

Epigenetics and the power of art

Heidrun Karlic · Pia Baurek

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Abstract This review presents an epigenetic view on complex factors leading to development and perception of “genius.” There is increasing evidence which indicates that artistic creativity is influenced by epigenetic processes that act both as targets and mediators of neurotransmitters as well as steroid hormones. Thus, perception and production of art appear to be closely associated with epigenetic contributions to physical and mental health.

Background

The Greek and Roman definitions of genius as a guardian spirit included genetic elements and were progressively associated with various aspects of creativity: It was seen as an illustrious creative power that could be passed to descendants. About 2,000 years later, the eugenics pioneer and founder of the first psychometric laboratory Francis Galton published his book “Hereditary Genius” in 1869. Lewis Terman extended such approaches in his five-volume “Genetic studies of the genius” in 1921 (Kaufman and Sternberg 2010).

However, irrespective of such eugenic approaches, genius motives as shown in Fig. 1 are illustrating a possible external “way of inspiration” throughout centuries, which

might be interpreted as an early vision of epigenetics: The genius is holding the paint brush in the picture of the baroque picture of Livio Mehus (1630–1691) (Fig. 1a), but when deprived of his tool in a recent work of a contemporary artist (Christoph Ueberhuber), he simply represents the holistic power of information which—like epigenetics, may be inherited or acquired, with the potential of reversibility throughout lifetime. Covering parts of the picture may also symbolize silencing effects of epigenetic processes, which may highlight other parts of a complex image that have been overlooked before.

Epigenetic regulation of artistic creativity by neurotransmitters and hormones

Epigenetic mechanisms influence production of signaling molecules such as neurotransmitters and hormones and thus are increasingly recognized in psychological sciences (Graff and Mansuy 2008).

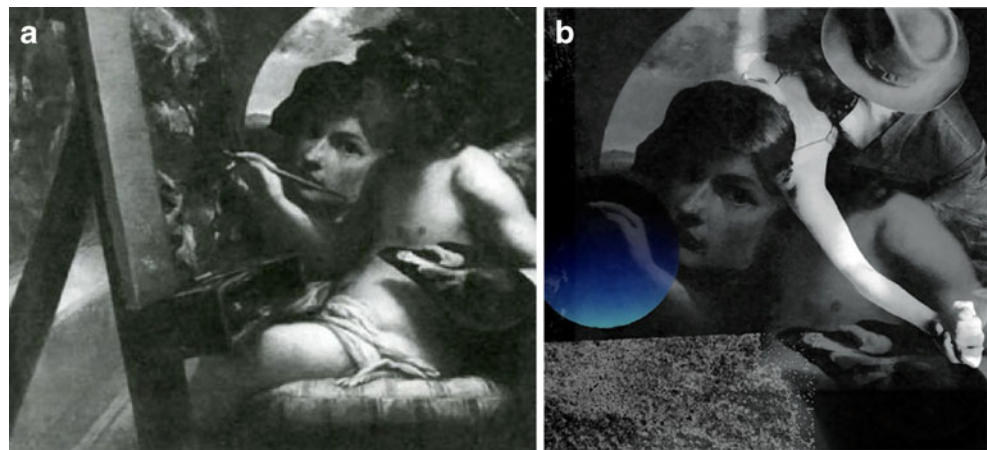
Regarding neurotransmitters, recent data indicate an immediate impact of dopamine on artistic creativity (Kulisevsky et al. 2009). The dopamine transporter gene (DAT1 or SLCA3) has a high inter-individual variability in its sequence including 897 small nuclear polymorphisms and about 90 repeats in addition to 27 CpG islands which may appear more or less methylated (Shumay et al. 2010). Considering the close association between a high dopamine level and a happy emotional status, this could provide an explanation for the close interaction of genetic and epigenetic features on emotions stimulating artistic creativity.

A “dark side of creativity,” as provoked by negative emotions, was detected in persons with reduced levels of dehydroepiandrosterone sulfate (DHEAS; Akinola and

H. Karlic (✉)
Ludwig Boltzmann Cluster Oncology
(LBI for Leukemia Research), Hanusch Hospital,
Heinrich Collinstraße 30,
1140 Vienna, Austria
e-mail: heidrun.karlic@meduniwien.ac.at

P. Baurek
Institute of Art History (Student’s Department),
University of Vienna,
Vienna, Austria

Fig. 1 Genius illustrating the interaction between epigenetics and art. **a** Genio della Pittura by a baroque artist (Livio Mehus). **b** Interpretation of Genio della Pittura by a contemporary artist (Christoph Überhuber)



Mendes 2008). DHEAS is generated by DHEA sulfotransferase. Vitamin D receptor (VDR) regulates the biosynthesis of this enzyme via a VDR-responsive element in its promoter (Echchgadda et al. 2004). This illustrates how the epigenetic cross talk between environment and lifestyle (Haslberger et al. 2006) is mediated by the central role of vitamin D (Karlic and Varga 2011).

Vitamin D also has a functional impact on estrogen receptor alpha (ERalpha; Banwell et al. 2006; Yao et al. 2011), which is another nuclear co-receptor of VDR. Its specific neurophysiologic role has been assigned to maternal inheritance but is influenced by hormonal and environmental cues as well. Recent studies that explore the role of DNA methylation in mediating these developmental effects particularly focus on the mediating role of maternal care. Besides its neurophysiological role, methylation status of ERalpha has implications for reproductive behavior, cancer susceptibility, and recovery from ischemic injury, suggesting an epigenetic basis for risk to resilience across the life span (Champagne 2008; Champagne and Curley 2008).

The fact that estrogen metabolism is associated with mood may provide an explanation for the recently discovered link between mood and preference of familiarity in depressive subjects, while individuals with a more hedonistic mood would be attracted by novel impressions including an affinity for more adventurous situations (de Vries et al. 2010). Furthermore, estrogen is known to influence the perception of facial “beauty” (Johnston et al. 2001) and attractiveness of creative intelligence (Haselton and Miller 2006).

Among hormones, there also exists an epigenetic affiliation to the insulin signaling system which is stimulated in cancer and closely associated with nutritional habits (Crowe et al. 2009) which may affect embryonic development (Ba et al. 2011). Promoter methylation of insulin-like growth factor is affected by alcohol (Zhou et al. 2011), which is known as a highly psychoactive drug appreciated both by artists and art consumers and provides an example

for multiple epigenetic effects resulting from its (over) consumption (Meeran et al. 2010; Shukla et al. 2008).

Impact of art on epigenetic patterns associated with physical and mental health

The role of epigenetics in the development and treatment of psychiatric disorders has been extensively reviewed (Tsankova et al. 2007) as well as general features of cognition and behavior (Graff and Mansuy 2008; Levenson and Sweatt 2005; Sweatt 2009). This includes age-related features such as the role of epigenetics in age-related long-term memory loss (DeAngelis and Tollefsbol 2010).

Thus, inborn (including inherited) epigenetic aspects include a possible emotional impact of the communicative power of different art styles, in different (ethnic) populations, impact of so-called “archetypus.” Visual imprinting in early childhood plays an essential role for recognition of ethnic faces. This is also associated with the so-called epigenetic memory including learning and association with emotional experiences (Bailey et al. 1996; Si et al. 2004) as well as an effect of genetic imprints with the potential to influence sexual orientation (Mustanski et al. 2005), maternal care (Champagne 2008), and the evolution of mirror neurons (Borenstein and Ruppin 2005). Epigenetic mechanisms have also been discussed as a possible background for interpre-

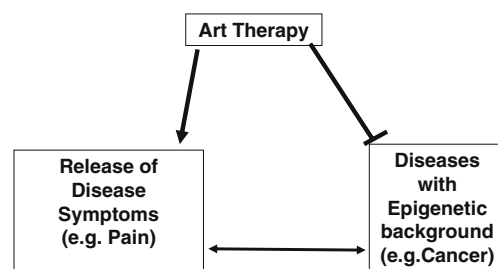


Fig. 2 Mechanisms indicating a possible epigenetic impact of “Art Therapy” on symptoms of various diseases

tation patterns of the Rorschach ink blot test in evaluation of inborn and acquired psychic disorders, as discussed since 1978 (Peterson 1990; Rothman 1978).

Thus, acquired epigenetic aspects are closely associated with the so-called epigenetic memory, which is primed by emotional experiences and their endocrine consequences including the abovementioned neurotransmitters and hormones. Various pathways of epigenetic dysregulation are clearly associated with cancer risk (Lichtenstein 2010; Voelker-Mahlknecht and Mahlknecht 2010).

Alzheimer's dementia has an epigenetic amnesia (see (Graff and Mansuy 2008) for review) and may be mirrored by the work of affected artists. However, the example of De Kooning's art shows impressively that art may also contribute to the healing process of this disease (Espinel 1996).

Figure 2 illustrates mechanisms indicating a possible epigenetic impact of "Art Therapy" on symptoms of various diseases including cancer (Nainis et al. 2006). In addition to well-described positive effects of music on cardiovascular and cerebral functions (Bernardi et al. 2009), this may further support the connection of art perception and epigenetics.

Thus, a change in epigenetic profiles of many diseases ranging from mental to metabolic disorders to cancers, where art therapy provides a proven amelioration, is worth to be subjected to more detailed analyses.

Exploring the world by a focus of attention greatly enhances the role that memory can play in perception and that epigenetics represents a model for memory on the genomic level which can be both inherited and acquired and also has the potential of reversibility. It opens the possibility, moreover, to decompose complex percepts and ideas into simple elements that can be rigorously serialized. Thus, a view into the world of arts appears to create some novel ideas on various aspects of clinical epigenetics with the potential to provide interpretation for a great range of psychosomatic aspects.

Conflict of interest The authors indicate that they have no conflicts of interests to declare.

References

- Akinola M, Mendes WB (2008) The dark side of creativity: biological vulnerability and negative emotions lead to greater artistic creativity. *Pers Soc Psychol Bull* 34:1677–1686
- Ba Y, Yu H, Liu F, Geng X, Zhu C, Zhu Q et al (2011) Relationship of folate, vitamin B(12) and methylation of insulin-like growth factor-II in maternal and cord blood. *Eur J Clin Nutr* 65:480–485
- Bailey CH, Bartsch D, Kandel ER (1996) Toward a molecular definition of long-term memory storage. *Proc Natl Acad Sci USA* 93:13445–13452
- Banwell CM, MacCartney DP, Guy M, Miles AE, Uskokovic MR, Mansi J et al (2006) Altered nuclear receptor corepressor expression attenuates vitamin D receptor signaling in breast cancer cells. *Clin Cancer Res* 12:2004–2013
- Bernardi L, Porta C, Casucci G, Balsamo R, Bernardi NF, Fogari R et al (2009) Dynamic interactions between musical, cardiovascular, and cerebral rhythms in humans. *Circulation* 119:3171–3180
- Borenstein E, Ruppin E (2005) The evolution of imitation and mirror neurons in adaptive agents. *Cogn Syst Res* 6:229–242
- Champagne FA (2008) Epigenetic mechanisms and the transgenerational effects of maternal care. *Front Neuroendocrinol* 29:386–397
- Champagne FA, Curley JP (2008) Maternal regulation of estrogen receptor alpha methylation. *Curr Opin Pharmacol* 8:735–739
- Crowe FL, Key TJ, Allen NE, Appleby PN, Roddam A, Overvad K et al (2009) The association between diet and serum concentrations of IGF-I, IGFBP-1, IGFBP-2, and IGFBP-3 in the European prospective investigation into cancer and nutrition. *Cancer Epidemiol Biomark Prev* 18:1333–1340
- de Vries M, Holland R, Chenier T, Starr M, Winkelman P (2010) Happiness cools the glow of familiarity: psychophysiological evidence that mood modulates the familiarity-affect link. *Psychol Sci* 21(3):321–328
- DeAngelis JT, Tollefsbol TO (2010) *Epigenetics of ageing*, vol. 3. Springer, New York
- Echchgadda I, Song CS, Roy AK, Chatterjee B (2004) Dehydroepiandrosterone sulfotransferase is a target for transcriptional induction by the vitamin D receptor. *Mol Pharmacol* 65:720–729
- Espinel CH (1996) de Kooning's late colours and forms: dementia, creativity, and the healing power of art. *Lancet* 347:1096–1098
- Graff J, Mansuy IM (2008) Epigenetic codes in cognition and behaviour. *Behav Brain Res* 192:70–87
- Haselton MG, Miller GF (2006) Women's fertility across the cycle increases the short-term attractiveness of creative intelligence. *Hum Nat* 17:50–73
- Haslberger A, Varga F, Karlic H (2006) Recursive causality in evolution: a model for epigenetic mechanisms in cancer development. *Med Hypotheses* 67:1448–1454
- Johnston V, Hagel R, Franklin M, Fink B, Grammer K (2001) Male facial attractiveness evidence for hormone-mediated adaptive design. *Evol Hum Behav* 22:251–267
- Karlic H, Varga F (2011) Impact of vitamin D metabolism on clinical epigenetics. *Clin Epigenetics* 2:55–61
- Kaufman J, Sternberg R (2010) *The Cambridge handbook of creativity*. Cambridge University Press, Cambridge
- Kulisevsky J, Pagonabarraga J, Martinez-Corral M (2009) Changes in artistic style and behaviour in Parkinson's disease: dopamine and creativity. *J Neurol* 256:816–819
- Levenson JM, Sweatt JD (2005) Epigenetic mechanisms in memory formation. *Nat Rev Neurosci* 6:108–118
- Lichtenstein A (2010) Cancer: evolutionary, genetic and epigenetic impacts. *Clin Epigenetics* 1(3–4):85–100
- Meeran S, Ahmed A, Tollefsbol T (2010) Epigenetic targets of bioactive dietary components for cancer prevention and therapy. *Clin Epigenetics* 1(3–4):101–116
- Mustanski BS, Dupree MG, Nievergelt CM, Bocklandt S, Schork NJ, Hamer DH (2005) A genomewide scan of male sexual orientation. *Hum Genet* 116:272–278
- Nainis N, Paice JA, Ratner J, Wirth JH, Lai J, Shott S (2006) Relieving symptoms in cancer: innovative use of art therapy. *J Pain Symptom Manage* 31:162–169
- Peterson C (1990) Administration of the thematic apperception test: contributions of psychoanalytic psychotherapy. *J Contemp Psychother* 20:191–200
- Rothman K (1978) Multivariate analysis of the relationship of psychosocial crisis variables to ego identity status. *J Youth Adolesc* 7:93–105

- Shukla SD, Velazquez J, French SW, Lu SC, Ticku MK, Zakhari S (2008) Emerging role of epigenetics in the actions of alcohol. *Alcohol Clin Exp Res* 32:1525–1534
- Shumay E, Fowler JS, Volkow ND (2010) Genomic features of the human dopamine transporter gene and its potential epigenetic states: implications for phenotypic diversity. *PLoS ONE* 5:e11067
- Si K, Lindquist S, Kandel E (2004) A possible epigenetic mechanism for the persistence of memory. *Cold Spring Harb Symp Quant Biol* 69:497–498
- Sweatt JD (2009) Experience-dependent epigenetic modifications in the central nervous system. *Biol Psychiatry* 65:191–197
- Tsankova N, Renthal W, Kumar A, Nestler EJ (2007) Epigenetic regulation in psychiatric disorders. *Nat Rev Neurosci* 8:355–367
- Voelter-Mahlknecht S, Mahlkecht U (2010) The sirtuins in the pathogenesis of cancer. *Clin Epigenetics* 1(3–4):71–83
- Yao S, Sucheston LE, Millen AE, Johnson CS, Trump DL, Nesline MK et al (2011) Pretreatment serum concentrations of 25-hydroxyvitamin d and breast cancer prognostic characteristics: a case–control and a case–series study. *PLoS ONE* 6:e17251
- Zhou FC, Balaraman Y, Teng M, Liu Y, Singh RP, Nephew KP (2011) Alcohol alters DNA methylation patterns and inhibits neural stem cell differentiation. *Alcohol Clin Exp Res* 35(4):735–746