Journal for ReAttach Therapy and Developmental Diversities
eISSN: 2589-7799
2022 December; 5 (2s): 229-234

Impact of Physical Activity on Central Nervous System, Neurogenesis and Brains Aging

[1]Anuj Kumari, [2]Pardeep Kumar, [3]Dr. Arti Yadav, [4]Prof. (Dr.) Pawan Kumar Maurya, [5]Dr. Ajay Pal

[1]Research Scholar, Department of Yoga, Central University of Haryana.
[2]Research Scholar, Department of Yoga, Central University of Haryana.
[3]Assistant Professor, Yoga Department, University of Patanjali, Haridwar, Uttarakhand, 249405 (arti@uop.edu.in) (correspondence author)
[4]Professor & Head, Department of Biochemistry Central University of Haryana Mahendergarh (Haryana)-123031, INDIA
[5]Assistant Professor & Teacher In-charge, Yoga Department, Central University of Haryana. Jant-Pali, Mahendergarh - 123031

Received: 12-September-2022
Revised: 28-November-2022
Accepted: 16-December-2022

Abstract

The study of neurogenesis in human brains disproved the long-held theory that an ageing brain cannot generate new nerve cells. All mammalian species, particularly the adult human brain also contains progenitor cells or precursors in addition to those that are present in the growing human brain. Fortunately, meditation and other mental and physical training synchronized with breath, focus, and awareness create the ideal atmosphere for neurogenesis to grow by sowing the healthiest neurological seeds, enriching and stimulating your brain in the most precise manners. Meditation and other yogic practices may be a complete solution that keeps your brain full of neurons all the time. Yogic practice which is synchronized with breath and mental awareness had a greater impact than doing any other practice separately. Although laborious, this program may be readily incorporated into daily life and does not take a lot of time or budget to implement.

Keywords: Neurogenesis, Yoga, Meditation, Neural Stem Cell, Hippocampus, Dentate gyrus

INTRODUCTION

There was little knowledge of adult neurogenesis among scientists. The idea that immature neurons continue to be absorbed It was not until the middle of the 20th century that the existence of -1990s, despite having defined a variety of approaches **(Gross, 2000).** In recent years, the medical profession has finally disproved the old myth that the mature human nervous system does not produce any new nerve cells. But more than twenty years ago, light & electron microscopy provided the first evidence that adult mammal brains experience neurogenesis **(Kaplan, 2001)**.The idea that mature human brains do not develop any fresh neurons has been a cornerstone of neuroscience for more than a century. This viewpoint explores the genesis of this belief, its tenacity in the face of conflicting facts, and its eventual demise.In the last couple of decades, there has been notable advancement when examining neurogenesis **(Deng et al., 2010),(Gage, 2000),(Zhao et al., 2008).** the long-held notion that an aged brain can't produce fresh nerve cells was debunked by the finding of neurogenesis in the brains of humans **(Altman & Das, 1965).** All mammalian species, particularly the adult human brain also contain progenitor cells or precursors in addition to those that are present in the growing human brain **(Gage, 2000).**

The nervous system's anatomical and functional unit, the neuron, is in charge of processing and disseminating information. The ependyma, a thin cell layer that encircles the brain's lateral ventricles, is close to the SVZ. It has been proposed that the adult ependymal neural stem cell is responsible for neurodevelopment and development subventricular zone **(Johansson et al., 1999).** However, numerous investigations have demonstrated that ependymal cells are dormant and lack the characteristics of neural stem cells **(Doetsch et al., 1999).** Quite significantly, Subventricular zone cells contribute to protracted neural cell proliferation mostly in the olfactory bulb and possibly fewer in the ependyma itself **(Consiglio et al., 2004).**

The mammalian hippocampus continues to produce nerve cells after birth **(Eriksson et al., 1998),(Lugliani et al., 2010)**. Nowadays, it is commonly acknowledged that neuronal regeneration takes place in the adult human brain's hippocampus and olfactory bulb. Elderly neural regeneration has been demonstrated in certain other regions, such as the neocortex, striatum, substantia nigra, and the amygdala, although it has proven challenging

to reliably reproduce this outside of the injured brain due to differences in the precision and accuracy of the techniques used to discover fresh neurons **(Gould, 2007).**Current advances in neuroscience have demonstrated the central nervous system of humans contains neural progenitor cells which can produce fresh neurons, microglia, and dendritic cells. These findings disprove the conventional wisdom that Inside the adult brain CNS, no new neurons are produced and open the door to the potential creation of innovative brain rehabilitation techniques. The most recent findings continuously happening on adult human neurogenesis, to outline the key distinctions among "neurogenic" and "non-neurogenic" areas of the mature mind, and to outline the distinguishing characteristics of two well-known The dentate gyrus and the olfactory bulbs system are two different parts of the brain **(Emsley et al., 2005).**

It has recently been demonstrated that trauma or stress prevents cell division and, finally, neural regeneration in the brain **(Mirescu & Gould, 2006)**.Adult humans' brains undergo neural regeneration throughout their lives, or under usual circumstances, It has been demonstrated beyond a reasonable doubt that the process takes place in the subventricular zones (SVZ) or sub-granular region (SGZ) of the brain. Neurons generated with in adult SVZ must traverse a long distance along the rostral migratory flow to grow into granule neurons or periglomerular neurons inside the olfactory bulb. Dentate granule cells are created when mature SGZ-formed neurons penetrate a dentate gyrus' granule cell layer.

The pre-existing network continues to converge as developing neurons inside the mature brain take in functional input, according to studies published recently.All aspects of neurodevelopment such as the differentiation, survival, growth, and incorporation of growing neural progenitor cells, are influenced by biological and pathological processes. The olfactory bulb and the hippocampal proper function may also depend on neural progenitor cell multiplication, both of which play important roles in a wide range of cognitive tasks. In the adult brain, there is debate concerning neurogenesis outside of the subventricular zone as well as the subgenual zone **(Zhao et al., 2008).**

Neurons, astrocytes, or oligodendrocytes are all examples of neural cells, can be produced by adult NSCs, which play important rolein the mature nervous system of humans**(Gage, 2000**). Astrocytes and oligodendrocytes, commonly regarded as glia, provide leading roles that seem to be crucial for the normal operation of the nervous system.

Type C transit amplification cells, type A migratory neuroblasts, and type B GFAP-positive precursors are all seen in the subventricular zone, which are three different types of progenitor cells **(Doetsch et al., 1999).** Morphological investigation by electron microscopy was the primary basis for locating subventricular zone progenitors.The outcome of their descendants is governed by the location information acquired during embryonic central nervous system maturation, it is noteworthy to observe that the capability of subventricular zone progenitor cells seems to be restricted **(Merkle et al., 2007).**

AGING AND NEUROGENESIS

According to D. Rossi and other colleagues, In both the SVZ & SGZ, neurogenesis declines with advancing years **(Rossi et al., 2007).**Epigenetic dysregulation also affects adult neurogenesis.Adult NSCs, for instance, lack the methyl-CpG binding protein(MBD1), which leads to greater genomic instability and decreased neural differentiation. Additionally, adult neural precursors are affected bycell cycle regulation, DNA damage,and nuclear chromosomal instability to function effectively.

In the laboratory, adult neural stem cells can be maintained by basic fibroblast growth 2 or epidermal growth regulators (EGF) (FGF2). Both medications stimulate Subventricular zone growth, however only FGF2 increases the number of neurons inside the Olfactory bulb **(Kuhn et al., 1997)**

In conclusion, many external and extracellular mechanisms have been linked to the regulation of adult neural progenitor stem cells. The development of neurons is also influenced by both physiological and pathological factors.

STRESS AND NEUROGENESIS

Gould and colleagues also proposed that SGZ neural regeneration may play a role in emotional processing in their study **(Gould et al., 1992),**which demonstrated that corticosteroids, which are frequently high in severe depressive sufferers and stressful individuals, decrease SGZ cell proliferation. Because stress is thought to initiate and amplify depressive episodes, Study on how to reduce stress while maintaining SGZ neurogenesis

has covered a wide range of organisms in depth. Stress-induced downregulation of SGZ neurogenesis is mostly attributed to the hypothalamic-pituitary-adrenal axis' rise in corticosterone levels.

Shreds of evidence lend credence to this conclusion: glucocorticoid levels are raised by a wide range of stress frameworks, and The stress-related reduction of SGZ cell growth is prevented by adrenalectomy. Corticosterone reduces cell growth while adrenalectomy improves SGZ neurogenesis,

It has recently been demonstrated that stress prevents cell division and, finally, neurogenesis in the brain. Among different organisms, this impact seems to be widespread. Conflicting findings exist, despite some evidence suggesting that glucocorticoids may be involved in regulating progenitor cells **(Mirescu & Gould, 2006).** It has been reported thataerobic, mental, and physical training,and long-term pharmaceutical antidepressant therapies boost SGZ cell proliferation and raise serotonin levels **(Warner-Schmidt & Duman, 2006).**

The degree of SGZ neurogenesis is positively correlated with the brain, as demonstrated by pharmacological activation on serotonin receptors. Similar to this, SGZ cell proliferation is decreased when norepinephrine is depleted by a neurotoxin. In contrast, promoting the longevity of developing neurons by inducing norepinephrine production in the brain encourages SGZ neurogenesis **(Curtis et al., 2007),(Eriksson et al., 1998),(Zhao et al., 2008).** During puberty, human brains undergo coordinated maturation of progenitor cells. Integrating embryonic neurons into maturing brain regions like the olfactory bulb and dentate gyrus hints at critical roles in adult neurodevelopment in cognition **(Imayoshi et al., 2009).**

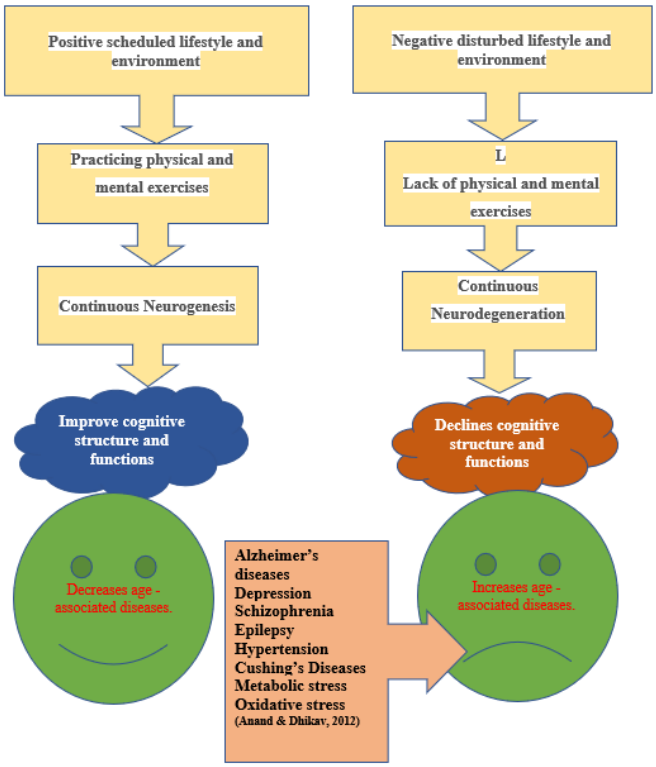
BOOSTING NEUROGENESIS

According to some theories, Health benefits of resveratrol are achieved through the same physiological signalling systems that are activated during calorie restriction and diet restriction, intermittent fasting, and a yogic diet.Resveratrol is a phenolic phytoalexin found in plant products like berries, cherries, pistachios, grapes, and peanuts. It has been shown in several studies to have medicinal benefits in experimental animals for energy metabolism and neurodegenerative disorders.

Resveratrol inhibited the growth of cultured mouse multi-potent NPCs and, in an intensity mode, stimulated AMP-activated protein kinase (AMPK). The treatment caused AMPK activation and a reduction in NPC development and survival with in dentate gyrus of a hippocampus dentate nucleus. Brain-derived neurotrophic factors (BDNF) or phosphorylated cyclic AMP response element-binding proteins (pCREB) levels were dramatically reduced in the hippocampus after resveratrol administration. Ultimately, hippocampus-dependent cognitive processes were impaired in resveratrol-treated mice. Our results indicate that, in contrast to caloric restriction, resveratrol negatively impacts hippocampus regeneration and brain ability through a process involving AMPK stimulation and repression of CREB and BDNF signaling.

Longevity and stem cell activation may be increased by caloric restriction. In the mature brain, neural stem cells may divide, specialise into distinct types of neurons, and either persist or die. Hippocampal neurogenesis takes place inside the dentate gyrus in response to both physical and mental stress. It has been demonstrated that nutrition can affect neurogenesis in the dentate gyrus as well **(Lee et al., 2000).** In a prior study, we found that caloric restriction improves hippocampus neurogenesis in mice by boosting neural progenitor cell survival. The up-regulation of BDNF is the principal process for this effect **(Lee et al., 2000), (Lee et al., 2002).**

Figure 1. Lifestyle Regulation of Sub-granular Zone Neurogenesis and Its Relation with Cognition



(Van Praag et al., 2005),(Kempermann et al., 2015)

Throughout their lifespan, mature mammals keep producing fresh brain cells. The biologist Joseph Altman first identified this process, known as neurogenesis, in the 1960s, but the theory was rejected and did not gain acceptance for several more decades. "Elizabeth Gould reported evidence of new neuron cells being produced in the dentate gyrus of the hippocampus in the middle of the 1990s, proving its validity" **(Anand & Dhikav, 2012).**

CONCLUSION

While others found that physical training or exercise might promote their proliferation, it has been discovered in 1999 that meditation practice with deliberate learning and mental and physical training could increase the survival of these new neural progenitor cells as compared to other physical training. Finally, yogic practice which is synchronized with breath and mental awareness had a greater impact than doing any other practice separately. Although laborious, this program may be readily incorporated into daily life and does not take a lot of time or budget to implement. Metal and physical training or Yogic practices like meditation is an examples of how neuroscientists might apply their findings from the lab to the real world to help humanity.

Yogic lifestyle rewires brains anatomy and physiology

- **↑Hippocampal Gray matter**
- **↑Hippocampal volumes**
- **↑Synaptogenesis**
- **↑Angiogenesis**
- **↑Neurogenesis**
- **↑Fiber integrity in white matter**
- **↑Brain structure and functions**
- **↑Anandamide**
- **↑Endocannabinoids**
- **↑Brain derived neurotrophic factor**

(Leung et al., 2013), (Luders, Kurth, et al., 2013), (Luders, Thompson, et al., 2013), (Luders et al., 2014), (Murakami et al., 2012), (Kalyani et al., 2011).

Fortunately, meditation and other mental and physical training synchronized with breath, focus, and awareness create the ideal atmosphere for neurogenesis to grow by sowing the healthiest neurological seeds, enriching and stimulating your brain in the most precise manners. Meditation and other yogic practices may be a complete solution that keeps your brain full of neurons all the time. As muscles, lungs,heart,and whole body need to be properly trained through muscular and cardiovascular workouts to increase longevity and health span, thus needs to accept the Yogic lifestyle.

References:

[1]. Altman, J., & Das, G. D. (1965). Post-natal origin of microneurones in the rat brain. *Nature*, *207*(5000), 953–956. https://doi.org/10.1038/207953A0

[2]. Anand, K., & Dhikav, V. (2012). Hippocampus in health and disease: An overview. *Annals of Indian Academy of Neurology*, *15*(4), 239. https://doi.org/10.4103/0972-2327.104323

[3]. Consiglio, A., Gritti, A., Dolcetta, D., Follenzi, A., Bordignon, C., Gage, F. H., Vescovi, A. L., & Naldini, L. (2004). Robust in vivo gene transfer into adult mammalian neural stem cells by lentiviral vectors. *Proceedings of the National Academy of Sciences of the United States of America*, *101*(41), 14835–14840. https://doi.org/10.1073/PNAS.0404180101

[4]. Curtis, M. A., Kam, M., Nannmark, U., Anderson, M. F., Axell, M. Z., Wikkelso, C., Holtås, S., Roon-Mom, W. M. C. van, Björk-Eriksson, T., Nordborg, C., Frisén, J., Dragunow, M., Faull, R. L. M., & Eriksson, P. S. (2007). Human Neuroblasts Migrate to the Olfactory Bulb via a Lateral Ventricular Extension. *Science*. https://doi.org/10.1126/SCIENCE.1136281

[5]. Deng, W., Aimone, J. B., & Gage, F. H. (2010). New neurons and new memories: how does adult hippocampal neurogenesis affect learning and memory? *Nature Reviews. Neuroscience*, *11*(5), 339. https://doi.org/10.1038/NRN2822

[6]. Doetsch, F., Caille, I., Lim, D. A., Garcia-Verdugo, J. M., & Alvarez-Buylla, A. (1999). Subventricular Zone Astrocytes Are Neural Stem Cells in the Adult Mammalian Brain. *Cell*, *97*(6), 703–716. https://doi.org/10.1016/S0092-8674(00)80783-7

[7]. Emsley, J. G., Mitchell, B. D., Kempermann, G., & Macklis, J. D. (2005). Adult neurogenesis and repair of the adult CNS with neural progenitors, precursors, and stem cells. *Progress in Neurobiology*, *75*(5), 321–341. https://doi.org/10.1016/J.PNEUROBIO.2005.04.002

[8]. 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. https://doi.org/10.1038/3305

[9]. Gage, F. H. (2000). Mammalian neural stem cells. *Science (New York, N.Y.)*, *287*(5457), 1433–1438. https://doi.org/10.1126/SCIENCE.287.5457.1433

[10]. Gould, E. (2007). How widespread is adult neurogenesis in mammals? *Nature Reviews. Neuroscience*, *8*(6), 481–488. https://doi.org/10.1038/NRN2147

[11]. Gross, C. G. (2000). Neurogenesis in the adult brain: death of a dogma. *Nature Reviews Neuroscience 2000 1:1*, *1*(1), 67–73. https://doi.org/10.1038/35036235

[12]. Imayoshi, I., Sakamoto, M., Ohtsuka, T., & Kageyama, R. (2009). Continuous neurogenesis in the adult brain. *Development Growth and Differentiation*, *51*(3), 379–386. https://doi.org/10.1111/j.1440-169X.2009.01094.x

[13]. Johansson, C. B., Svensson, M., Wallstedt, L., Janson, A. M., & Frisén, J. (1999). Neural Stem Cells in the Adult Human Brain. *Experimental Cell Research*, *253*(2), 733–736. https://doi.org/10.1006/EXCR.1999.4678

[14]. Kalyani, B. G., Venkatasubramanian, G., Arasappa, R., Rao, N. P., Kalmady, S. V, Behere, R. V, Rao, H., Vasudev, M. K., & Gangadhar, B. N. (2011). Neurohemodynamic correlates of "OM" chanting: A pilot functional magnetic resonance imaging study. *International Journal of Yoga*, *4*(1), 3. https://doi.org/10.4103/0973-6131.78171

[15]. Kaplan, M. S. (2001). Environment complexity stimulates visual cortex neurogenesis: death of a dogma and a research career. *Trends in Neurosciences*, *24*(10), 617–620.

https://doi.org/10.1016/S0166-2236(00)01967-6

[16]. Kempermann, G., Song, H., & Gage, F. H. (2015). Neurogenesis in the Adult Hippocampus. *Cold Spring Harbor Perspectives in Biology*, *7*(9). https://doi.org/10.1101/CSHPERSPECT.A018812

[17]. Kuhn, H. G., Winkler, J., Kempermann, G., Thal, L. J., & Gage, F. H. (1997). Epidermal Growth Factor and Fibroblast Growth Factor-2 Have Different Effects on Neural Progenitors in the Adult Rat Brain. *Journal of Neuroscience*, *17*(15), 5820–5829. https://doi.org/10.1523/JNEUROSCI.17-15-05820.1997

[18]. Lee, J., Duan, W., Long, J. M., Ingram, D. K., & Mattson, M. P. (2000). Dietary restriction increases the number of newly generated neural cells, and induces BDNF expression, in the dentate gyrus of rats. *Journal of Molecular Neuroscience : MN*, *15*(2), 99–108. https://doi.org/10.1385/JMN:15:2:99

[19]. Leung, M. K., Chan, C. C. H., Yin, J., Lee, C. F., So, K. F., & Lee, T. M. C. (2013). Increased gray matter volume in the right angular and posterior parahippocampal gyri in loving-kindness meditators. *Social Cognitive and Affective Neuroscience*, *8*(1), 34–39. https://doi.org/10.1093/SCAN/NSS076

[20]. Luders, E., Cherbuin, N., & Kurth, F. (2014). Forever Young(er): Potential age-defying effects of long-term meditation on gray matter atrophy. *Frontiers in Psychology*, *5*(OCT). https://doi.org/10.3389/FPSYG.2014.01551/ABSTRACT

[21]. Luders, E., Kurth, F., Toga, A. W., Narr, K. L., & Gaser, C. (2013). Meditation effects within the hippocampal complex revealed by voxel-based morphometry and cytoarchitectonic probabilistic mapping. *Frontiers in Psychology*, *4*(JUL), 398. https://doi.org/10.3389/FPSYG.2013.00398/BIBTEX

[22]. Luders, E., Thompson, P. M., Kurth, F., Hong, J. Y., Phillips, O. R., Wang, Y., Gutman, B. A., Chou, Y. Y., Narr, K. L., & Toga, A. W. (2013). Global and regional alterations of hippocampal anatomy in long-term meditation practitioners. *Human Brain Mapping*, *34*(12), 3369–3375. https://doi.org/10.1002/HBM.22153

[23]. Lugliani, R., Whipp, B. J., Seard, C., & Wasserman, K. (2010). Effect of Bilateral Carotid-Body Resection on Ventilatory Control at Rest and during Exercise in Man. *Https://Doi.Org/10.1056/NEJM197111112852002*, *285*(20), 1105–1111. https://doi.org/10.1056/NEJM197111112852002

[24]. Merkle, F. T., Mirzadeh, Z., & Alvarez-Buylla, A. (2007). Mosaic Organization of Neural Stem Cells in the Adult Brain. *Science*. https://doi.org/10.1126/SCIENCE.1144914

[25]. Mirescu, C., & Gould, E. (2006). Stress and adult neurogenesis. *Hippocampus*, *16*(3), 233–238. https://doi.org/10.1002/HIPO.20155

[26]. Murakami, H., Nakao, T., Matsunaga, M., Kasuya, Y., Shinoda, J., Yamada, J., & Ohira, H. (2012). The Structure of Mindful Brain. *PLOS ONE*, *7*(9), e46377. https://doi.org/10.1371/JOURNAL.PONE.0046377

[27]. Rossi, D. J., Bryder, D., Seita, J., Nussenzweig, A., Hoeijmakers, J., & Weissman, I. L. (2007). Deficiencies in DNA damage repair limit the function of haematopoietic stem cells with age. *Nature*, *447*(7145), 725–729. https://doi.org/10.1038/NATURE05862

[28]. Van Praag, H., Shubert, T., Zhao, C., & Gage, F. H. (2005). Exercise enhances learning and hippocampal neurogenesis in aged mice. *The Journal of Neuroscience : The Official Journal of the Society for Neuroscience*, *25*(38), 8680–8685. https://doi.org/10.1523/JNEUROSCI.1731-05.2005

[29]. Warner-Schmidt, J. L., & Duman, R. S. (2006). Hippocampal neurogenesis: Opposing effects of stress and antidepressant treatment. *Hippocampus*, *16*(3), 239–249. https://doi.org/10.1002/HIPO.20156

[30]. Zhao, C., Deng, W., & Gage, F. H. (2008). Mechanisms and functional implications of adult neurogenesis. *Cell*, *132*(4), 645–660. https://doi.org/10.1016/J.CELL.2008.01.033