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Berkeley Scientific Journal

Title

Savant Syndrome: Growth of Empathy and Creativity

Permalink

<https://escholarship.org/uc/item/3c9157k2>

Journal

Berkeley Scientific Journal, 15(1)

ISSN

1097-0967

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Publication Date

2012

DOI

10.5070/BS3151012137

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Undergraduate

SAVANT SYNDROME:

GROWTH OF EMPATHY AND CREATIVITY

Kapil Gururangan

Recent years have seen the rise of autism spectrum disorders in global news. Diagnosed cases are at an all-time high (affecting 1 in 110 children) and awareness for the condition has been aided by benefits, celebrity activism, and more sophisticated research. However, another condition, not so dissimilar, has remained largely underground in its significance to our understanding of the human brain. The character brought to fame by actor Dustin Hoffman in *Rain Man*, Raymond Babbitt, was based off one of the rarest of individuals – a savant.

Individuals diagnosed with savant syndrome boast unparalleled ability in certain skills and subject areas. However, they also display trademark signs of autism spectrum disorders (ASD, including autism and Asperger syndrome) and other learning and developmental disabilities, which creates an interesting backdrop to a savant's impressive talent (Treffert 2009, 1351). Dr. John Langdon Down, who was famous for identifying Down's syndrome, labeled ten of his patients as "idiot savants" in 1887, bringing "the remarkable coexistence of deficiency and superiority" to the attention of the scientific community (Treffert & Wallace 2004, 16). Notable scientists, such as Dr. Darold Treffert from the University of Wisconsin, Dr. V.S. Ramachandran of University of California, San Diego, and Dr. Simon Baron-Cohen at the University of Cambridge, have tried to discover where this extraordinary talent comes from and how it coexists within the vicinity of a savant's disability.



Figure 1. Dustin Hoffman portraying a savant in *Rain Man* alongside Tom Cruise. (Associated Press 2009)

EXPLAINING SAVANTISM: AN INTRODUCTION TO INTRINSIC GREATNESS

The extraordinary talents associated with prodigious savants are invariably linked to memory (Treffert 2009, 1351). Savant syndrome can be congenital, meaning the result of a genetic defect, or acquired following brain

"damage compensation" theory explains the skewed ratio, roughly 6:1, of male to female savants (Treffert 2009, 1353). The left hemisphere develops slower than the right, and is thus vulnerable for a longer period. Higher levels of testosterone circulating in male fetuses inhibits the growth left hemisphere, causing the right brain to adapt and compensate for the inability of the left brain to perform optimally (Treffert & Wallace 2004, 21). This not only causes most savant abilities, such as math, music, and art, to be centered in the right brain but also supports the idea that a savant derives his memory and ability by drawing on low-level information processing (Treffert 2009, 1356; Treffert & Wallace 2004, 17; Peek 2006). Ramachandran calls this a lack of "conceptual encoding," which causes a savant to remember information exactly as it is presented without analyzing it (Peek 2006). This causes savants

"the remarkable coexistence of superiority and deficiency."

injury or disease later in infancy, childhood, or adult life (Treffert 2009, 1354). Their conditions are varied and no one explanation appears to satisfy every case, but one of the most prominent theories concerning the incidence of savantism says that the right hemisphere of the brain compensates for damage in the left hemisphere (Moran 2010, 14; Treffert 2009, 1354). This

to remember vast amounts of rote knowledge, but fail to comprehend or understand what they know. The left hemisphere typically dominates this encoding and when it is compromised, the individual can access the less-processed information with ease. Damage-compensation theory seems to explain not only the gender discrepancies in savantism, but also the mechanism and reason for a savant's limited and focused talents and powerful memory.

There are many links between autism and savantism, with roughly half of savants being autistic and 1 in 10 patients diagnosed with ASD display a form of savantism (Treffert 2009, 1352). While there is no definite causal link between autistic disorders and savantism, the two are very similar in the development of the social and the analytic brain. According to Baron-Cohen, a leading authority on autism, high local connectivity within a neural network presenting in tandem with low long-range connectivity between two parts of the brain may lead to the localized talent typical of both savantist and autistic patients (Baron-Cohen & Belmonte 2005, 117). This causes the analytic capabilities of a savant to develop deeply into a limited breadth of areas. The social brain is perhaps more interesting however, because while a savant's areas of talent persist at the same level, or even improve, over time with continued use, the disabilities of a savant (i.e. their social skills) can recede (Treffert 2009, 1354; Dawson et al 2008, 767). Dr. Treffert argues that the nurturing of savant abilities results in a broadening of focused abilities and the flourishing of previously limited social abilities (Dawson et al 2008, 767; Treffert 2009, 1354). There is no trade-off, in most cases, between the acquisition of language, socialization, or daily living skills with these abilities. In fact, a savant's abilities, when harnessed and built on, may even become conduits toward normalization (Treffert & Wallace 2004, 21; Treffert 2009, 1354). That is, the sense of accomplishment that savants receive from their talents allows them to participate more fully in this world (Treffert & Wallace 2004, 22).

The growth of emotion and creativity in savants can be examined through the case studies of three savants: Kim Peek (KP), Derek Paravicini (DP), and Daniel Tammet (DT). Their life stories exemplify not only the limitations of their disability and the extent of their talent, but also the potential for personalities to change and for people to grow as

individuals. Drawing evidence from documentaries made of these individuals' lives and the scientific evidence concerning their conditions, there is worthy cause to suspect that the limitations associated with savantism can slowly be chipped away.

CASE STUDY 1

KP

THE EMERGENCE OF CREATIVITY AND SOCIALABILITY



"A savant's abilities, when harnessed and built on, may even become conduits toward normalization."

Kim Peek was the world's most famous mega-savant. Now deceased, he was also the basis for the Rain Man character. His prodigious memory and interest in a wide range of topics was unique, as savants generally have narrow fields of interest. KP was not diagnosed with a specific developmental disability, but he was likely not autistic. He would have been diagnosed with Opitz-Kaveggia syndrome (commonly called FG syndrome), which manifests with poor muscle tone, macrocephaly (enlarged cranium), and the absence of the corpus callosum (Peek 2006). This last symptom is the most interesting in KP's case.

The corpus callosum is the largest white matter mass in the brain – it is the neural superhighway that effectively links the left and right hemispheres. In KP, the neurons that would have formed the corpus callosum rewired themselves to connect distant parts of his brain, allowing him to store a massive volume of information and recall it instantaneously (Peek 2006). This eidetic memory spans not only a depth of knowledge, but also a breadth of information uncharacteristic of savants: fifteen subject areas (Treffert & Christensen 2009). However this ability came at a price, as he was unable to care for himself without the vigilance of his father, Fran Peek, and exhibited many of the social and behavioral signs of autism, including a lack of "theory of mind" (Peek 2006).

The "theory of mind" is what human interactions have styled as empathy: the recognition of the emotions and thoughts of another in nonverbal communication (Baron-Cohen et al 1985, 39). This is what we rely on every day to comfort someone who is feeling sad or to tell a joke to a receptive audience.

“Confident, outgoing, and unique, KP appeared in front of millions to share his condition – both his talent and his disability – with the world.”

KP, according to scientists, lacked this fundamental trait, which stunted his social skills and limited his emotional outreach. In recent years since the release of Rain Man, however, those around KP noticed changes in his memory and behavior that hint at the emergence of creativity and sociability (Peek 2006).

After Rain Man made KP a celebrity, his inclination to engage socially grew dramatically (Treffert & Wallace 2004, 22). In the documentary

The Real Rain Man, KP said that, “Until [he] started being Rain Man, [he] couldn’t look in a person’s eyes,” but after meeting film director Barry Morrow and being recognized in national spotlight, his desire to socialize became more apparent (Peek 2006). Confident, outgoing, and unique, KP appeared in front of millions to share his condition – both his talent and his disability – with the world (Associated Press 2004; Alden 2009). He answered obscure questions from attentive audiences who want to test his knowledge and his father speaks to the impact of Rain Man’s production on awareness of savantism. Along with social communication came symbolic and metaphorical decoding, like understanding sarcasm and rhetorical devices. While savants tend not to be interested in fiction and non-literal literature, KP had started reading books by Stephen King (Associated Press 2004). KP emerged from his social isolation after Rain Man brought his accomplishments to national recognition, providing evidence that developing and displaying a savant’s abilities can help normalize his social abilities by providing an avenue to interact socially.

Eidetic savants commonly fall short of understanding what they have memorized – few can logically link the many details in their heads together. KP, however, had acquired an ability to think quickly and create intricate associations with his facts. Much like a musician improvises with the notes he can play on his instrument, KP used his knowledge to give new meanings to what he experienced around him (Treffert & Christensen 2009; Peek 2006). In the last two years of his life, KP had even started playing music on the piano rather than simply learning about it. His manual dexterity was increasing and “when seated at the piano, he may play the piece he wishes to discuss, sing

the passage of interest or describe the music verbally” (Treffert & Christensen 2009). His forays into music as well as his advanced comprehension of what he absorbed lent credence not only to his claim to fame as a mega-savant, but also to the idea that savants may expand

or creatively enhance their memory by nurturing their abilities (Treffert & Christensen 2009).

These are anecdotal clues that a savant may grow outside of his or her disability, but full scientific experimentation was not possible due to KP’s passing. Corpus callosum researchers such as Dr. Lynn Paul at Caltech discovered that while KP’s social skills still suffered from a lack of “theory of mind,” his original introverted nature appears to have given way to a more social person (Peek 2006). Despite the shortcomings of his social abilities, KP demonstrated an impressive growth over and above the effects of FG syndrome in the realms of creativity and social connection, and even pushed the limits of human potential by expanding his already impressive abilities.



Figure 2. Mega-savant Kim Peek, pictured in front of an MRI of his brain – the black area above his head is where the corpus callosum should be (Treffert 2011)

Case Study 2

ENCODING OF EMOTION
AND
STRUCTURED IMPROVISATION



Derek Paravicini is a blind, autistic pianist who has been certified as a musical prodigy. To explain his condition, researchers point to events that took place shortly after his birth, which was 3 ½ months premature (Paravicini 2003). To aid his underdeveloped lungs, doctors gave him oxygen, but an overdose destroyed his retinas and damaged his brain (Paravicini 2003). His brain is solely devoted to processing, hearing, and reproducing music on the piano. He can play a piece after hearing it only once and is gifted with absolute pitch, which is so finely tuned that he can distinguish between any number of notes played at once (Paravicini 2003).

This innate ability to know exactly what he hears is due to his lack of auditory processing (Paravicini 2003). Imagine having a conversation with a friend at a train station – a normal person would focus on the friend’s dialogue and the surrounding noise seems to blur around their ears, almost like white noise. For DP, none of the noise is filtered out; he hears all of it and his brain can rapidly process the information with unbelievable speed and accuracy. Amidst this talent, his autistic condition limits his communication and comprehension skills to a childish level.

At the age of two, DP was seen to have innate musical abilities on the piano and has been nurtured by his teacher, Dr. Adam Ockelford, who

music lends itself to sequence and pattern, musical interest in autistic patients can be developed to savantism (Paravicini 2003). Dr. Ockelford observed his pattern over DP’s life and condensed his creative process as a function of memory. His playing “invariably makes musical sense,” and when playing a piece that is beyond his working memory, he fills the gaps in his knowledge intuitively (Ockelford & Pring 2005, 905). For example, after being played a complicated chromatic piece in an early jazz style, DP was able to work out the majority of the song, but in certain sections, he adapted by rearranging elements of the tonality, meter, and phrase structure with subtle transformations and introducing new material from pieces of similar style (Ockelford & Pring 2005, 905). Often more important to DP’s process is



Figure 2. Derek Paravicini in concert (Chapman2010)

understanding the overall concept of the song rather than every minute detail – this forms the basis for his complex improvisation which stands to compete with non-autistic virtuoso players (Ockelford & Pring 2005, 906)

One aspect of expression that often escapes autistic musicians is the emotion of playing and the transmission of that emotion to the listener. Performances are often technically proficient, but emotionally stilted by the analytical

approach to the piece. Researchers have analyzed DP’s playing for emotional relevance and understanding of emotional cues. In an experiment conducted by Dr. John Sloboda, DP was asked to play the same piece three

“DP is a fascinating insight into how savants may grow, harnessing the potential of resources that are both innate and foreign to them to enhance their abilities.”

has observed his creative process and improvisational technique (Paravicini 2003). Dr. Baron-Cohen notes in the documentary *The Musical Genius* that people with autism tend to be good at systemizing and because

different ways, each meant to exemplify a different emotion (Paravicini 2003). To communicate “happy”, DP played in a major key, fairly up-tempo, and staccato, which was effective at capturing the emotion. For “sad”, he switched to minor key immediately, showing some emotional encoding (minor = sad, and visa versa) and began playing slower and more legato. Lastly, DP was asked to play “angry”, which seemed to stump him – he played it much the same as happy, but began grunting under his breath, hinting that he knew there was something else he had to add, but he did not know how to phrase it musically. The second experiment involved having DP identify the emotion communicated by another musician playing a piece three different ways, using the same emotions. His insecurity in his answers, even though all were correct, communicated that while he had begun to, as Dr. Sloboda said, “understand the code of emotional communication,” there is great room for improvement (Paravicini 2003). He does seem to be learning the emotional code of music and musicians like Jools Holland notes that his playing is “an extension of his personality and his feelings” (Paravicini 2003).

In looking at creativity in musical savants, jazz is the playground of the innovative. The tradition of improvisation and artistic freedom within jazz might be thought to deter savants, who generally adhere to structure and pattern, but DP flourishes in early-jazz pieces where his solos can color his playing with whatever he hears and feels (Paravicini 2003). With highly analytic hearing, an abundance of creativity, and evidence of emotional communication via music, DP is a fascinating insight into how savants may grow, harnessing the potential of resources that are both innate and foreign to them to enhance their abilities.



EXTRAORDINARY TALENT REACHES SOCIAL NORMALITY

Daniel Tammet is a rarity in the savant world. He is gifted with prodigious unconscious abilities with numbers, numerical color-form synesthesia, and a

“These shapes are distinct and clear – longer strings of numbers form mental landscapes from which he reads individual digits.”

proclivity for languages (he knows nine), but appears to have few, if any, social hindrances. Although he was diagnosed with high-functioning Asperger



Figure 3. Daniels Tammet’s synaesthetic visualization of the number pi rendered in painting entitled “Pi Landscape.”

syndrome, DT can hold a conversation, hold stable relationships, live a life without constant care, and has created a career as a writer (Tammet et al. 2006). In the documentary *The Boy with the Incredible Brain*, Dr. Baron-Cohen remarked: “for whatever reason, he has managed to adapt to our world” (Tammet et al. 2006). He is the lynchpin of savant research because he has the ability to describe how his mind works.

Synesthesia is the cross-activation of two separate sensory parts of the brain when stimulation of one sense automatically triggers a perception in a second sense without any direct stimulation between the first and second sense (Baron-Cohen et al 2007, 238). The experience of seeing sounds and hearing colors or associating days of the week unconsciously with colors are examples of this double-stimulation effect. For DT, numbers and sensory experiences are linked in such a way that he can visualize all numbers up to 10,000 as distinct shapes, textures, colors, and feelings (Tammet et al. 2006; Baron-Cohen et al 2007, 241). He can identify prime numbers without performing division and calculate vast mathematical equations without consciously performing a step – his mind appears to subconsciously perform these feats, leaving him to translate the shapes he sees into numbers (Tammet et al. 2006). These shapes are distinct and clear – longer strings of numbers form mental landscapes from which he reads individual digits. Figure 3 is a drawing made by DT to show how he experiences the number pi (©).

The emotional connection DT has to numbers started after several epileptic seizures that may have created this synesthesia (Tammet et al. 2006). Much like KP, DT is renowned for mental feats, such as memorizing and reciting the first 22,514 digits of pi

actions appeared to other children, a phenomenon called “mindblindness,” but after he became thirteen, his mother began to teach him to focus on the other person’s face (Baron-Cohen et al 2007, 247-248). His social growth reveals new ways that savants can become more normal and productive, giving proof that “people on the autistic spectrum could learn to recognize facial expressions with conscious effort” (Baron-Cohen et al 2007, 248).

In his best-selling novel, *Born on a Blue Day*, DT notes that he is still a slave to his systemizing tendencies, but these do not manifest in detrimental developmental disabilities (Tammet 2007, 1-2, 6). In addition to his amazing mental abilities, DT created a new language called Mänti, a feat of innovation that is not typically associated with savants who tend to regurgitate information rather than create it (Tammet et al. 2006). As a seemingly normal person, DT is capable of explaining the mind of a savant, lending

Implications for Humanity

Is there a savant within us all?



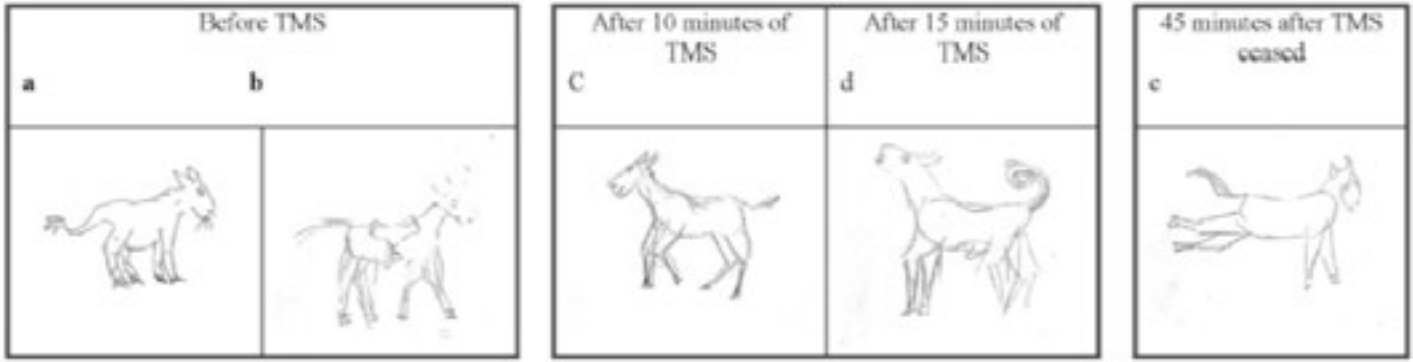
The question of whether savant-like abilities can be extended to individuals without disabilities has lead scientists to the frontier of neuroscience. All three savants presented here show some growth into the world of social communication, creativity, and emotion. However, is there a possibility that humans can attain the talent of a savant without sacrificing everyday function?

The talents of KP, DP, and DT are unconscious and intuitive. They draw upon the singular outcomes of their disabilities to focus their energy and ability on certain subjects and knowledge bases. Their skills may not be outside the normal human’s grasp. Studies of patients with frontotemporal dementia (FTD), the degeneration of the frontal and

temporal lobes of the brain, revealed that right-brain abilities, like those typically associated with savantism, were amplified (Treffert 2009, 1355; Treffert & Wallace 2004, 16, 23). The patients with inhibition of the left anterior temporal lobe (LATL) gained artistic and calendrical skills as the dementia progressed, making them a class of “acquired savants” (Treffert 2009, 1355). This discovery not only confirmed the theory

“...deep in all our brains are phenomenal abilities, which we lose for some reason as we develop into ‘normal’ conceptual creatures”

(©) and learning Icelandic in a week (Tammet 2007, 234-235). He is unique in that he seems to have picked up enough social skills to blend in so that his singular ability does not appear to be fettered by any visible disability. While he is still on the autistic spectrum, his syndrome does not impair his day-to-day functioning. DT initially lacked a theory of mind as a child in the sense that he was unaware how his



of left brain damage with right brain compensation, but also opened up the possibility of inducing these effects by controlling brain activity with magnetic stimulation and inhibition at the correct loci.

Dr. Allan Snyder postulated that advanced memory, absolute pitch, and synesthesia are latent in everyone, but are repressed due to the cognitive processing and conceptual encoding performed by the left hemisphere of the brain (Snyder 2009, 1400). Savants are able to access these abilities precisely because the left hemisphere is damaged. Dr. Snyder used repetitive transcranial magnetic stimulation (rTMS) to temporarily inhibit the LATL of normal human subjects and then gauged numerosity and drawing abilities at regular intervals (Snyder 2009, 1401). It was found that the subjects experienced temporary savant-like abilities and improvements in intuitive counting and pattern recognition (Snyder 2009, 1402; Snyder et al 2006, 842; Osborne 2003). Tasks like drawing cats and guessing how many dots were printed on a page reflected how the procedure awakened latent neural capabilities that rely on simply accessing raw, less-processed sensory information.

Not every scientist is convinced of these findings, however. Dr. Michael Howe, a psychologist at the University of Exeter argued that these abilities are “the result of incessant practice and specialization” in tasks that most humans would not be bothered with (Osborne 2003). Robert Hendren at the University of California, San Francisco also adopted some caution in accepting Dr. Snyder’s results, stating that drawing cats over and over again would lead to improvement

on its own, regardless of magnetic stimulation (Osborne 2003). In defense of Dr. Snyder’s results, it should be pointed out that savants, like DP, are indeed cultivated through practice, but music is by no means a field normal people avoid. In addition, Dr. Snyder’s experiment also tested numerosity skills, which are not known to necessarily improve with repetition or practice – the knowledge there is more intuitive and must rely on the sensory information our brains store about our surroundings.

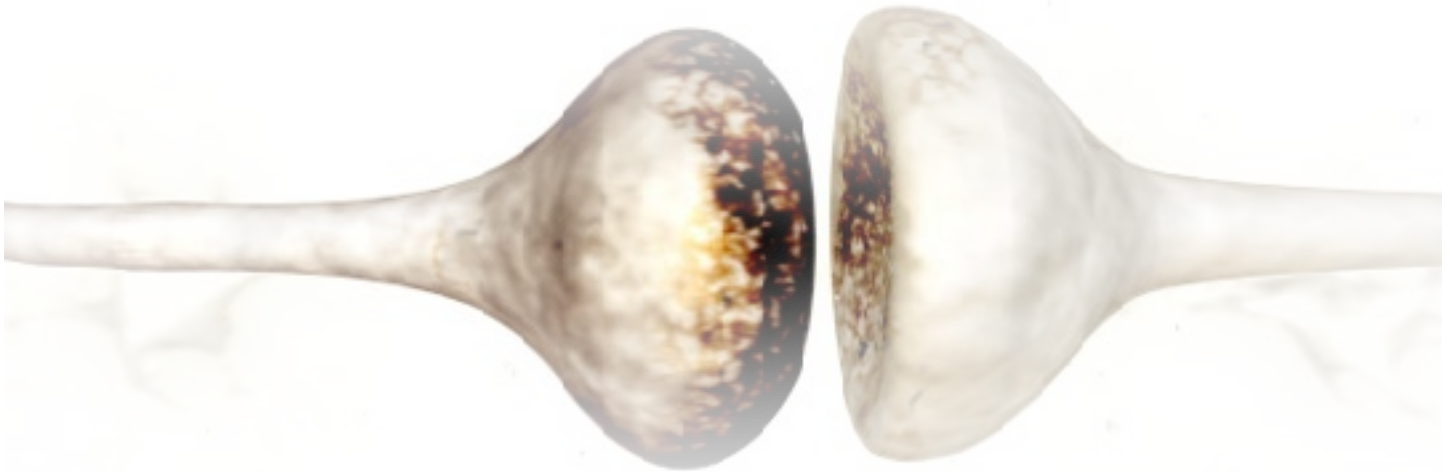
What these findings show is that savant-like abilities may be induced in individuals by repressing neural centers that encode sensory information. These centers form the basis for subjectivity, and once inhibited, allow a person to be objective in their senses. Subjects begin to see what is truly there rather than what their minds think is there. One of Dr. Snyder’s experiments included reading a well-known phrase several times, arranged on a paper thusly:

A bird in the
the hand is worth
two in the bush

If read aloud, many people would fail to notice that an extra ‘the’ is printed in the third line; the human brain absorbs this, but encodes the sensory information such that we obtain the meaning of the phrase without being bothered with the now obvious misprinting (Osborne 2003; Snyder et al. 2003, 155-156). Dr. Snyder told Lawrence Osborne, one of his subjects: “we remember virtually everything, but we recall very little ... Buried deep in all our brains are phenomenal abilities, which we lose for some reason as we develop into ‘normal’ conceptual creatures” (Osborne 2003). By subjecting individuals to rTMS to inhibit certain areas of the brain that are often damaged by FTD, normal people can temporarily experience new, savant-like abilities without drawback (Treffert 2009, 1357; Treffert & Wallace 2004, 23).

“Subjects begin to see what is truly there rather than what their minds think is there.”

Bridge Between Two Worlds



B S J

The growth of emotion, social skills, and creativity in savants shows that they have the potential to be more like us, and the scientific findings regarding their prodigious ability hints that we could be more like them than we think. As Dr. Snyder's experiments with magnetic stimulation showed, if indeed savant abilities are latent in all of us, then there may be the possibility to awaken them without drawbacks.

"...they have the potential to be more like us, and the scientific findings regarding their prodigious ability hints that we could be more like them..."

The meeting between Peek and Tammet and the spontaneous interest each had with the other was described as a union of "kindred spirits" (Peek 2006; Tammet et al. 2006). Autism does not preclude pleasure in social interaction and neither does savant syndrome (Dawson et al 2008, 767). In fact, the abilities of a savant may be cultivated to create a path towards normality and sociability. The stories and scientific studies of Kim Peek, Derek Paravicini, and Daniel Tammet have shed new light on both savant syndrome and the broader human condition. Their limitations, much like a normal person's, need not be absolute barriers to aspirations of intrinsic greatness.

One of the greatest lessons of savantism is that these extraordinary people "thrive because of the reinforcement provided by the unconditional love, belief, and determination of those who care for them" (Treffert & Wallace 2004, 23). The bridge between the two worlds is being built from both sides – it is only a matter of time until humans can walk freely between the normality of modern society and the island of genius called savant syndrome.

I would like to add a special thanks to Dr. Darold Treffert and the Optimnem staff whose comments and encouragement helped shape my understanding of savant syndrome and motivated me to delve deeper into the body of savantism research.

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