Brain of the genius – Albert Einstein

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Our brain is a mystery organ. It is one of the most highly perfused organs of the body which metabolizes only glucose in presence of oxygen for its activity. Various parts of this soft organ inside our cranium are endowed with the responsibility for an individual's intelligence, consciousnes, various talents and learning capacities, thoughts, etc. Different areas of our brain regulate and respond to specific activities. Size of the brain and structure of each area of the organ contribute to the efficiency of the function performed by that particular area. Brain of the renowned scientist, the genius, Albert Einstein has been investigated through ages and studies reveal some exciting and interesting findings about the brain that made him so different from the general mass.

The German-born scientist, Albert Einstein is well known for his theory of relativity connecting energy, mass and light. He was a genius as proved by his work, mathematical efficiency and scientific contributions. His brain is considered extraordinary and has always been evoking inquisitiveness among researchers and scientists. The great scientist breathed his last in 1955. After his demise, Einstein's body was cremated according to his wish, but before that, his brain was removed. Brain autopsy was done by the pathologist Thomas Harvey in Princeton Hospital[1]. Harvey did not have permission to preserve the brain of the great scientist, but he somehow managed to convince Einstein's son. Harvey wanted to study the brain as it may unveil new features of brain anatomy and thus may enrich science[2]. Harvey was ultimately thrown out of his job in the Princeton Hospital, as he refused to hand over Einstein's brain. The brain had been cut into 240 pieces. Ultimately Harvey returned the brain to the then pathologist at the Princeton Hospital, almost 40 years later[1].

Several photographs of Einstein's brain have been taken; and researchers have been studying these for years and have deduced several significant inferences about the extraordinary brain of the genius[3,4]. These photographs taken were in black and white, before the brain was cut into pieces. Histological tissue samples were also prepared from the pieces of the brain by Harvey. Histological slides were made by some of the famous neuropathologists around the globe[5].

Studies revealed various secrets about the brain of Einstein. His brain was found to have certain unusual features and was different from that of normal humans. Harvey and Anderson studied the neuronal density, neuron size and the number of neurons under 1 mm^2 of cerebral cortical surface area in the right prefrontal cortex. Their study showed that there was no difference between Einstein's cortex and that of control subjects in respect to the number of neurons under 1 mm^2 in cerebral cortex or in mean neuronal size. The cortex of Einstein's brain was, however, found to be thinner[2]. Witelson *et al.*[6] reported that the weight of his brain (1230 g) was different from the ordinary brain of an adult human male of his age, i.e. a man of 76 years. Surprisingly, Einstein's brain was 8.61% smaller in size than that of a normal adult human. But the parts of the brain, concerned with spatial and visual reasoning and calculations and mathematical skills, i.e. occipito-parietal pathway and the prefrontal cortex, were larger in the brain of Einstein than that of normal adults[7,8]. The area responsible for spatial and visual reasoning was a single section in Einstein's brain, unlike that of a normal male, which is separated into two distinct compartments divided by Sylvian fissure[8]. The brain of the genius lacked furrow in the parietal lobe and also the operculum.

Men *et al.*[3] found that the prefrontal cortex of Einstein's brain was also extraordinary. They had collected 12 historical photographs of the brain from the National Museum of Health and Medicine in Maryland and studied them in detail[5]. They reported that the inferior portions of the primary somato-sensory and motor cortices were greatly expanded in the left hemisphere. It was found that there were some unusual patterns of complexity and convolutions in the prefrontal region of Einstein's brain[9]. The expanded portions observed in the prefrontal cortex of the genius has evoked curiosity among the scientists even more after the report by Semendeferi *et al.*[10] in 2011, which hinted towards a correlation between the evolutionary expansion of the same parts of the prefrontal cortex as those observed in the brain of Einstein with evolution of higher cognitive abilities in organisms. The prefrontal cortex is concerned with thinking, the ability to imagine, intelligence, personality expression, decision making, etc. Men *et al.*[2] studied the corpus callosum to draw a concrete conclusion regarding extraordinary intelligence of the genius. The study was conducted in 2013 using the high-resolution photographs of Einstein's brain[2]. All changes that occur in normal human brain due to ageing, were observed in the brain of the genius also[5]. Einstein's brain revealed a large number of glial cells, which are non-neuronal cells and are considered to provide nutrition and support to the neurons[9]. The right superior parietal lobule was found to be wider than that the left lobule[11].

Thus, the studies revealed that Einstein's brain was different from those of normal human beings and had some characteristic features. It was of exceptional size. The right frontal lobe was wide and forward projecting, and the left occipital lobe was posteriorly protruding. The brain had expanded prefrontal cortices and this probably the prime contributing feature for Einstein's exceptional and outstanding cognitive ability[10].

Brains of other famous people have also been preserved and studied by scientists to investigate whether any structural changes in them are responsible for their unusual intelligence and capacities. The brain of the famous Russian communist politician Vladimir Lenin[12], the great German mathematician Carl Friedrich

Gauss[13], the famous amnesian Henry Gaustav Molaison[14], the legendary philologist and criminal Edward H. Rollof[15], etc. were preserved and studied. They revealed different structural and morphological features compared to those of normal brains, establishing the fact that structural changes in the brain are important determinants for differentiating a genius from a normal human being.

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OPINION

Riparian forests for healthy rivers

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With the new government, have come new promises. With a new hope and name for Ministry for Water Resources, River Development and Ganga Rejuvenation created especially for the rivers, can the rivers hope for a cleaner future remains an unanswered question.

India is home to 16% of the world's total population, but has only 4% of the water resources sustaining the economy in terms of agriculture, power and biological productivity[1]. As a large part of the population is directly dependent upon rivers, it is all the more important to sustain clean water in them. However, are various methods of clean-up, including setting up of effluent-treatment plants and sewage treatment plants the only means to maintain our rivers? Why are we still ignoring the landscape perspective for managing rivers, treating them as isolated systems?

Civilizations developed along the river banks. Forests were burnt in the river basins for cultivation. Later during the British rule, trees were cut down relentlessly and just floated downstream for shipbuilding and railways. Forests got cleared and submerged as large hydroelectric projects came up on the rivers[2]. The rivers had to bear it all as the country was developing. Presently, we should also be contemplating the consequences of river-linking projects which would entail more deforestation, enhanced regulation of water flow and unprecedented modification of the riverine landscape. The impact of water-intensive agriculture, altered riverine biodiversity and spread of invasive species owing to river linking could do us more harm than good[3]. We have now been driven to a tipping point when the rivers are drying up or there are unprecedented flooding events, they are polluted to the extent of drains, and productivity and diversity have declined drastically.

Biological and habitat diversity and water quality of the rivers are strongly influenced by land use within the surrounding area at numerous scales[4]. The forests associated with a river called the riparian forests act as buffers to reduce the impact of anthropogenic disturbances on the river. Riparian zone represents a transition between the terrestrial and aquatic ecosystems and is influenced by both longitudinal gradients of variation like climate and elevation as well transverse gradients like flooding, groundwater availability and substrate texture[5–7]. High rate of disturbance due to these variations results in high and unique biodiversity in this zone[8]. Riparian forests provide food and organic matter for terrestrial and aquatic organisms, moderate stream temperature, filter out sediments, nutrients and pollutants, stabilize river banks, and function as a corridor for movement of animals. They also prevent erosion and floods, recharge groundwater and provide good quality water for drinking, irrigation and fishing[8–10]. Despite their immense ecological and economic significance, riparian forests are one of the most degraded and least managed in most parts of the world[11]. A study in the Ganga river basin by Forest Survey of India in 1995 showed that 85% of the basin was devoid of any forest cover[12]. While the headwater tributaries of Ganga like Bhagirathi and Alaknanda still support few stretches of good riparian forest cover, these forests almost disappear downstream[13]. This can be attributed mainly to agriculture, which has been the dominant land use in the Gangetic plains since centuries and has affected the natural cover in the basin and polluted the river. Further, regulation of rivers by construction of dams and reservoirs, logging, grazing, mining, water extraction and tourism have all harmed the riparian forests[14]. According to a study by Pandit and Grumbine[15], around 300 dams proposed to be constructed and under construction in the high biodiversity regions of the Indian Himalaya are predicted to lead to the submergence of 54,117 ha of forests. Unchecked urbanization and agriculture in the Yamuna river basin and enhanced nutrient load leading to high