

CHAPTER 14

Creativity, DNA, and Cerebral Blood Flow

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INTRODUCTION

If we had to select one trait crucial for the human species, or if we were asked to choose a desirable attribute, in both cases, perhaps many of us would choose creativity. Creativity not only enables us to adapt to the environment (which has been relevant for the survival and evolution of our species), it also enables us to transform it, to generate multiple possible alternatives for a single challenge, and allows us to give birth to aesthetic products. Creativity gives foundations to science, art, philosophy, and technology. In addition, creativity is important for social survival and individual well-being (Tiedt, 1976; Torrance & Safter, 1999). Understanding how creativity occurs and what brain processes are involved with it is challenging, and such an understanding might transform our view of ourselves and our societies (Zeki, 2001).

Creativity is a process that leads to the generation of something, transforming and transcending the existent (Chávez, 1999). This process is integrated by three overlapping and highly dynamic phases: (a) Association/Integration phase where the individual connects previously unrelated elements of inner and outer experiences. That is, the individual makes associations between elements of the external world and their subjectivity, becoming aware of these associations, continuing to incorporate new elements from external reality and from the interior world; connecting ideas, images, sensations, emotions, all kinds of sensory perceptions, sometimes with periods of apparent latency. During this phase there occurs a perceptual, sensory, cognitive, and affective integration. Different levels of consciousness are involved in

this phase. (b) The Elaboration phase involves the individual deliberately working with these associations and developing them in detail and building a product by using her or his particular talents and abilities. This phase is conscious and involves volition. (c) The Communication phase involves sharing the creative product; the associations are transmitted to and reproduced in others, as well as the sensory and emotional experiences. This leads those who encounter the creative product to produce new associations in themselves. Communication ends the process, but at the same time there begins new creative processes in other people, thus making creativity contagious. Consequently, reality is understood from a new perspective, and conceptual and aesthetic fields might be expanded (Chávez, 1999). Indeed, multiple neurological functions take place during the creative process.

THE INQUIRY INTO CREATIVITY FROM A NEUROBIOLOGICAL PERSPECTIVE

Galton's (1892) work was seminal for its inquiry into creativity from the perspective of natural science, which considers creative ability and genius as natural and heritable. However, Galton worked more to elucidate the heritability of genius than to understand the creative process. He studied families with a high incidence of geniuses (such as his own family) and applied statistical procedures to evaluate his observations. Galton (1880) also found that synaesthesia, to experience a particular sense through the modality of other senses (e.g., to see numbers in specific colors, to taste shapes, or to have a tactile experience with sound) is seven times more frequent among highly creative individuals than in the general population.

Galton's work was also seminal for the development of genetics (from the Greek root *gen* which means "becoming"), which began as a science in 1865 under two paradigms (both great examples of creative thinking): Galton's (1892) application of statistical methods to biological phenomena and Mendel's observations concerning the distribution of traits among generations and his contribution to the concept of the gene, even before DNA was discovered (Lisker & Armendaris, 2001).

Further, Galton (1892) developed the principles that are now used in the field of genetics to study the heritability of different kinds of traits, including personality and intelligence. After Galton, the interest in genius and creativity among geneticists almost disappeared. Nonetheless, the field of genetics is a good source of interesting examples of the creative process; that is the case of the controversial discovery of the DNA structure: "In 1953 James Watson and Francis Crick deduced

the three dimensional structure of DNA and immediately *inferred* its mechanism of replication . . . (they) analyzed x-ray diffraction photographs of DNA fibers taken by Rosalind Franklin and Maurice Wilkins and derived a structural model that has proved to be essentially correct" (Stryer, 1995, p.80, emphasis added). The inquiry of molecular genetic variations became possible in 1984 after Mullis had a powerful insight while driving. He had a vivid visualization of DNA replicating that led him to devise an ingenious method for amplifying specific sequences of DNA, the polymerase chain reaction or PCR (Laque-Cabrea & Herráez-Sánchez, 2001; Stryer, 1995). Through this method, millions of copies of a single targeted gene can be obtained and analyzed. From this, molecular genetics has advanced tremendously. Nonetheless, it was not until the 1990s that the interest in complex traits, in particular in cognitive ability, reappeared among geneticists (e.g., Bouchard, 1990; Plomin, 2002); and a great amount of molecular genetic research about personality has been performed (see Benjamin, Eibstein, & Belmaker, 2002 for a review). However, no molecular genetics research that focused on creativity has been conducted until the recent study detailed later in this chapter (Chávez-Eakle, 2004).

However, researchers have been interested in investigating the neurophysiological processes involved in the act of creation. For example, Arieti (1976) proposed that creativity is associated with an increase in the temporo-occipito-parietal cortex's functioning, and also with an increase in the interactions between these areas and the prefrontal cortex, independently from the stimuli intensity, keeping the mentioned areas a disposition to activation. In addition, Martindale pioneered work in this field, finding that highly creative individuals have a tendency to be physiologically overreactive to stimulation when compared to less creative subjects. For instance, the highly creative exhibit prolonged alpha blocking in response to tones; they habituate slower to stimuli; and rate electric shocks as being more painful (Martindale, 1978; Martindale, Anderson, Moore, & West, 1996; Martindale, Hines, Mitchell, & Covello, 1984). Moreover, Martindale and his colleagues found large and consistent electroencephalographic (EEG) differences between high and low creative individuals, observed only during creative task performance. The right-hemisphere EEG activity in parieto-temporal areas tends to be significantly higher than left-hemisphere activity in highly creative individuals during the performance of creative tasks (Martindale, 1990; Martindale et al., 1984). Further, less creative individuals tend to show alpha blocking on all types of cognitive tasks, including creative ones, while highly creative participants tend to be differentially reactive, exhibiting alpha blocking during the performance of noncreative tasks but

showing alpha enhancement during creative tasks (Martindale & Hasenbus, 1978). Furthermore, highly creative individuals exhibited higher alpha indices during an analog of creative inspiration than during an analog of creative elaboration, which was not found in less creative participants (Martindale, 1978).

Brain-function imaging is becoming a promising alternative for the study of creativity. Carlsson, Wendi, and Risberg (2000) compared the regional cerebral blood flow (rCBF) between low and highly creative individuals during the performance of a divergent thinking task. Highly creative participants showed more prefrontal rCBF in both right and left hemispheres, whereas low creative individuals had activation predominantly in the left cerebral hemisphere. In addition, Bekhtereva, Dan'ko, Starchenko, Pakhomov, and Medvedev (2001) compared the results of electroencephalography and CBF measurements from two different samples of students. Participants were not selected by their creativity indexes, but the same verbal creative tasks were administered to all the subjects. It was found that greater creative performance was related to higher values of spatial synchronization in anterior cortical areas and a general increase of the coherence in both frontal areas. Highly creative performance was also associated with higher CBF in both frontal lobes, particularly the Brodmann's areas (BA) 8-11 and 44-47 (Bekhtereva et al., 2001).

Indeed, there is still much to inquire about the neurobiology of the creative process. In the following sections of this chapter, the results of a research project that studied creativity from a multiple perspective, including the study of some specific molecular genetic variation and its association with creativity, and the evaluation of the cerebral blood flow during creative performance will be presented. To my knowledge this is the first molecular genetic study to focus on creativity and the first brain images study using the Torrance Tests of Creative Thinking.

CREATIVITY AND MOLECULAR VARIATIONS IN CANDIDATE GENES

Genes have variations, and some of these variations are responsible for variability in and between species; other gene variations can be a consequence of mutations that might lead to better environmental adaptations or to pathological conditions. When variations are present in more than 1% of the population, and are not associated with a pathological condition, these are known as polymorphisms. When studying the associations between polymorphic variations and a specific trait, it is important to choose carefully the most appropriate genes from all the genes that are available. One criterion in selecting appropriate

genes is to choose those that are related to a system that could be physiologically involved with the trait being investigated. In this research, some specific molecular genetic variations were analyzed in order to find whether these could be associated with the creative potential and with some of the temperamental and behavioral traits present in highly creative individuals (Chávez-Eakle, 2004). Two candidate genes were chosen: the gene that codes for the serotonin transporter and the gene that codes for the Dopamine receptor DRD4.

Serotonin is a major modulator of emotional behavior (Westenberg, Murphy, & Den Boer, 1996); it integrates cognition and has been found to be involved in the modulation of sensory input, the experience of time, sleep and dreaming, anxiety traits, fear, and pain (Rhawn, 1996). Further, serotonin orchestrates the activity and interaction of several other neurotransmitter systems, and its action is primarily terminated by reuptake via the serotonin transporter (Lesch, Greenberg, Higley, Bennett, & Murphy, 2002). In addition, it has been reported that there is an association between harm avoidance (a temperament trait related to anxiety behaviors) and a variation of the serotonin transporter gene (Lesch, Bengel, & Hells, 1996; Lesch et al., 2002), and harm avoidance is a temperament dimension that scores low among highly creative individuals (Chávez-Eakle, Lara, & Cruz-Fuentes, 2006).

Dopamine was another interesting candidate to explore, for it is known to play an important role in cognition and motor functioning, is a modulator of exploratory behavior in animals and humans, is involved with euphoria stimulation, and with emotion, mood, and reward. Further, the dopamine receptor DRD4 gene has been described as having an association with novelty seeking (Eibstein, 1997; Prolo & Licinio, 2002), a personality trait that involves seeking new situations and sensations (Cloninger, Svrakic, & Przybeck, 1993). However, other research teams have reported negative associations between the DRD4 and the novelty seeking trait (e.g., Sullivan, Fiffels, & Kennedy, 1998). Interestingly, a positive, significant correlation has been found between the creativity index and the exploratory excitability, a component of the Novelty Seeking dimension (Chávez-Eakle, Lara, & Cruz-Fuentes, 2006).

For this research, 100 individuals were recruited. Forty percent were famous scientists or artists with national and international awards and with a sustained productive activity in their fields. They were members of the Mexican National System of Researchers, the National System of Creators, or were awarded as Young Creators. These three systems provide economic support to the most productive scientists and artists, and in order to remain in these systems, members have to prove a relevant and constant production in their fields. The remaining participants were healthy control individuals or psychiatric outpatients

without pharmacological treatment at the moment of the evaluations. All the participants were tested with the Torrance Tests of Creative Thinking, Verbal and Figural forms (Torrance, 1990). The Torrance Tests are the most acknowledged and employed creativity instruments; they have shown high reliability and high predictive validity in longitudinal studies (Torrance, 1993; Torrance & Safer, 1999). The figural and verbal TTCT provide a creativity index, which is an indicator of creative potential. The figural TTCT provides scores on the following creative dimensions: fluency, originality, elaboration, abstraction, and premature closure resistance. The verbal TTCT provides scores of fluency, flexibility, and originality (Torrance, 1990). The Temperament and Character Inventory (Cloninger, Svrakic, & Przybeck, 1993) and the Overexcitability Questionnaire OEQII (Falk, Lind, Miller, Piechowski, & Silverman, 1999) were also administered. The temperament and character inventory is based on the psychological model of personality (Cloninger et al., 1993), which considers four temperament and three character dimensions. In this model, temperament was defined in terms of individual differences in learning everyday behaviors. Temperament involves heritable neurobiological dispositions to early emotions and their related automatic behavior and responses to specific environmental stimuli. Character refers to self-concept and individual differences in goals and values and involves higher-order cognitive processes such as logic, formal construction, symbolic interpretation, and creation. The Overexcitability Questionnaire is based on Dabrowsky's theories. After working with gifted children and highly creative adults, Dabrowsky found that they tend to react with more intensity and more frequency to diverse kinds of stimuli, naming this as "overexcitability." There are five kinds of overexcitabilities: sensual, intellectual, imaginal, emotional, and psychomotor (Dabrowski, Kawczak, & Piechowski, 1970). Overexcitabilities have been described as indicators of giftedness (Falk, Manzanero, & Miller, 1997).

Blood samples were taken from 90 individuals, and DNA was extracted. The serotonin-transporter-gene regulatory region (5'SL6A4) and the dopamine receptor DRD4 gene were amplified using the PCR method mentioned in the previous section, and typed through electrophoresis. The serotonin-transporter gene (5'SL6A4) modulates the transcriptional activity of the serotonin-transporter gene and is unique in humans and other primates (Lesch et al., 2002). In humans, most of its alleles are composed of either 14- or 16-repeat elements (short s and long l alleles). The following allele frequency was found in our sample: ss = 45.56%, ls = 41.11%, ll = 13.33%. These frequencies were under Hardy-Weinberg equilibrium, which means that in the absence

of disturbing forces such as selection, mutations, or migrations the allele frequencies show equilibrium in populations (Lisker & Armendaris, 2001). An association was not found between the polymorphic variation of the serotonin-transporter gene and the creativity index. However, we found a significant association between the short allele and the harm-avoidance temperament trait, $F(1, 89) = 3.8, p = 0.06$, which is similar to what has been found by previous research groups investigating molecular genetics of human personality (Lesch, 2003; Lesch, Bengel, et al., 1996; Lesch, Greenberg et al., 2002). Another interesting discovery in this research was the significant association observed between the polymorphic variation of the 5'SL6A4 gene and the emotional overexcitability, $F(1, 89) = 4.09, p = 0.05$. Higher scores on emotional overexcitability were found among individuals carrying two copies of the long allele (Chávez-Eakle, 2004). Emotional overexcitability corresponds to the intensity and frequency of responses when exposed to emotional stimuli.

The gene that codes for the dopamine receptor DRD4 has more polymorphic variations than the 5'SL6A4 gene, which increases the complexity of the analysis. Allelic variations correspond to the number of repetitive units of 48 pairs of bases (Eibstein & Auerbach, 2002). It has been described that longer alleles correspond to more excitable receptors. The 7-repeated unit allele was the last appearing during evolution. The following allele frequency was found in our sample: 24 = 8%, 27 = 2.7%, 34 = 1.3%, 44 = 36.0%, 46 = 5.3%, 47 = 44%, 66 = 2.7%. These frequencies were not under Hardy-Weinberg equilibrium, which could suggest that the genetic variation is related to the trait investigated or that there are other traits involved in such variation. A significant association between the polymorphic variation of the DRD4 gene and the sensual overexcitability, $F(6, 74) = 3.74, p = 0.003$ was found (Chávez-Eakle, 2004). Sensual overexcitability corresponds to the intensity and frequency of responses to different kinds of sensorial stimuli: visual, auditory, tactile, olfactory, and gustative (Dabrowski et al., 1970). This is an important finding considering the role dopamine has in the modulation of exploratory behavior.

A principal finding of this research was the significant association observed between the creativity index obtained with the Torrance Test of Creative Thinking Verbal form and the polymorphic variation of the DRD4 gene, $F(1, 74) = 3.50, p = 0.07$; the level of significance increased when associating the genotype with verbal creativity fluency scores, $F(1, 74) = 4.6, p < 0.05$. In both cases, individuals carrying the 7-allele had the higher creativity scores (Chávez-Eakle, 2004).

This is the first study reporting an association between molecular genetic variations and creativity. The observed significant associations between overexcitabilities and molecular genetic variations are relevant findings suggesting that overexcitabilities have a biological correlate. However, it is very important to say that to find an association does not indicate that the associated gene is responsible or causal for the trait investigated; other genes and several environmental factors probably intervene. Creativity is such a crucial trait in the evolution of our species that the likelihood of it depending upon a single gene is small, and it is important to mention that different genes interact differently during fetal neural development than in later life (Lesch et al., 2002). In the case of complex traits (like creativity) the contribution of a single gene to the variance of the trait is a small 1.5-3%. Having found an association between the creativity index and the molecular variation in the dopamine transporter gene DRD4 means that there is a positive sign in this direction, and further studies involving more genes of the dopaminergic system are needed. Other research alternatives might be to evaluate the activation of specific brain areas during the creative performance.

CEREBRAL BLOOD FLOW ASSOCIATED WITH HIGHLY CREATIVE PERFORMANCE

In other research, we evaluated the cerebral blood flow (CBF) associated with the figural and verbal creativity indexes (Chávez-Eakle, 2004; Chávez, Graff-Guerrero, García-Reyna, Vaquer, & Cruz-Fuentes, 2004) using the Torrance Tests of Creative Thinking (TTCT) Figural and Verbal (Torrance, 1990), Single Photon Emission Computerized Tomography (SPECT), and statistical parametric mapping. Participants were recruited from the cohort mentioned in the previous section of this chapter. Twelve individuals were invited to participate in the functional brain images project and were selected using their creativity indexes (Verbal and Figural TTCT). Six of these individuals had creativity scores above the 99th percentile, whereas the remainder corresponded to the 50th percentile. The twelve subjects did not present medical, neurological, or psychiatric disorders, were not under medication, and did not consume any psychoactive drug. Two TTCT verbal tasks were used when performing the brain images acquisition. The first task ("Just Suppose") was a warm-up activity, whereas the second ("Unusual Uses") was administered after intravenous injection of the radiotracer Tc99m-ECD. CBF was determined using SPECT. The image processing and analysis were performed using statistical parametric mapping SPM2. The SPECT images were visually inspected

for image quality. All the images were transformed to the ANALYZE format for their further automatic realignment (Friston et al., 1995). The images were spatially normalized using the SPECT image template from the Montreal Neurological Institute (MNI). The significant threshold for *a priori* regions (fronto-temporal) was $t > 3$, *p-corrected* < 0.01, and clusters formed by more than 10 voxels were analyzed. Linear correlations between the figural and verbal creativity indexes and the CBF were also completed. Results were graphically presented using the Talairach-Tournoux coordinates system (Talairach & Tournoux, 1988).

We found a positive, significant correlation between the figural and verbal creativity indexes and the CBF in the right precentral gyrus, Brodmann area (BA) 6. The figural creativity index also showed a positive, significant correlation with the CBF in the right anterior cerebellum. The creativity index obtained with the TTCT verbal showed a positive, significant correlation with the CBF in the right postcentral gyrus, BA 3; the left middle frontal gyrus, BA 11; the right rectal gyrus, BA 11; the right inferior parietal lobule, BA 40; and the right parahippocampal gyrus, AB 35. Results are summarized in Table 1 and Figure 1.

To my knowledge, this was the first study correlating the CBF with the figural and verbal creativity indexes obtained by the Torrance Tests of Creative Thinking. Our results showed that a bilaterally distributed brain system is involved in creative performance. Most of the brain areas that showed a correlation correspond to the right cerebral hemisphere; however, correlations were observed in both cerebral hemispheres, suggesting that creative thinking involves bilateral activation. Both figural and verbal creativity indexes showed a significant positive correlation with the CBF in the right precentral gyrus; this area has been involved in association processes, the assimilation of sensorial information, the modulation of impulses transmitted to motor areas, motor learning, in the perception of phantom limb movements, and in sexual arousal (Malouin, Richards, Jackson, Dumas, & Doyon, 2003; Mouras et al., 2003; Rhawn, 1996). The right frontal rectal gyrus has been related with emotion processing and to complex cognitive tasks such as meditation (Newberg et al., 2001). The inferior parietal lobule is a multimodal assimilation area and the right postcentral gyrus, a primary sensory area (Rhawn, 1996). The right cerebellum (culmen) is involved in emotional reactions and is directly linked to the amygdala, hippocampus, temporal lobe, hypothalamus, thalamus, anterior cingulate, and orbital frontal lobes (Rhawn, 1996). The right cerebellum is interconnected with the left hemisphere and becomes activated in some verbal tasks such as the production of verbs in response to nouns. Furthermore, it has been reported that individuals with lesions in the

Table 1. Coordinates and anatomical localization of clusters for the regions of correlation between the CBF and the creativity indexes obtained with the Torrance Tests of Creative Thinking (Figural and Verbal forms). Z , r , p corrected, and p uncorrected correspond to the values obtained through linear correlation for the voxel with maximum significance of each cluster. BA, Brodmann area. Coordinates correspond to the Montreal Neurological Institute (MNI). Size of cluster corresponds to the number of voxels for each clusters.

Creativity Index	Coordinate (MNI)			Hemisphere	Region	BA	Cluster size	Values			
	X	Y	Z					r	Z	p -corr	p -no corr
Figural	58	-6	48	Right	Precentral gyrus	6	20	0.78	3.07	0.01	0.001
	22	-34	-28	Right	Anterior cerebellum		16	0.74	2.61	0.03	0.005
Verbal	54	-8	52	Right	Postcentral gyrus	3	148	0.83	3.58	0.003	0.000
	62	6	28	Right	Precentral gyrus	6	15	0.78	3.0	0.01	0.001
	-42	48	-18	Left	Middle frontal gyrus	11	13	0.78	2.89	0.02	0.002
	10	10	-22	Right	Rectal gyrus	11	21	0.78	2.82	0.02	0.002
	64	-28	38	Right	Inferior parietal lobe	40	16	0.75	2.75	0.02	0.003
	24	-34	-26	Right	Parahippocampal gyrus	35	14	0.74	2.52	0.04	0.006

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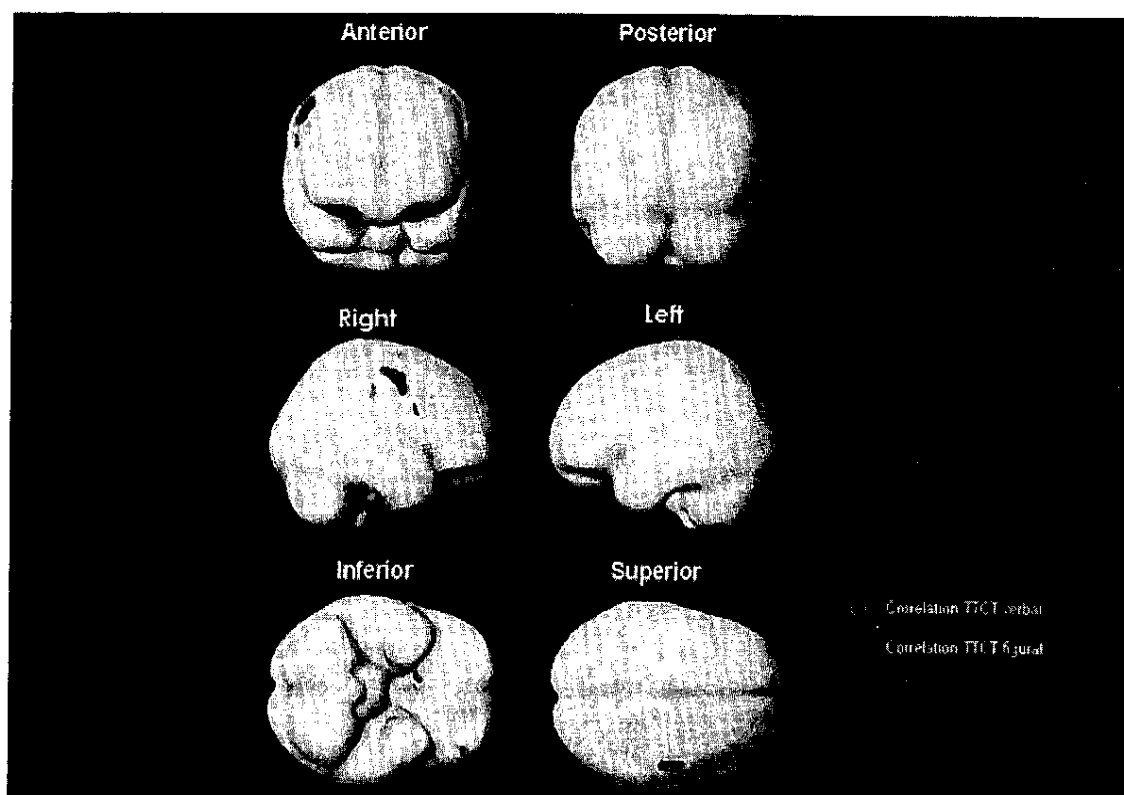


Figure 1. Regions of correlation between the CBF and the creativity index obtained with the Torrance Tests of Creative Thinking (Figural and Verbal). Localization details and size of clusters are specified in Table 1. (Published in *Salud Mental*, 27(3), 2004, p. 47, reproduced with authorization from the editor.) To see color details go to http://www.inprf-cd.org.mx/revista_sm/pdf/sm2703/sm270338ivo.pdf

right cerebellum have disturbances in verbal association and spatial tests (Rhawn, 1996) and show frontal hypoactivity (Arai et al., 2003). The middle frontal gyrus is a structure related to higher level processing of the emotional significance of complex stimuli. The middle frontal gyrus, in association with the mediofrontal and anterior cingulate cortices are sites of convergence for limbic inputs and are involved in the integration of cognition and emotion, affect and meaning, and also in the representation of the mental states of others (Berthoz et al., 2002). These areas maintain rich interconnections and are related to the conscious experience of emotion (Lane et al., 1998). Higher activation in these areas could be related to the vivid conscious experience of feelings and perceptions described in highly creative individuals (Chávez & Lara, 2000; Dabrowski et al., 1970). The latter, combined with higher symbolic abilities that are processed mainly in frontal lobes, might enable highly creative individuals to translate their experiences into creative works. Creativity is a complex, dynamic, multi-integrative process that involves perceptual, volitional, cognitive and emotional functions. Our results suggest that a bilateral, distributed, specific neural network is related to the creative process. These brain areas are engaged in the multiple processing of reality. Creativity makes possible the transformation of this reality.

CONCLUSIONS

In the research described in the previous sections of this chapter, several relevant findings were reported: (a) an association between the presence of the allele 7 of the dopamine receptor DRD4 gene and the creativity index; (b) an association between the polymorphic variation of the serotonin-transporter/promoter region gene and emotional over-excitability; and (c) and association between the polymorphic variation of the DRD4 and sensual overexcitability. These associations do not implicate causality; however, they suggest a promising starting point for further molecular genetic exploration of the creative potential. The contribution of a single gene for a complex trait is small, other genes (with additive and no-additive effects) and other environmental and sociocultural factors might be involved. Multiple neurological processes occur during creative acts. When evaluating the activation of specific brain areas during creative performance, it was found that figural and verbal creativity indexes correlated with CBF in specific areas in both cerebral hemispheres; these areas are involved in multimodal processing, in complex cognitive functions (such as imagery, memory, and novelty processing among others) and in all levels of emotion processing. This suggests that creativity is performed by a highly distributed

bilateral brain system. The brain-culture interactions, and the gene-environment interactions as well, are fascinating and challenging issues; creativity involves both sociocultural and psychological complex processes; therefore research on creativity could be a promising field that would lead us to increase our understanding of these topics. Neuroscience and molecular genetics offer rich possibilities to explore further the creative process. This knowledge is not separate from the experience of creating and could provide significant data for other researchers interested in creativity in various disciplines.

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CHAPTER 15

Artistic Creativity and Affective Disorders: Are They Connected?

Dennis K. Kinney and Ruth L. Richards

INTRODUCTION

Associations between great creativity and serious disturbances of mood have been observed for millennia, as a number of creative geniuses in ancient Greece appear to have had severe mood disorders. A century ago, the eminent psychiatrist, Emil Kraepelin, noted that some features of mania might facilitate creativity in certain artistic endeavors. However, while there has long been extensive speculation about relations between creativity and psychopathology, most empirical research on the topic has been conducted in recent decades.

In this chapter, we first review lines of empirical research that bear on the question and that suggest that there are indeed significant relationships between creativity and mood disorders or liability for these disorders. Next, we review complementary evidence for a relationship between creativity and mood elevation. We then discuss factors that may mediate these associations, with a particular focus on evidence for personality traits that are associated with both familial liability for mood disorders and enhanced creative potential. Finally, we discuss clinical and social implications of this research and make recommendations for future research.

EVIDENCE FOR ASSOCIATION OF CREATIVITY WITH LIABILITY FOR MOOD DISORDERS

Biographical and Anecdotal Reports of Links between Creativity and Mood Disorders

The likely presence of major mood disorders in a number of artistic geniuses, such as Van Gogh, has prompted much theorizing about

Evolutionary and Neurocognitive Approaches to Aesthetics, Creativity, and the Arts

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Foundations and Frontiers in Aesthetics

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