measure the essence of art or its unique features, whereas there are numerous tests that measure neuro-components of language, and other types of cognition, and their localization in the brain. We know only a few of the equivalents of "words" and "grammar" in art although we are able to derive meaning from art without being aware of its vocabulary and syntax. In the visual arts, for instance, the vocabulary is based on forms, shapes, and patterns that are represented with angles, perspective lines, convergence, vanishing points, overlap, light–dark gradations, illusory depth, canonical views, embedding, texture, medium, colors, shadows, edges, and much more. These examples name but a few of the alphabetical primitives in the visual arts, and they do not all have ready interpretations within existing neuropsychological tools or models. Clarifying the relationship between art and brain has not been top priority in neuroscientific research, despite the enormous intellectual appeal inherent in the relationship; it is barely in its initial stages of scrutiny. Moreover, the significance of the full artistic composition, as a whole, lies in interpreting the cultural (and ecological, environmental) context in which the art is produced and is experienced. An interdisciplinary approach to the neuropsychology of art is thus essential.

The core of neuropsychology has been built from investigations of neurological patients with localized brain damage. However, neuropsychological and neurological reports of artists with brain lesions are rare, commonly not empirical, and are published by non-artists. In the majority of those published cases, little information is provided for the immediate post-damage period, to say nothing of the ensuing few months, and hardly any empirical data are provided; the reports are based predominantly on observations. With the famous artists, there could have been an incentive not to hold on to documentation of initial attempts at art production particularly when preserved art skills emerged subsequently with time. Documentation of very early works could be extremely useful and revealing for neuropsychology, even if complicated by the immediate neurophysiological reactions in the brain to the damage. The best that neuropsychologists can do with the data is be guided by existing neuropsychological principles (derived and gleaned from non-artists) that tap known components of general perception and cognition. Exploration of art following acquired neurological brain disorders in established artists, in artists with congenital brain disorders, and in artists with sensory deficits, helps build up a broad elucidation of the relationship between art and brain. All of this is attempted in this book.

Neuropsychologists have traditionally separated sensory deficits from central impairments in order to be sure that the behavior under study is due to brain rather than to sensory damage. Sensory issues that are not clarified muddy the neuropsychological picture. For this reason, clarification of any sensory deficits in artists further informs the relationship between neuropsychology, the brain, and art. It is particularly important not to ignore deficits in vision and hearing in a field as little explored as this. For example, in assessing central control of visual art, eye health has to be taken into account, either explained or ruled out. Exploring the nature of art from its early beginning hundreds of thousands of years ago through

its development and multi-formed practice, as is done in this book, enhances the potential for insights into art's neural substrates and propels the extraction of meaningful patterns. An understanding of the neuropsychology of art requires an interdisciplinary approach: combining such diverse fields as neuropsychology, neurology, and psychology with art history, anthropology, archaeology, and evolutionary and biological theories means talking about some basic essentials of these fields and creating a knowledge base for the reader. In addition, society's preoccupations and expectations at the time of production are invaluable for obtaining a judicious perspective on the art. In the dawn of human evolution, habitat, climatic conditions, terrain, predators, food sources, and more, all played roles in what could be produced by way of art.

The literary and written arts are not examined in depth in this book simply because neurological cases of literary artists are exceptionally rare. They have ceased to produce (artistic works) following left hemisphere damage [the second edition of this book illustrates otherwise], and no published cases with right hemisphere damage from the literary arts are known to me. Unlike the visual and musical arts, in the production aspect of the literary arts artists rely heavily (perhaps even principally) on the workings of the left hemisphere. Any role that the right hemisphere might have in these arts is little explored and is uncertain, largely because of a paucity of relevant neurological cases. While there is continuing debate on the components of language to which the right hemisphere contributes (e.g., jokes, humor), in the normal or damaged brain, there is wide agreement on the main specialization of the left hemisphere in language functions (see end of Chapter 1 for discussion of aphasia and laterality). Consequently, for now, it is difficult to meaningfully explore the ways in which brain damage fragments elements of literary writing and the whole cognitive and creative thinking that goes into it.

Both the visual and musical arts are explored here; more discussion is devoted to the former than to the latter. The elements that enter into artistic productions in the artist and the reactions to them by viewers are important. Questions about the neural substrates of art (neuro-components) have been a source of deep fascination in diverse and wide scholarly and scientific fields. Neurological evidence from brain-damaged artists is critical, even if such cases are relatively rare, because ultimately the damage breaks behavior into units that help shed light on the artist's brain and cognition. Extracting and distilling the post-damage artistic behavior in order to formulate a unitary theory of the neuropsychology of art can, however, be complicated by lack of uniformity in the behavior.

I discuss the visual and musical arts against the background of early human beginnings and the biological origin and significance of the practice of art, as well as the effects of brain damage on art productions by established artists. I consider, too, special groups of artists such as autistic visual savants, and dementia patients. I examine the relationship between art and functional localization in the brain, hemispheric specialization, handedness, the health status of the eye, neurocognitive abilities and the brain, stored concepts in long-term memory and experience, emotions, film (cinema), colors, talent, creativity, beauty, art history, and relevant

neuropsychological issues. The bottom line in art production is talent, an elusive, ill-defined attribute, which, considering the evidence presented in this book, may be diffusely represented in the brain and thus explain preservation of skills and creativity despite neurological damage.

A major brain and behavior organizing principle in neuropsychology is hemispheric specialization. Empirical studies have supported the widely accepted notion that the two hemispheres are distinguished by characteristic cognitive and thinking computational styles: the left hemisphere, besides its main language specialization, applies a detailed, attentive, piece meal, analytic, and logical computational approach whereas in the right hemisphere, computations are assumed to be done according to global, wholistic, or gestalt strategies. However, there is no strong evidence to support an early theory that the right hemisphere specializes in art (production or appreciation), in creativity, or in music, more than the left hemisphere. That the right is the creative and artistic hemisphere is an old notion originally formulated only as a working hypothesis in left–right hemispheric research. The ensuing years did not support that early hypothesis. Unfortunately, the hypothesis became a statement with no verified basis. It is highly likely that both hemispheres modulate many human perceptions and expressions through functional specialization and complementarity, and this includes art, creativity, and emotions.

Moreover, as will become clear by reading Chapters 2 and 5, brain damage, whether unilateral or diffuse, does not lead to creation of brand new artistic styles but rather to adjustments to the motoric or sensory consequences of the damage (see introduction to Chapter 2 for artistic style definition). An artist dedicated to abstract expressionism, an art style devoid of realistic figurative forms, does not begin to depict representational forms following brain damage; pre-morbid specialization does not swing into a diametrically opposite mode of representation. Changes in techniques can and do occur, however. Artistic talent and skills remain preserved despite ravages of brain damage, regardless of laterality or etiology.

Chapter 1 is an overview; it introduces the major issues that need to be considered in discussing the neuropsychology of art and imparts a backdrop for further discussions in the following chapters. Chapter 2 describes specific established professional visual artists with acquired brain damage due to unilateral stroke, as well as art in slow neurodegenerative diseases that compromised both hemispheres. Functional compensation and reshaping of neuronal substrates contribute to post-damage production, and these reorganization issues are covered. Chapter 3 discusses vision and color perception at the level of the eye as well as the brain, and discusses the effects on art of sensory alterations in vision, and damage compromising visual processing areas in the brain. This chapter also describes eye diseases and problems in specific established artists. Chapter 4 combines discussion of autistic savants and those with frontotemporal dementia. Highly skilled visual autistic artists demonstrate functional separation in the brain between two modes of communication, language versus art, and they contribute to an understanding of brain and art by what is absent (or severely compromised) in their art. The issue of emerging artistic productions in non-artists with dementia is discussed in terms of functional

compensation, neuronal re-wiring, and the serial lesion effect. Chapters 5 and 6 cover music. Chapter 5 focuses on established composers with localized brain damage and those with neurodegenerative diseases. As with the visual artists, such cases are extremely rare. Well-known composers with neurological disorders caused by syphilis and other causes are described and explored as well. Chapter 6 progresses to musical performers and amusia, and very recent findings from fMRI and other neuroimaging experiments designed to determine cortical localization of aspects of music listening. Chapter 7 emphasizes many known concepts from neuropsychology of perception and cognition, gleaned over the years from non-artists that enter into visual art production and art observation. The role of the right hemisphere in drawing and space perception in pictures is essential for gaining an understanding of the neuropsychology of art. Consequently, the development of illusionistic depictions of depth in the history of Western art is covered here. Chapter 8 concentrates on drawings in patients with various etiologies of brain damage and describes the syndromes of hemi-neglect and simultanagnosia. Chapter 9 is a discussion of beauty and its depiction in visual arts (including film), pleasure in art, and emotions as pertaining to art. Empirical studies of brain activity in these three areas are described, even as there is a remarkable dearth of such studies. The relevance of the reward system to pleasure is argued and explored. Chapter 10 intensifies and expands the discussions in the previous chapters by reviewing issues of human brain evolution, early emergence of art, archaeological finds, and the biology of art, both visual and musical. Animal displays in mate selection strategies are juxtaposed with the display and purpose of human art, bringing ethological observations into the discussion. The relevance of early emergence of symbolic representation to writing and pictures is also explored. Chapter 11 examines some important issues in the neuropsychology of creativity, of talent, and clues to talent from special artists (autistic savants and dementia patients). The main inferences from the lessons of art in established artists are offered in the ending sections. Chapter 12 offers conclusions and directions for future research in the neuropsychology of art. At the end of each chapter (save for 12) there is a list of additional readings. A subject index and an author index are provided at the end of the book.

Ever since I first used art works as stimuli in neuropsychological experiments, I became fascinated with the mind of the artist and its underpinning in neuroanatomy (Zaidel, 1990). Creating tests in the laboratory in order to explore behavior based on a theory is highly controlled by scientific rules and conventions so that valid, reliable, repeatable data can be obtained. René Magritte, the Belgian Surrealist painter, created art works that were similar to my laboratory-created stimuli, only they were more imaginative, more daring in violating physical and logical rules of the real visual world. The distortions were relevant to my work at that time. Wanting to gain additional insights, I used them to supplement and enrich my research and have continued to use art works as stimuli in subsequent experiments designed to determine hemispheric roles in art (Zaidel & Kasher, 1989). Not being an artist, but a lover of art, this approach to science allowed me to enjoy and wonder about art in a scientific laboratory setting.

I would like to thank Hana Jung for preparing some of the illustrations, Christina Kyle for general assistance, Stanley Schein and Jim Thomas in my psychology department for discussions of color vision, Ross Levine for many suggestions that improved parts of the manuscript, Andrea Kosta for extensive discussions, comments, and suggestions, and Chris Code for invaluable feedback on versions of the manuscript.

Dahlia W. Zaidel
University of California, Los Angeles, 2004

PREFACE TO THE SECOND EDITION

Interest in brain and art has continued to grow and be of wide interest to laypersons and scholars in all fields, not just neuroscience, neurology, neuropsychology, cognitive psychology, art, and philosophy. The 10 years since the publication of the first edition of this book have seen major growth in several art and brain fields, a growth that seems to increase unabated. Additional relevant neurological cases of visual, musical, and literary artists with unilateral and diffuse brain damage due to dementia have been published, and most are described here. They confirm some previous conclusions appearing in the first edition and they help shed wider light on the brain's underpinning of art production. Aesthetic reactions to art through functional neuroimaging, now considered the field of neuroaesthetics, have been published in increased numbers and relevant new studies are summarized in this edition.

The approach taken in this book continues to be that brain damage fractionates cognition and behavior in ways that enable insights into the organization of the mind in the brain. Of special interest here is the production of art and its underpinning in the brain. The major distinction between the production and reaction to art is that the former is studied with reference to brain damage in artists while the latter is studied principally in healthy subjects through their reactions to art works. With dance, for example, the majority of published studies deal with healthy subjects and their reactions to viewing the art. Evolutionary perspectives can help expand our understanding of how the brain controls the production and viewing of art, and such scholarship continues to be part of the discussions presented here.

Several new topics and sub-sections have been added, others were elaborated upon with new insights and data, and many were expanded, updated, and explored further. Literary artists with brain damage have now been included and the dance

arts have been addressed as well. In all, the present edition of the book is a revised and expanded edition, citing and updating new data material when applicable. I hope this edition will continue to inspire new scientific discoveries and scholarly discussions on art and brain.

Dahlia W. Zaidel
University of California, Los Angeles, 2015

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APPROACHES TO THE NEUROPSYCHOLOGY OF ART

Introduction

Beginning in the mid-nineteenth century, with the establishment of an association between language and brain regions within the left cerebral hemisphere, there has been a trend in neuropsychology to link specific behaviors with discrete regions of the brain. This has largely been accomplished through studies of fractionated cognition following acquired brain injury in neurological patients. The neuroanatomical location of the damage, together with the consequent behavioral breakdown, opened windows on mind–brain associations, particularly those involving language, perception, knowledge, concepts, problem-solving, memory, motor skills, personality, and what are generally considered to be higher cognitive functions. The linking with the brain assumes that the components of the behavior in question are defined. By contrast, the association between art production and brain has proven difficult because art's components are elusive. What abilities of Michelangelo's mind went into painting the Sistine Chapel or sculpting *Moses* or the *Pietà*? What in Monet's mind controlled his water lily paintings, or in Gauguin's his *Ancestors of Tehamana* painting, or in ancient artists' paintings on the cave walls at Lascaux and Altamira? Similarly, what were the components of Verdi's mind when he composed *Aida*? And what brain mechanisms were at work in the great plays, poems, novels, and ballets that continually remain sources of attraction and fascination? The answers to some of these challenging questions can be explored with the perspectives of neuropsychology.

While practically everyone can learn to speak and comprehend language at an early age, only a select few in modern Western society can create art with qualities that elicit aesthetic reactions and appreciation universally for many centuries and even several millennia. The compositions of such artists seem to incorporate special and unique abilities. Neuropsychological methods, neuroimaging techniques,

and physiological recordings provide only a partial view into the "neuro-map" of art production. To gain further clues and insights we need to uncover deeper roots and wider perspectives on the nature of art. We need to consider the life of early humans, their immediate ancestors, the evolution of the human brain itself as well as evidence and discussion from diverse fields such as archaeology, evolutionary biology, anthropology, sexual and mate selection in nature, the fossil record, and ancient art.

Symbolic and abstract thinking is the hallmark of human-unique cognition, and it is only humans who create art spontaneously. Interestingly, despite the fact that anatomically modern humans first surfaced around 200,000 years ago, in Africa, hardly any archaeological evidence for art is associated with them. There is, however, evidence linked to expressions of symbolic cognition in configurations and organization of early human living sites (Wadley et al., 2011), and to earlier trickles of art-relevant expressions from Africa (McBrearty, 2007; McBrearty & Brooks, 2000). The influx of visual art began to emerge only around 45,000 years ago, and this happened in Western Europe (Bahn, 1998). What determined the change from trickle to abundance? Any changes in the morphology of the human brain could not have been sudden. The underlying neuroanatomy and neurophysiology evolved slowly, well before that "abundant" period (Lieberman, 2015). Other conditions coalesced to explain the influx of art productions. This topic is covered in Chapter 10.

The relationship between art production and the brain needs to be charted through the study of artists with localized, focal brain damage. The relationship could benefit a great deal from exploring deficits as well as artistic patterns in established artists after they have sustained the damage. Documentation of their artistic endeavors post-damage helps reveal aspects of the anatomical and functional underpinning of art and brain. The effects of dementing diseases on artists are enormously useful in this regard and such cases are described and discussed (Chapters 2 and 4).

Not all of the arts can be covered in this book. Neurological disorders have been described and published predominantly in visual and musical artists, and to a lesser extent in the writing and dancing arts (Chapter 2). Dance choreography, in particular, is hardly ever treated in the context of neurological brain damage; the one exception known to me is Agnes de Mille, who suffered a stroke, and a description of her case is in Chapter 2. Dancing has been studied a bit more extensively in the context of the aesthetic reaction to it (covered in Chapter 9). Much of what is known about dance and brain activation comes from healthy subjects, and not from the fractionation of behavior following brain damage. Thus, the visual and musical arts dominate the explorations here.

Definitions and purpose of art

What is art? For the most part, art does not seem to have a direct utilitarian or obvious biological purpose, and, yet, it includes paintings, drawings, sculptures, pottery, jewelry, music, dance, theater, creative writing, architecture, film (cinema, movies),

photography, and many additional formats. The list is long. A myriad of examples of art works throughout the world complicates the imposition of clear-cut, precise, or logical boundaries on art as a category of human creation. By and large there seems to be a consensus that art is a human-made creation that communicates ideas, concepts, meanings, and emotions, and in this regard it has a social anchor; that art represents human-unique talent, skill, and creativity; and that art gives rise to aesthetic response.

Indeed, the wide range of possible human activities that express art is described by anthropologist Ellen Dissanayake (1988):

> Perhaps the most outstanding feature of art in primitive societies is that it is inseparable from daily life, also appearing prominently and inevitably in ceremonial observances. Its variety is as great as the kinds of lives (hunting, herding, fishing, farming) and the types of ritual practices (ceremonies to ensure success in a group venture or to encourage reunification after a group dissension; rites of passage; accompaniments to seasonal changes; memorial occasions; individual and group displays). All these may be accompanied by singing, dancing, drumming, improvisatory versification, reciting, impersonation, performance on diverse musical instruments, or invocations with a special vocabulary. Decorated objects may include masks, rattles, dance staves, ceremonial spears and poles, totem poles, costumes, ceremonial vessels, symbols of chiefly power, human skulls; and objects of use such as head rests or stools, paddles, dilly bags, pipes and spear-throwers, calabashes, baskets, fabric and garments, mats, pottery, toys, canoes, weapons, shields; transport lorry interiors and exteriors; cattle; manioc cakes and yams; or house walls, doors, and window frames. Songs may be used to settle legal disputes or to extol warriors as well as for lullabies and the expression of high spirits. A large part of the environment may be rearranged and shaped for initiation or funeral rites; theatrical displays may go on for hours or days. There may be painting on a variety of surfaces (ground, rock, wood, cloth); piling up of stones or pieces of roasted and decorated pork; considered display of garden produce; body ornamentation (tattooing, oiling, painting). Many of these occasions for art have counterparts in the modern developing world.
>
> *(Dissanayake, 1988, pp. 44–45)*

As this description shows, art can be many things. We in Westernized societies typically think of art as something viewed in museums or seen in the theater or heard in a concert hall or read in a book. By comparison, the list of artistic expressions provided by Dissanayake demonstrates the motivation, need, and drive as well as the capability that humans possess to create boundless expressions of art. Language, the prime example of the human mind, is characterized by its combinatorial power and infinite potential to create units of meanings through vocabulary, syntax, and prosody. In this regard, art and language share the same human cognitive endowment, namely symbolic and abstract thinking. Art can be infinitely combinatorial, too. It

should thus not be surprising that the art of many human societies is nearly limitless in creativity and skill.

Why do humans create art?

Neuropsychological understanding of art must consider early artistic expressions in the course of human evolution (discussed in Chapter 10). The early art forms provide windows onto further insights. An underlying assumption concerning the beginnings is that biological mechanisms were in place to support cognitive abstraction; both art and language are modes of social communication that rely on abstract expressions. The artist and the viewer need to share the same neural substrates in order for abstract concepts to be communicated. Some ancient creations consist of only a few engraved lines grouped to form a simple pattern while others are complex and detailed depictions; similarly, some incorporate colors while others do not. These are all considered to be expressions of symbolic thinking. Prehistoric surviving art rarely depicts stories in scenes, emphasizing instead individual objects such as animals, faces, hands, single dots, figurines, or geometrical shapes. Perhaps, however, the grouping of the individual figures meant something specific in those early societies. Modern viewers ponder even the simplest depictions, attempting to interpret and explain them, whether accurately or not. These attempts reflect the fact that art is a communicative system between artist and viewer. Art is meant for human consumption, to be understood and interpreted by observers whose minds are equally shaped by the brain that houses them.

Regardless of the true reasons behind painting animals on cave walls in prehistoric Western Europe, the caves' ancient occupants could have experienced an aesthetic reaction not unlike our own as we view these "galleries" nowadays. The driving force behind the depictions could have been social and symbolic, and the satisfaction of viewing symbolic objects could have been purely intellectual (we derive satisfaction from ideas). While artistic expression is broad, and as limitless as language, it is nevertheless a cognitive characteristic of the human brain. The aesthetic response to art seems to cut across human epochs, cultures, mediums, and art styles.

The fact that the practice of art is ubiquitous in all human societies supports the notion of the common origin of *Homo sapiens* and certainly points toward shared mechanisms for brain and cognitive growth. European artists around the beginning of the twentieth century were greatly influenced by Polynesian and African art. The fact that they were drawn to art from non-Western cultures, incorporated their forms and designs, and, under its influence, willingly changed their own artistic style of representation, illustrates the universal communicative value of art (Snapper, Oranç, Hawley-Dolan, Nissel, & Winner, 2015). Unlike language, which needs to be learned in order to be understood, works of art produced by talented individuals trigger reactions in any and all viewers with no prior training required. Still, the symbolic aspect of language and of representation in art share a common form of cognition unique to humans. Although the two forms of expression take

separate routes in what they accomplish and in the effects of their communication, it can nevertheless be said that, with the possible exception of the bowerbird (an avian species known for designing and building complex architectural marvels), only humans create art spontaneously. Since only humans have elaborate syntax and a rich vocabulary, it is only logical to assume that the communicative nature of art has neuroanatomical underpinnings, too. The benefit of communicative systems is that they promote survival through social bonding, and this in turn maximizes survival of the group.

Early beginnings of art production by humans

Neither humans nor animals can construct anything unless their physiological reality permits it. This applies both to brain and body development. The developmental course of the brain after the anatomically modern humans emerged from Africa approximately 100,000 years ago (or maybe even earlier, according to some views; see Mithen & Reed, 2002) was predicted by its neuronal flow-chart. But actual art (symbolic, representational, and nonfunctional) appeared in substantial quantities in Western Europe much later, as mentioned above. From a purely biological perspective, it is hard to conceive that new neurotransmitters and extensive new neuronal pathways with new relay nuclei and projections had abruptly emerged in the brains of *Homo sapiens* whose art managed to survive compared to those anatomically modern humans whose art did not survive. Rather, it is more reasonable to assume that the development was a gradual adaptation to the environment, one where symbolic cognition led to successful survival (see Chapter 10).

Possible reasons for the emergence of consistently produced art are speculative. In one scenario, possible factors could lie more in the reality of the environment in which early humans found themselves than in any sudden major changes in their brains. Some environments are friendlier than others, meaning that for some it could have been easier to capture and eat the kinds of foods that would further enhance the brain's biochemistry (Mirnikjoo et al., 2001). Possibly, the presence of the Neanderthals played a pivotal role in ways not yet understood, even if not directly linked to the development of symbolic image-making (Conard, Grootes, & Smith, 2004). However, with everything else being identical, the modern human brain, once formed, had to follow a common path of development and change, and it is likely that it is still evolving. All healthy humans have language no matter where they reside geographically. The brain that supports language is the same one that gives rise to the production of art. Thus, it is not surprising that art is ubiquitous, with similar running motifs, even if artworks are separated by huge bodies of water or impassable mountains, and nor is it surprising that humans share aesthetic reactions (see Chapter 10).

Although, as stated above, anatomically modern humans in Western Europe created art in greater quantity beginning 45,000–35,000 years ago, there is evidence for visual art predating this European period. A small volcanic stone figure, sculpted by human hands and estimated to be around 220,000 years old, was discovered in

the Golan Heights of Israel. Careful examination of this figurine supports the practice of symbolic art (d'Errico & Nowell, 2000; Marshack, 1997). Predating that by 130,000 to 180,000 years are some 300 pieces of color pigments and paint-grinding instruments believed to possibly be implements for the decoration of the body and other objects, found in a cave in Twin Rivers, near Lusaka, Zambia (McBrearty, 2012; Wadley et al., 2011; Zaidel, Nadal, Flexas, & Munar, 2013). Did early hominins use these pigments to paint their bodies in order to symbolically resemble animals, either to appropriate their power and agility or possibly for deception, or for socially symbolic reasons, or for all of those reasons and others (perhaps medicinal purposes)? Humans and their immediate ancestors were creating paint to represent ideas well before written language developed, although speech too existed well before writing.

One fascinating feature of the widespread practice of art is some running motifs in creations across distant geographical regions, so far apart that it becomes difficult to imagine the role of direct influence or shared ancestral memory. Consider the pyramids of ancient Egypt and those of the Mayas and the Aztecs—is it coincidence? Did the Mayan and Aztec peoples know of the Egyptian pyramids through legends related by ancestors who originated in Asia and perhaps heard such tales from earlier African ancestors? Consider that the reasons for constructing such monuments were probably the same: a need to construct something colossal in size that had symbolic and religious significance and would serve to impress as well as demonstrate strength and power (regardless of whether or not someone was buried inside). The cognitive processes required to conceive and execute stone constructions of such magnitude are mental properties of a natural biological evolution propelled by genetic control, selection forces, development, and growth of the brain unrelated to where the various humans lived. Human constructions in widely dispersed locations bespeak a shared brain neuroanatomy as well as common cognitive processes.

The most important lesson regarding artwork from ancient, prehistoric times is that its original intended meaning eludes us but its aesthetic appeal does not. This suggests that there is dissociation between the meaning and the aesthetics of art, implying that the latter has a stronger biological basis than the former.

Beauty and its role in art and brain evolution

Perceiving and judging art are not the same as producing it. Extracting beauty from art through the perception of art requires separate brain pathways from producing the art. Beauty in art plays a prominent role in attracting us to it and in enticing us to consider its contents (Zaidel, 2015b). It attracts us to directly ornament our homes with it, listen to it, visit museums and galleries to view it, read it in poetry and prose, and think of it as symbolic of our time and culture. Even without decorations, a single architectural structure can elicit beauty reactions. Paintings, sculptures, pottery, films, and architecture—all elicit neural as well as conscious reactions supposedly through their beauty. Art, however, conveys a meaning independent of

its beauty, and this meaning could also play a major role in attracting us to it (covered in Chapter 9).

There seems to be no convincing evidence of spontaneous art creations by non-human primates or any other animal, although there is some evidence of purposeful, artful, and three-dimensional creations by some birds. The best known avian in this context is the bowerbird. The idea behind the creations is attraction of the female to be followed by mating (see Chapter 10). It is hard to determine whether the female is attracted by some kind of a "beauty notion" in the male's creations or something else. Thus, although humans may not be the only beings responsive to beauty, currently there is no evidence, or even the means, to measure aesthetic responses in animals (Zaidel, 2015b).

Early humans could have been inspired by the beauty of nature and animals, or have derived benefits from constantly being surrounded by aesthetic sources (notwithstanding the dangers that would be present in real life), at the same evolutionary period that they wanted to communicate with each other, either verbally or non-verbally, through abstract symbols. Pictorial art could have followed the practice of body decoration for social identification reasons. Equally plausible is the idea that the original reasons for the early steps in the direction of art creations were purely symbolic with the beauty aspect being an emergent property as opposed to an element purposefully included in the artistic formula. Beauty now is considered an emergent property in the brain of the viewer rather than a separate entity that the artist "puts" into it (see Chapter 9).

Art production and brain damage in established artists

How are we to understand the neuroanatomical and neurophysiological underpinnings of all of the artistic expressions? A unified behavioral expression represents a complex conglomerate that is more than the sum of its parts, with several brain regions simultaneously involved in its execution. Art production is not alone in this regard. Mere observations of psychological phenomena or theorizing alone are not sufficient to uncover the components of complex behaviors, abilities, and talents. At the same time, the ability to create art is just as susceptible to breakdown and fractionation following brain damage as other behaviors, which suggests that some of its units and mechanisms can be unmasked. Similarly, sensory deficits in artists, particularly in vision and hearing, can throw additional light on the final artistic product. A painting by Vincent van Gogh, for example, is a unified product, the execution of which required multiple components from diverse functional domains including visual perception, color vision, creativity, fine finger dexterity, motor control, eye–hand coordination, conceptual understanding, spatial perception, problem-solving, reasoning, and memory—to name but a few requirements. And, of course, it is the fusion of the elusive attribute of talent with training and expertise—the unique decision-making apparatus determining the nature of the composition, the colors, the lines, tilts, angles, and so