

## CHAPTER 20: CAN WE CHANGE?

1. These words of the Dalai Lama's have sometimes been interpreted as an apology for selfishness. He is, of course, not advising people to be actually selfish (he is constantly stressing the danger of cherishing oneself excessively). What he means is that someone who really wants to benefit himself should understand that loving his neighbor and showing altruism is the best way not just to accomplish the benefit of others but also to ensure one's own happiness. Pursuing a basically selfish happiness is, in fact, doomed to failure.
2. André Comte-Sponville, remarks made during a discussion arranged by the kind auspices of Christophe and Pauline André.
3. Begley, S., *Train Your Mind, Change Your Brain: How a New Science Reveals Our Extraordinary Potential to Transform Ourselves*, Ballantine Books, 2007, p. 7.
4. These phenomena were observed among ferrets made deaf at birth, whose auditory cortex dealt with perception of light rays, and among mice blind from birth, whose visual cortex dealt with the perception of sounds. In a way, one could say that the ferrets *heard light* and that the mice *saw sounds*. Begley, S. (2007). *Op. cit.*, pp. 51–53, as well as Sur, M., Leamey, C. A., *et al.* (2001). Development and plasticity of cortical areas and networks. *Nature Reviews Neuroscience*, 2(4), 251–262; Sur, M., & Rubenstein, J. L. R. (2005). Patterning and plasticity of the cerebral cortex. *Science's STKE*, 310(5749), 805.

5. Altman, J. (1962). Are new neurons formed in the brains of adult mammals? *Science*, *135*(3509), 1127–1128.
6. Nottebohm, F. (1981). A brain for all seasons: Cyclical anatomical changes in song control nuclei of the canary brain. *Science*, *214*(4527), 1368.
7. The hippocampus is an area of the brain that manages knowledge acquired from new experiences, then spreads this knowledge to other areas of the brain where it will be memorized and reused.
8. Kempermann, G., Kuhn, H. G., & Gage, F. H. (1997). More hippocampal neurons in adult mice living in an enriched environment. *Nature*, *386*(6624), 493–495.
9. Eriksson, P. S., Perfilieva, E., Björk-Eriksson, T., Alborn, A. M., Nordborg, C., Peterson, D. A., & Gage, F. H. (1998). Neurogenesis in the adult human hippocampus. *Nature Medicine*, *4*(11), 1313–1317.
10. Fred Gage, during the Mind and Life XII conference in 2004 (“Neuroplasticity: The Neuronal Substrates of Learning and Transformation”) in Dharamsala, India, with the Dalai Lama. See Begley, S. (2007), *Train Your Mind, Change Your Brain (op. cit.)*, p. 65.
11. Elbert, T., Pantev, C., Wienbruch, C., Rockstroh, B., & Taub, E. (1995). Increased cortical representation of the fingers of the left hand in string players. *Science*, *270*(5234), 305–307.
12. Maguire, E. A., Spiers, H. J., Good, C. D., Hartley, T., Frackowiak, R. S. J., & Burgess, N. (2003). Navigation expertise and the human hippocampus: A structural brain imaging analysis. *Hippocampus*, *13*(2), 250–259; Maguire, E. A., Woollett, K., & Spiers, H. J. (2006). London taxi drivers and bus drivers: A structural MRI and neuropsychological analysis. *Hippocampus*, *16*(12), 1091–1101.
13. Carey, N., *The Epigenetics Revolution*, Icon Books, 2011.
14. Epigenetic modifications can occur because of several mechanisms. One of them is the “methylation” of genes. A methyl group fixated on one of the bases that comprise DNA blocks access to the gene in question. This gene can no longer be transcribed into a protein and remains inactive. One could say that the expression of this gene has been “repressed.” Researchers think that methylation acts by modifying the tridimensional structure of the DNA, causing a sort of “fold” at gene level, thus preventing access of the RNA that causes transcription of the gene into proteins which will then be active in the cell. I am grateful to Michael Meaney for these explanations.

Aside from methylation, which is stable, the acetylation of histones, a group of proteins associated with DNA, can cause epigenetic effects lasting a shorter amount of time, while certain types of RNA,

- which don't encode any protein, can interact with genes and render them silent. See Francis, D., Diorio, J., Liu, D., & Meaney, M. J. (1999). Nongenomic transmission across generations of maternal behavior and stress responses in the rat. *Science*, 286(5442), 1155–1158; Champagne, F. A., Weaver, I. C. G., Diorio, J., Dymov, S., Szyf, M., & Meaney, M. J. (2006). Maternal care associated with methylation of the estrogen receptor- $\alpha$ 1b promoter and estrogen receptor- $\alpha$  expression in the medial preoptic area of female offspring. *Endocrinology*, 147(6), 2909–2915. See also Carey, N. (2011), *The Epigenetics Revolution*. *Op. cit.*
15. Heim, C., Shugart, M., Craighead, W. E., & Nemeroff, C. B. (2010). Neurobiological and psychiatric consequences of child abuse and neglect. *Developmental Psychobiology*, 52(7), 671–690.
  16. In the case of people who committed suicide, postmortem analysis revealed high levels of methylation of genes in the cerebral neurons when the subjects were abused in childhood, but relatively low levels of methylation among those who did not experience such abuse. That means that the fact of having been abused leads to lasting modifications in the expression of genes. McGowan, P. O., Sasaki, A., D'Alessio, A. C., Dymov, S., Labonté, B., Szyf, M.,... Meaney, M. J. (2009). Epigenetic regulation of the glucocorticoid receptor in human brain associates with childhood abuse. *Nature Neuroscience*, 12(3), 342–348. Quoted in Carey, N. (2011). *Op. cit.*
  17. Kaliman, P., Álvarez-López, M. J., Cosín-Tomás, M., Rosenkranz, M. A., Lutz, A., & Davidson, R. J. (2013). Rapid changes in histone deacetylases and inflammatory gene expression in expert meditators. *Psychoneuroendocrinology*; doi:10.1016/j.psyneuen.2013.11.004. There was, of course, no question of removing neurons from the meditators, but one can also observe epigenetic changes in blood cells, and it turned out, studying the cells of deceased individuals, that these changes correspond to similar modifications of the neurons in the brain. Studies on the epigenetic effects of meditation on altruistic love are also under way in Barbara Fredrickson's laboratory.
  18. Richerson, P. J., & Boyd, R. (2004). *Not by Genes Alone*. *Op. cit.*, p. 247.