Genius: The Neurobiology of Giftedness

Irma Iskandar

Toby Rosenberg, in all the five years of his life, has never been your typical toddler. At age 14 months, Toby could read aloud from posters his stroller passed by. A year later, he spoke both Polish and English fluently, and at the age of 4, he compiled a dictionary of hieroglyphics after visiting a museum shop and perusing through a book on ancient Egypt (1). From W.A. Mozart to Bobby Fisher to Toby Rosenberg, some children have since their birth amazed the world with their incredible intellect and abilities that can at times outdo even the brightest of adults. Why is this so, and, as many parents-to-be wonder, can a genius be created? It is evident that when a child's mental development is displayed far beyond the usual time, the only reasonable explanation is that the brain and nervous system are much more highly developed than is normal for the age (2). Some scientists believe that there are quantitative differences in these children's cerebral organization, and that these differences may possibly have a genetic link. However, although results seem to indicate this as so, more data is needed to establish this firmly and to ultimately explain why so few children have such gifted abilities.

First, however, one must have a clear notion of what is meant by giftedness. Only the top 2-5 % of children in the world are truly gifted. These children are precocious, self-instructing, can intuit solutions without resorting to logical, linear steps, and have an incredible interest in an area or more that they focus so intently on, that they may lose sense of the outside world (3). Early reading and development of abstract thought are typical characteristics as well. The acceleration of mental growth, however, is not the only factor involved in giftedness. The final stage of development is formal operative thinking (2), which is the ability to move beyond the concrete world and work with abstractions. Although until recently scientists had believed that these are stages normal in adults, studies now indicate that many college freshmen and even adults have not yet reached this stage. Having such advanced cognitive abilities and early development, therefore, appears to be characteristics of the gifted. Why do such few children have these characteristics? The answer remains unsolved; however, neurological studies seem to hint towards several answers.

The study of the gifted brain has been utilized by scientists throughout much of history. The effort to reduce genius to bulges in the brain has its roots in 19-th century pseudoscience, where phrenologists pinned personality traits to swatches of the cortex and measured the size of bumps on people's heads. Vain Victorian intellectuals bequeathed their brains to craniometers, in order to measure up to the myth "bigger is better" (4). Today, various neuroimaging, more reliable technologies have been used to determine differences in brain structure between the gifted and those of average intelligence. The gifted brain is implicated in having more numerous, more complex, and more active neural connections (2). PET and EEG tests have revealed that the brain organization of exceptionally mathematically-inclined teenagers are atypical to some extent - several areas of the cortex are more differentiated in the gifted teenager's brain, especially the frontal areas (5), than those of his or her peers. In another EEG study where the alpha wave power of mathematically-gifted teenagers were compared to that of SAT-matched college students, results showed that the gifted students had superior alpha wave power, and superior frontal activity (5). The hippocampus of the gifted, a major area involved in memory, was found to be not as compartmentalized as those of lower achieving students (5). In another study, the examination of Albert Einstein's brain yielded findings of a larger-than-normal, un-folded parietal lobe, an area of the brain that is usually folded and that is associated with visuo-spatial and mathematical abilities (6). Although many tests have been undertaken with various results, one may fathom that many factors may be influenced in the brain of a genius, and that

no one area of the brain may be responsible for giftedness. Furthermore, the prospect of external environmental factors in influencing the development of the brain has not even been discussed in this paper, although some scientists believe that these factors are extremely influential. It is easy, therefore, to see how complex finding the answer to giftedness may actually be.

Furthermore, neurophysiologists have disputed whether genius can be mainly localized in the right hemisphere of the brain or not. For example, Alexander, O'Boyle, & Bendow (1996) have suggested that "enhanced right-hemisphere involvement occurring during information processing, as well as superior coordination and allocation of cortical resources within and between the hemispheres, are unique characteristics of the gifted brain" (7). In another study, average students tested on verbal skills thought in the left hemisphere only: however, when mathematically talented children were tested, both the left and right hemispheres were implicated in controlling language - therefore, the right side was participating in tasks originally reserved for the left (3). Although findings about left and right hemisphericity may hint towards generalizations regarding their role in mental activity, one must keep in mind that many exceptions were found that defy association with particular locations of the brain (8).

As this paper has suggested, although various answers regarding areas in the brain have been implicated in localizing genius, no strong conclusion may follow, except the fact that many areas of the brain may be involved in the process. There are also disadvantages with the technologies used in making these findings- for example, PET is not suitable to use for young children (the age-group needed most for these findings) and is temporally insensitive. EEGs may have weak signals that are corrupted by the thickness of the skull, and is spatially insensitive to the mid-brain (3). Furthermore, although physical parts of the brain may be implicated, what can one suggest about other factors such as genes and the external environment? How could one make sure that Einstein's genius wasn't due to enlarged parietal lobes but childhood experiences, his readings (he had owed his theory of relativity to his reading of David Hume's *A Treatise of Human Nature*, or a million other factors (6)? Other insights I found that could be derived from the study of giftedness is that we still do not know what makes one smarter than another - smart parents have children of average intelligence, intellectually challenged parents have brilliant children. Genius children have thrived in areas where the environment is not conducive to learning, and may have superior reading skills for their age despite there being very few books in the house. Although parents eager to make their kids super-geniuses may put them in a constant intellectually stimulating environment, still only 2-5% of the population of children are considered truly gifted.

In conclusion, more data is needed to establish firmly the significance of brain differences in gifted and average children, and to ultimately explain why so few children have such gifted abilities. There are many facets about the brain that are still indeterminate - however, a stronger realization is that regarding even the most desirable traits, being a genius may to a large extent be beyond a person's control, and cannot be intentionally created. Sometimes, no matter how ambitious a person may be or how mentally stimulating an environment may be, the desired results are not fulfilled. This lack of knowledge about genius is a present problem - in the future, however, perhaps scientists will find what exactly makes a person brilliant. Genetic engineering could be utilized to artificially induce areas of the brain to be larger than normal, or less compartmentalized in terms of memory. Having a genius child could be as simple as paying a visit to a doctor's office. Perhaps then it is best not to know what makes a genius child tick. In this way, humans can avoid the mundane prospect of reducing human intelligence to scientific measurements of brain features with the use of a brain scan.

WWW Sources

1)How to Raise a Genius, Recent New York Times article about a five-year-old genius

2)A Tangled Web, Characteristics are listed that are typical of the gifted, and more information about giftedness

3)Uncommon Talents: Gifted Children, Prodigies, and Savants, Possessing abilities well beyond their years, gifted children inspire admiration but also suffer ridicule, neglect, and misunderstanding.

4)His Brain Measured Up, Studies regarding Einstein's brain may or may not indicate the source of genius.

5)The Gifted Brain, Recent developments are described in cognitive neuroscience and human genetics concerned with human learning, memory, and intellectual developments which have implications in gifted education.

6)Raising Albert: Can studying dead brains ever tell us anything about genius?, Environmental factors may be a source of Einstein's genius.

7)TI: Mental rotation and the right hemisphere, Abstract of research findings regarding enhanced development of the right cerebral hemisphere and its connection to extreme intellectual giftedness.

8) Wetware: The Biological Basis of Intellectual Giftedness, A thorough analysis of the parts of the brain and their related systems in comparison to the intellectually gifted.