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The Savant Syndrome and Its Connection to Talent Development

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To cite this article
Éva Gyarmathy. The Savant Syndrome and Its Connection to Talent Development. *Open Science Journal of Psychology*. Vol. 5, No. 2, 2018, pp. 9-16.

Received: April 14, 2018; **Accepted**: May 15, 2018; **Published**: July 5, 2018

Abstract

The savant phenomenon cannot be linked solely to a mental deficit, as its previous label (savant idiots) suggested, and is not necessarily accompanied by autism. Its essence is that a special ability shows up in a certain area. The fact that people with usual abilities can also acquire savant abilities after head injuries suggest that the neuroplasticity of the brain could show special abilities and new ways of the ability development through special ways. This study examines the savant syndrome and its connection to other syndromes and the talent development. Though there are more and more documented cases and studies on the savant syndrome, this phenomenon is so neglected area that it is not even mentioned in the main diagnostic systems. Talent is much more studied than the savant syndrome, but still, it can't be known with certainty what cerebral and developmental processes are behind outstanding abilities, and especially, talent. A review and comparison of the savant syndrome, autism and talent development lead to some mutual developmental and neurological characteristics. The results suggest that a savant is not a talent automatically, as the high ability and the compulsion on themselves are not enough to be a talent, but many talents can possess savant abilities. Savants can be regarded as pathological cases of talent development, and their study can reveal parts of the neurological background behind talent development in many ways. For example, the phenomenon, called „islands of genius" and an intense interest that are characteristic of savants appear even in non-pathological cases. Studies with savants seem to support theories of talent development according to which talent is a pre-disposition which appears as talent if the environment makes it possible through acceptance, encouragement and optimal challenges. The relationship between talent and the savant syndrome indicates that the savant syndrome might be a special form of talent, a neurological predisposition arising, like any other congenital potential, as a function of environmental influences in the form of different-from-normal behaviour.

Keywords

Savant Syndrome, Cognitive Abilities, Talent, Autism

1. Introduction

19-year-old Peter had an accident in the spring of 2002, in which the left side of his skull received a strong hit, and he fell into a coma. It was established in the hospital that his left temporal lobe had been injured. His recovery after coma and anaesthesia was rather long, during which time he received various neurotransmitters and his recovery was also helped with electromagnetic machines.

Owing to the injury to the left side of his skull, the right-hand body side of Peter became paralysed and was incapable of speech. The experts did not see much chance of full recovery. Peter was not taken to rehabilitative therapy. His parents took the task of „re-teaching" him on themselves.

Learning to walk again – as indeed learning the use of the complete right-hand body side, including the use of the hand – took strained practice. It took several hours each day, but Peter managed to learn to walk again. Learning to speak took much of his and his parents' efforts, but after two or three months, there were promising signs. After two months, Peter started going to a speech therapist, and after further persistent learning, could speak impeccably again. Following half a year of recovery, he went back to college, and finished his studies as a teacher majoring in geography and history.

After his recovery, Peter noticed abilities in himself that he had scorned prior to the accident. Gradually, his interest turned toward the sciences, such as mathematics and physics. Even his acquaintances were surprised, because he had never really been good at either mathematics or physics. Now, however, his research in these science areas is at such a high level that he has already published in scientific journals.

Because outstanding abilities have appeared suddenly in an area that used to be a weakness, suspicion of the savant syndrome arose, whose acquired form appears in most cases following an injury to the left temporal lobe. However, in Peter's case, there is no sign of autism or mental deficit that also often accompanies the savant syndrome, while he does display creative thinking. The rarity of the syndrome and the lack of an unambiguous clinical diagnosis make it impossible to answer the question with certainty.

The goal of the study is, however, not to attempt a diagnosis or solve a case, but to study, apropos of this case, the relationship of the savant syndrome to talent, that is, to the characteristics of individuals capable of outstanding achievements, and a better understanding of the nature of the savant syndrome. This is a review and a rethinking of the field.

2. The Savant Syndrome

The 18th century saw the appearance of the first descriptions of the savant syndrome. For example, Benjamin Rush described the case of Thomas Fuller, the counting savant who could, for instance, instantly tell you that a person who lived for 70 years, 17 days and 12 hours lived for 2 210 500 800 seconds (and could adjust the result to take into account leap years). The scientific description of the savant syndrome had to wait a century, and was made by J. Langdon Down, who, based on observation data of thirty years, identified the phenomenon in 1887 and used the term „savant idiot" as its designation (Treffert, 2009).

However, it wasn't Down who introduced this label for this strange syndrome. (This is already suggested by the fact that „savoir", the French verb for „know", is at the root of the label.)

The term „idiot savant" was used by Edouard Seguin already in 1870, and George W. Grabham cites him in the *British Medical Journal* in 1875 (Dawson, 2012).

The term „idiot" was commonly used as a technical term earlier on, and while afterwards, at the suggestion of Binét (1905), it was no longer employed by the profession, the word was still retained for a long time in the name of the savant syndrome. The reason for this may have been the extraordinary contradiction manifested in the structure of abilities displayed by such individuals. The essence of the syndrome is, namely, that some outstanding ability manifests itself against a background of mental disorder. Treffert (1988) was the one to suggest today's label.

According to the definitions, the savant syndrome is a rare syndrome in whose case the affected individual possesses abilities, expertise or acuity in one or more areas that contrast with the individual's general mental abilities.

The medical/clinical diagnostic system basically does not recognise this syndrome: it does not appear in either in the editions of the DSM so far, or in the ICD system.

2.1. Acquired and Congenital Savant Syndromes

According to Treffert and Wallace (2002), the savant syndrome can arise in two ways. On the one hand, there are savant abilities that develop on a genetic basis, and on the other hand, the savant syndrome can also be acquired through brain injury.

The most well-known Hungarian autistic artist, poet, painter and writer with savant syndrome, Seth F. Henriett, or the „RainGirl", has congenital savant abilities. In her childhood, she was mistakenly diagnosed as mentally disabled. Her intelligence is high, but the number concept has not developed correctly, and as such, a diagnosis of dyscalculia is appropriate in her case. She has outstanding visual and verbal abilities, but at the same time suffers from communication disorders. By today, she is the author of several books and poems and her works appear in various art exhibitions.

There is a huge scientific interest in such „autistic savants", whose incredible mental abilities are difficult to fathom. Perhaps even more interestingly, people with apparently usual abilities can also acquire such „miraculous" abilities in a short time following certain injuries to the head (Treffert, 2009).

The acquired form of the syndrome most often develops following a fronto-temporal lesion on the left side of the brain. Individuals suffering from the syndrome are typically characterised by an outstanding memory ability (photographic memory), which is not necessarily accompanied by an ability to apply it in practice.

Orlando Serell was hit by a ball – on the left side of his head – at the age of 11. Serell collapsed after the trauma, and then following his recovery complained of a serious headache. However, after the headache was gone, Serell became capable of outstanding mathematical calculations and his memory became photographic (Gururangan, 2011).

Serell's case seems, and is indeed, rare. Out of the 7 billion inhabitants of Earth, about 15-20 such documented, savant" cases have been recorded. These are the cases of the so called acquired savant syndrome", in which individuals who otherwise seem perfectly normal sustain some serious trauma, in almost each case, to the left side of their brain.

One of the most famous people with savant syndrome alive today is Jason Padgett, a furniture salesman turned mathematical genius from the US. Jason Padgett sustained a serious concussion and post-traumatic stress disorder following a street attack. Following these events, however, Padgett also came to see the world through the lens of geometry. He didn't use to have such interests earlier on, but due to the hit he received, he developed the ability to visualize complex mathematical relationships.

But there were earlier published studies on cases of savant

syndrome, as well. Minogue (1923) reports the case of a three-year-old child in whose case outstanding musical abilities appeared following a meningitis. Brink (1980) describes a case where outstanding mechanical abilities appeared following a shot injury to the left brain hemisphere at the age of nine, while the boy in question became mute, deaf and, on the left-hand side, paralysed. Dorman (1991) describes an eight-year-old boy's case, who became a calendar calculating savant following the surgical removal of his left hemisphere.

Smith and Tsimpli (1991) describe the case of a linguistic savant, which is a rarer, but not a unique case, and does not seem to be an acquired syndrome. Christopher is able to translate to English from 15-16 languages, while his IQ is around 70. He often does not even understand what he is translating. His performance is more similar to that of a translation program.

There are researchers who claim that a differentiation between the acquired and the congenital syndrome is misleading, and maybe all savant abilities are acquired. Autistic savants also only manifest their special abilities at the age of three or four years, and it is possible that the source of their abilities is autism – while in the case of other savants, it is a trauma to the left side of the brain. It is conceivable that in the seemingly acquired cases, the abilities were there in the brain to begin with, and it took a trauma to the head to raise them from a dormant state. It is conceivable that this „ability" is latently present in every person. If that is true, then it should be possible to awaken with transcranial magnetic stimulation (TMS) (Kaku, 2014).

But if the potential for outstanding abilities is indeed there in the human brain, then, theoretically, the conditions under which outstanding ability in a certain area can be acquired could be created through natural development, that is, with the appropriate developmental and educational environment. If this could be verified, then the concept of a „talent" would essentially cease to exist, because if everyone is outstanding, then no one is outstanding.

The question if it is possible to develop these outstanding cognitive functions in everyone, or if it requires a certain neurological predisposition is also relevant from the point of view of talent support.

2.2. Autism and the Savant Syndrome

Young (1995) carried out one of the most extensive studies by collecting data from 51 savant individuals and using standardized testing. According to the results, each individual showed autistic characteristics, and out of the 51 individuals, 41 met the criteria of autism, with the others also showing mental deviations from the norm. From the point of view of abilities, 12 were prodigious savants, 20 were rated talented and 19 showed so-called „splinter" skills.

Young identified the following as common characteristics of savants:

i. neurological impairment with idiosyncratic and divergent intellectual ability,
ii. language and intellectual impairments,
iii. intense interest and preoccupation with a particular area,
iv. rule-based, rigid and highly structured skills,
v. a lack of critical aspects of creativity and cognitive flexibility,
vi. a well-developed memory,
vii. a family history of similar cases, or in the absence of similar abilities, at least a familial predisposition towards high achievement,
viii. climate of support, encouragement and reinforcement from the environment.

There was a conspicuously great proportion of savants on the autism spectrum in the sample, which reinforces the probability of a connection between the neurological patterns behind the two syndromes.

Rubenstein and Merzenich (2003) suggested in their model of autism that the syndrome may be caused by an increased ratio of excitation/inhibition in sensory, mnemonic, social and emotional systems, and in turn identified effects of genetic and environmental variables impinging on the neurological system as being at the root of this increased ratio.

Not all neurological studies confirm this model (Said, Egan, Minshew, Behrmann, Heegen, 2013), while other studies identify hyper-functionality as the basis of autism, based on animal experiments.

Markram, Rinaldi and Markram (2007) attribute autism to valproic acid (VPA), a medicine used as a mood-stabilizer and anti-epileptic. In animal studies, valproic acid administered during pregnancy increased the risk of autistic offspring. Based on synaptic, cellular, molecular and behavioural data from studies on rats, it is hypothesized that the pathology is caused by the hyper-reactivity and hyper-plasticity of the autistic brain's local neuronal microcircuits.

Such excessive neural processing can lead to the phenomenon of hyper-perception, hyper-attention and hyper-memory, which are central symptoms in the case of most autistics persons. On this view, the autism spectrum disorder is essentially hyper-functionality that gets identified as under-functioning, that is, hypo-functionality.

According to the „Intense World Theory" of Markram and colleagues, if the molecular syndrome described above gets activated, it results in an over-sensitivity to environmental stimuli, and autistic traits may develop.

In normal circumstances, these neural circuit paths would make it possible for a stimulus-rich environment to help brain development, but if the paths are over-sensitive, environmental stimulation can result in an excessive and accelerated development in the brain in general, and especially in the neural microcircuits of the glutamate system, in particular (Markram, Markram, 2010).

The possibility arises that a similar excessive functioning could be identified in the case of the savant syndrome, which involves hyper-learning in certain specific ability areas rather than a general hyper-functionality.

Synaesthesia, a type of hyper-connectivity, is a frequent characteristic of the savant cognition. Daniel Tammet the

mathematical and linguistic genius is a high functioning autistic savant. Tammet doesn't calculate numbers. For him, each number has a colour, a shape and texture (Jawier, 2014). The visual and mathematical areas are unusually closely connected in Tammet's brain.

A case of a young woman, who perceived sounds as colours and claimed to have elaborated complex astrophysical reasoning, despite having experienced difficulties at school, especially in mathematics, has been reported by Bouvet et al. (2017). This woman was considered to be schizophrenic. A form of hyper-functionality as hyper-connectivity can be spotted in her synaesthesia, too.

3. Intelligence and Special Abilities

The savant syndrome is a big challenge for theories of intelligence. As a syndrome, it has outgrown the „savant idiot" idea, because more and more cases have showed that although there is an „island of genius", the sea need not necessarily be only water beyond the „island". Studies indicate that polygenic, small-effect size alleles that increased risk of autism are also associated with increased intelligence (Crespi, 2016). Contrary to the findings on autism, the genetic risk of schizophrenia is negatively related to cognitive abilities and intelligence (Hagenaars et al., 2016; Hubbard et al., 2016).

Crespi (2016) hypotheses that higher intelligence may co-occur with higher risk for imbalance. Autism involves high but imbalanced intelligence.

However it is to be considered that IQ assessments are unable to identify the true mental potential of these special individuals.

3.1. The Problem of Intelligence Assessments in the Case of Special Abilities

Institutions designed for the average break down in the case of outliers, as do theories designed for the average. Ability assessments can also err in several ways in the case of individuals with atypical development. The reason for this is that in assessments, the standard situation is to see how an individual is able to perform in circumstances well-tolerated by the majority.

In this respect, atypical development presents a challenge for those doing assessments. Gifted individuals, and especially gifted individuals with special circumstances will easily be assigned into the category of mentally disabled. This is because tests in fact do not only measure the individual's ability, but often, without being aware of this, also the individual's desire to meet expectations. A lack of this desire is generally described with the expression „not motivated", or the lack of the desire for compliance is diagnosed as the lack of abilities (Gyarmathy, 2010).

The desire to meet expectations is generally not a priority for individuals on the autism spectrum. Therefore, several autistic persons or even autistic-like individuals who are autonomous or highly independent thinkers will perform poorly and receive a low IQ score, and may even fall into the category of mental retardation based on their results. This in itself does not mean much to such individuals, but the diagnosis can severely affect their future development.

Assessment errors and problems can also affect scientific theories, since they are based on study results. This is another reason to rethink assessment methods, and, first and foremost, theoretical models of intelligence and abilities. Anderson (1994) did exactly that. Anderson's model has so far stood up to the test of time and scientific progress. Maybe the reason it is an enduring model is that it only specified a flexible framework for thinking about abilities and their development.

3.2. The Minimal Cognitive Architecture Model

Intelligence is the ability to think; it is a mental power, one of the most efficient ways to cope with the challenges of the environment and to adapt. Knowledge and intelligence, however, are not one and the same.

The strength of the thinking ability and the method of thinking, that is, the characteristics of information processing depend on different systems. According to Anderson (1994), at least three systems are involved in the development of knowledge:

1. The basic processing mechanism: synaptic efficiency, the general intellectual strength, which shapes knowledge through thinking. In the case of general deficiencies in mental abilities and of mental retardation, the cause of the deficiencies in knowledge is a weakness of the basic processing mechanism.
2. The modules are functionally independent, complex processes with evolutionary significance, which function independently of the level of intelligence in each individual and assist survival with ready-made cognitive kits. Fodor's (1983) theory of modularity has been the subject of debate for some decades, and does not seem to be shaken fundamentally, although several refinements and interpretations have been improving the understanding of the evolutionarily economic development of the brain (Barrett, Kurzban, 2006). For example, three-dimensional imaging and the linguistic pre-wiring of the brain are realized through modules, and mentalization, that is, the ability to attribute consciousness to others independent of own, also has a modular basis.
3. Special processing modes make the processing of information possible. Research has identified two kinds of processing modes:
4. the detailed, verbal-analytical-sequential, and
5. the holistic, kinaesthetic-visual-simultaneous processing modes.

The ratio and dominance of these two modes constitutes an individual pattern in knowledge acquisition. If the involvement of any of the special processing systems in information processing is significantly lower, then, irrespective of the general mental abilities of the individual, specific learning difficulties (dyslexia, dyscalculia) can arise.

Anderson (1994) called his model the Minimal Cognitive Architecture, because this is what is minimally needed to explain all the phenomena that research and experience have described. The above systems are not independent structures in the brain, but are instead different modes of functioning. While research will probably identify other, less or more significant modes of functioning, at the moment, this architecture is suitable to grasp and comprehend several different phenomena.

3.3. Mental Deficit and Autism in the Light of the Minimal Cognitive Architecture

According to Anderson's model, there are at least two ways leading to mental deficits:

1. the under-functioning of the basic processing mechanism, or
2. a lack or deficit of modules that play a central role in cognitive functioning.

The special processing mechanisms only determine the mode of thinking, and as such, their role in the development of knowledge is indirect.

If, however, important modules like the linguistic representation module is lacking or impaired, then severe cognitive functioning disorders may arise.

These disorders differ from the general intellectual deficit caused by the weakness of the basic processing mechanism, but by studying intelligence with not sufficiently refined methods, such as IQ tests, this otherwise important difference does not generally become apparent, and the diagnosis will be general intellectual deficit.

The role of the impairment of modules in the development of mental deficit is indicated by the frequent co-occurrence of autism and mental deficit (Anderson, 1998).

The impairment of the 'theory of mind' module can be the cause of the characteristic cognitive background to autism. It is not only human behaviour that is affected; the general ability to abstract away from the particular is not automatic, or requires serious mental energies in these cases. Thinking is thereby also idiosyncratic and difficult, which can be reflected in IQ scores.

At the same time, as emphasized above, the desire to meet expectations is not necessarily present even in a talented individual without autism, not to mention that an intelligence test itself might not pose enough of a challenge for them to exert mental effort. As such, a low score may indicate lack of motivation and disinterestedness instead of lack of ability.

Importantly, the modules are independent of the basic processing mechanism, which means that general mental abilities can vary widely in cases of the autism spectrum. Thus, there may be individuals with outstanding, average, and poor thinking abilities alike among those with autism spectrum disorder.

The same problem arises if a modular divergence at the root of the savant syndrome is assumed. If it is caused by factors independent of intelligence, then a particular module may show extreme hyper-functioning even against a background of outstanding general intellectual abilities. Naturally, there is a far greater probability of talent development in such cases, than when the general abilities of the individual are impaired or low.

3.4. The Savant Syndrome in the Light of the Minimal Cognitive Architecture

Anderson (1994) assumes that the savant syndrome is also caused by an abnormal functioning of the modules, that is, outstanding abilities in the area of a specific module is due to that module's hyper-functioning.

According to Howard Gardner (1983), there are automatic, unstoppable cerebral processes behind the counting and other abilities of savants. These independently functioning processes can also serve as fundamental evidence in his model of „Multiple Intelligence".

Outstanding abilities indeed do not mix with each other in the case of the savant syndrome, and typically appear in main areas of human abilities, that is, those which Gardner describes as "intelligence". However, it is arguably not intelligence, but different modules that can be identified to lie at the heart of the ability areas described by Gardner (1983). Savants mirror these modules behind the main human abilities very closely: music, counting, and spatial-visual cases are the most frequent ones, and somewhat more rarely, the area of language may also be an „island of genius".

In the light of all this the savant syndrome is an independent phenomenon involving outstanding abilities in one or more narrow areas, and can be either congenital, familial or acquired, that is, arising through special cerebral connections developed following a brain injury.

As such, the syndrome is to be differentiated from mental retardation, autism and talent, alike, because all of these arise as a result of factors that are independent of the savant syndrome. At the same time, the savant syndrome may be associated with all of these three phenomena, because both its congenital and its acquired form may impinge on these other phenomena.

The approach and system of the Minimal Cognitive Architecture helps to set apart and then connect similar and often co-occurring phenomena that are to be, however, differentiated.

4. The Connection Between the Savant Syndrome and Talent

The acquired savant syndrome is connected with a thousand threads to autism, and according to the leading approaches today, its symptoms are caused by an abnormal amount of neural functioning, that is, hyper-functioning. Hyper-functioning, however, is a phenomenon that is also often mentioned in the case of talents (Gyarmathy, 2009).

4.1. Artificially Induced Abnormal Excitation/Inhibition and Outstanding Abilities

Rimland (1978) observed based on a large sample of

autistic individuals that savant abilities are most often abilities associated with the right brain hemisphere, and the deficits are generally associated with functions of the left hemisphere.

The acquired savant syndrome also often arises following a trauma to the left brain hemisphere (frontotemporal dementia), but not in every case, and, conversely, an injury to the left hemisphere also does not invariably bring out the „scientist" or „genius" syndrome. Indeed, unfortunately it is not at all the typical outcome of such brain injuries. At the same time, the phenomenon raises the possibility that the human brain possesses far greater potential than it was thought. Even researchers have become interested in this possibility.

According to Snyder and Mitchell (1999), special mathematical and drawing abilities characteristic of the savant syndrome can be achieved without a brain injury by inhibiting the functioning of the left hemisphere.

Young, Ridding and Morrell (2004) interrupted the functioning of the frontotemporal lobe (which is implicated in the development of savant abilities) using rTMS, that is, repetitive transcranial magnetic stimulation in the case of 17 subjects, and 5 out of them showed significant improvement in abilities related to memory, drawing, mathematics and calendar calculation.

It is striking that Renzulli (1978) estimated the size of the talent pool to be around 20-25%, which is remarkably similar in its magnitude to the proportion of those in whom savant abilities could be artificially induced.

Several researchers have already arrived at the conclusion from different routes that the problem of the savant syndrome can in many ways be indicative of the neurological background of talent development (e.g., Wallace, 2008; Hughes, 2010).

4.2. Common and Specific Traits

The savant syndrome has both specific traits, and traits that are clearly linked to talent. It would be important to clear up the relevant concepts and the factors behind them, because confusion in terminology sets back the identification of connections and relationships.

Characteristics of the savant syndrome:

i. Island-like outstanding abilities with different strengths in areas operating with well-defined rules and algorithms, typically associated with the right hemisphere.
ii. These abilities can arise congenitally or following a brain injury, but a supportive environment also clearly plays a role in their development.

Note that mental disorders were not included among the characteristics, because it is not necessary for the island-like outstanding ability acquired through a brain trauma to be accompanied by other disorders, as the artificially induced ability development indicates.

Characteristics of talent:

i. Outstanding general and specific abilities at different, but above-average levels, internal drive and creativity.
ii. These abilities lead to a talent capable of outstanding achievements through an interaction of individual and environmental factors.

Outstanding abilities and obsession also often lead to various psychiatric labels, such as a diagnosis of autism spectrum disorder, in the case of talents (Gyarmathy, 2009). The savant syndrome could be seen as a caricature, an excessive form of talent.

The single important difference is the creative product, which, in the case of the savant syndrome, even if present, cannot compare with the individual's levels of obsession and ability, if the individual fails to possess sufficient general intellectual abilities, because creativity is not part of the savant syndrome.

Nothing links the savant syndrome to mental retardation, however, even if there are savants whose actual intelligence level is indeed low. There may therefore be savants in whose case their savant abilities are not identified, because their level of thinking is outstanding in general. Savants who are able to bring about a creative product are also talents.

5. Conclusion

The purpose of this study was to analyse the savant syndrome in light of the by today ample amount of scientific results, to place the phenomenon on the map in relation to other phenomena leading to different-from-normal achievements, and to describe some special potentials inherent in the human brain. In addition, the present study also calls attention to some weaknesses of ability diagnostics, which are due to the fact that a regular approach can lead to misleading results in special cases.

Medical science does not, as yet, regard the savant syndrome as an existing phenomenon. Its incidence and its identification are both sparsely documented, but an increasing number of research studies aim to uncover the special cognitive development inherent in the savant syndrome.

The study of the acquired savant syndrome and an understanding of how such special abilities arise is of particular importance from the point of view of the natural and educational development of outstanding cognitive abilities.

Commonalities in descriptions of theories of the savant syndrome and theories of talent are:

i. neurological pre-disposition showing also family aggregation,
ii. neurological hypersensitivity,
iii. obsession,
iv. supportive, encouraging, reinforcing climate.

That neurological predisposition is necessary is supported by the fact that in brain stimulation studies, a higher level of mental functioning was only achieved in the case of about a fourth of the subjects, so it is conceivable that not everyone has a nervous system capable of the plasticity that is necessary for a significant increase in cognitive performance, even if the necessary extreme neurological circumstances for

it are ensured. The talent field accounts for 20-25% of the population. The similarity of the two ratios allows the assumption that the two phenomena are in connection.

Studies with savants seem to support theories of talent development according to which talent is a pre-disposition which appears as talent if the environment makes it possible through acceptance, encouragement and optimal challenges.

If an environment supportive of development is lacking then this pre-disposition, which predisposes the individual at the level of neural transmitters to a different-from-normal mode of perception and reactions, will manifest itself to the environment as behavioural disorders.

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