

# The savant syndrome: an extraordinary condition. A synopsis: past, present, future

Darold A. Treffert<sup>1,2,\*</sup>

<sup>1</sup>*University of Wisconsin Medical School, Madison, WI 53726, USA*

<sup>2</sup>*Behavioral Health Department, St Agnes Hospital, 430 East Division Street,  
Fond du Lac, WI 54935, USA*

Savant syndrome is a rare, but extraordinary, condition in which persons with serious mental disabilities, including autistic disorder, have some ‘island of genius’ which stands in marked, incongruous contrast to overall handicap. As many as one in 10 persons with autistic disorder have such remarkable abilities in varying degrees, although savant syndrome occurs in other developmental disabilities or in other types of central nervous system injury or disease as well. Whatever the particular savant skill, it is always linked to massive memory. This paper presents a brief review of the phenomenology of savant skills, the history of the concept and implications for education and future research.

**Keywords:** savant syndrome; autism; memory; brain; education

## 1. INTRODUCTION

Without doubt, the best-known autistic savant is a fictional one, Raymond Babbitt, as portrayed by Dustin Hoffman in the 1988 movie *Rain man*. However, the original inspiration for the savant portrayed in *Rain man* was a now 57-year-old male who has memorized over 6000 books and has encyclopedic knowledge of geography, music, literature, history, sports and nine other areas of expertise (Peek & Hanson 2008). He can name all the US area codes and major city zip codes. He has also memorized the maps in the front of telephone books and can tell you precisely how to get from one US city to another, and then how to get around in that city street by street. He also has calendar-calculating abilities and, more recently, rather advanced musical talent has surfaced. Of unique interest is his ability to read extremely rapidly, simultaneously scanning one page with the left eye and the other page with the right eye. Magnetic resonance imaging (MRI) shows the absence of the corpus callosum along with other substantial central nervous system (CNS) damage.

The combination of blindness, mental handicap and musical genius is conspicuously over-represented throughout the reports of savant syndrome from earliest times. Prominent cases include Blind Tom who travelled internationally and became famous in the 1800s, Tredgold’s case at the Salpetriere even earlier than that and a number of well-known present-day musical savants. Why that rare triad of musical genius, blindness and mental handicaps should occur so consistently in the already rare condition of savant syndrome deserves very careful study.

\* Address for correspondence: Behavioral Health Department, St Agnes Hospital, 430 East Division Street, Fond du Lac, WI 54935, USA (daroldt@charter.net).

One contribution of 18 to a Discussion Meeting Issue ‘Autism and talent’.

Reports of female savants continue to be relatively few. Selfe (1978) described the case of Nadia, which has triggered considerable debate about the possible ‘trade-off’ of special skills for language and social skills acquisition. Viscott (1969) documented in detail, including psychodynamic formulations, a female musical savant whom he followed for many years. Treffert (2006a) described a blind, autistic musical savant who, along with her musical ability, demonstrated very precise spatial location abilities and precise time-keeping skills without access to a clock face or other time instruments.

Detailed reports of these and many other savants dating from Down’s original description of the disorder are contained in *Extraordinary people: understanding savant syndrome* (Treffert 2006a). Moreover, information about many of them, including some video clips, can be accessed on the savant syndrome website at [www.savantsyndrome.com](http://www.savantsyndrome.com) maintained by the Wisconsin Medical Society Foundation.

## 2. WHERE WE HAVE BEEN

Savant syndrome, with its ‘islands of genius’, has a long history. The first account of savant syndrome in a scientific paper appeared in the German psychology journal, *Gnothi Sauton*, in 1783, describing the case of Jedediah Buxton, a lightning calculator with extraordinary memory (Mortiz 1783). Rush (1789), the father of American psychiatry, also provided one of the earliest reports when he described the lightning calculating ability of Thomas Fuller ‘who could comprehend scarcely anything, either theoretical or practical, more complex than counting’. However, when Fuller was asked how many seconds a man had lived who was 70 years, 17 days and 12 hours old, he gave the correct answer of 2 210 500 800 in 90 s, even correcting for the 17 leap years included (Scripture 1891).

However, the first specific description of savant syndrome took place in London in 1887 when Dr J. Langdon Down gave that year's prestigious Lettsomian Lecture at the invitation of the Medical Society of London. In that lecture, he reflected on his 30 years as a physician at the Earlswood Hospital and described 'an interesting class of cases for which the term 'idiot savants' has been given, and of which a considerable number have come under my observation'. He then presented 10 cases of persons with 'special faculties' that read exactly similar to cases now 121 years later. One of his patients had memorized *The rise and fall of the Roman Empire* verbatim and could recite it backwards or forwards. Other children drew with remarkable skill but 'had a comparative blank in all the other faculties of mind'. Still other children showed music ability, arithmetical genius or precise timekeeping skill, all of which, taken together, comprised a clinical picture of savant syndrome—special skills+phenomenal memory—which unfailingly reoccurs in case reports to this day.

In 1887, 'idiot' was an accepted classification for persons with an IQ below 25, and 'savant', or 'knowledgeable person', was derived from the French word *savoir* meaning 'to know'. Down joined those words together and coined the term idiot savant by which the condition was generally known over the next century. While descriptive, the term was actually a misnomer since almost all cases occur in persons with an IQ higher than 40. In the interest of accuracy and dignity, savant syndrome now has been substituted and is widely used. Savant syndrome is preferable to 'autistic savant' since only approximately 50 per cent of persons with savant syndrome have autistic spectrum disorder and the other 50 per cent have some other forms of CNS injury or disease.

Tredgold (1914), also from the Earlswood Hospital, wrote a very comprehensive account of savant syndrome in a chapter in his well-known textbook, *Mental deficiency*. This classic chapter, which was carried for many years into subsequent editions, described over 20 additional cases from a variety of clinicians. Hill (1978), provided a review of the literature between 1890 and 1978, including 60 reports involving over 100 savants. That same year, Rimland provided a summary of his data on 'special abilities' in 531 cases from a survey population of 5400 children with autism. Treffert (1988) provided an updated review, which contained more detail on all of those earlier cases and suggested that the name of the condition be changed to savant syndrome. In 1989, *Extraordinary people* was first published by Treffert, summarizing a century of cases, observations and research findings since Down's 1887 description of the disorder. In her book, *Bright splinters of the mind*, Hermelin (2001) summarized her findings based on 20 years of research by her and her co-workers. A comprehensive review article by Heaton & Wallace (2004) also provides an extensive bibliography on research to that date.

#### (a) *Did Dr Down describe autism?*

While Down is best known for having described Down's syndrome (trisomy 21) and savant syndrome in his 1887 lecture, he made an additional very astute

observation about what he called 'developmental retardation'. Today, that condition is known as autistic disorder (Treffert 2006b). Reflecting on his 30 years of experience, he divided mental retardation into 'congenital' and 'accidental' categories. However, he mentioned, there was a third kind of mental retardation that occurred in children who did not have the usual 'physical aspects' of retardation. Some of these children had developed normally and then suddenly regressed and 'lost wanted brightness' and 'lost speech'. There was the suspension of 'normal intellectual growth'. These children lived 'in a world of their own', spoke 'in the third person', had 'rhythmical and automatic movements' and 'lessened responsiveness to all endearments of friends'.

Down called this 'developmental retardation' and described what are, without doubt, cases of both early-onset and late-onset (regressive) autism. That he should choose the term 'developmental' for this form of disorder is interesting indeed, because it was fully 93 years later that the term 'developmental disorders' was included, for the first time, in the DSM III (DSM-III, 2009), for the category in which autistic disorder was included. The fact that regressive or late-onset autism occurred, and was described so accurately by Down, more than a century ago is an important perspective to bear in mind in present-day discussions about the autism 'epidemic' and causes of regressive autism.

Of course, it was Kanner (1944) who described what he called 'early infantile autism'. Many of the same behaviours and traits Down commented on in his developmental retardation group of patients were similarly noted by Kanner in his description of his 10 original cases. Six of those individuals had special musical abilities and Kanner was struck as well by the overall heightened memory capacity of all 10 persons in that original group.

### 3. WHAT WE DO KNOW

After several centuries of reports and observations, we know that:

#### (a) *The condition is rare but one in 10 autistic persons show some savant skills*

In Rimland's (1978) survey of 5400 children with autism, 531 were reported by parents to have special abilities and a 10 per cent incidence of savant syndrome has become the generally accepted figure in autistic disorder. Hermelin (2001), however, estimated that figure to be as low as 'one or two in 200'. But the presence of savant syndrome is not limited to autism. In a survey of an institutionalized population with a diagnosis of mental retardation, the incidence of savant skills was 1 : 2000 (0.06%; Hill 1977). A more recent study surveyed 583 facilities, and found a prevalence rate of 1.4 per 1000, or approximately double the Hill estimate (Saloviita *et al.* 2000).

Whatever the exact figures, mental retardation and other forms of developmental disability are more common than autistic disorder, so a reasonable estimate might be that approximately 50 per cent of persons with savant syndrome have autistic disorder

and the other 50 per cent have other forms of developmental disability, mental retardation or other CNS injury or disease. Thus, not all autistic persons have savant syndrome and not all persons with savant syndrome have autistic disorder.

**(b) Males outnumber females in autism and savant syndrome**

Males outnumber females by an approximate 6 : 1 ratio in savant syndrome compared with an approximate 4 : 1 ratio in autistic disorder. In explaining that finding, Geschwind & Galaburda (1987) in their work on cerebral lateralization pointed out that the left hemisphere normally completes its development later than the right hemisphere and is thus subjected to prenatal influences, some of which can be detrimental, for a longer period of time. In the male foetus particularly, circulating testosterone, which can reach very high levels, can slow growth and impair neuronal function in the more vulnerably exposed left hemisphere, with actual enlargement and shift of dominance favouring skills associated with the right hemisphere. A 'pathology of superiority' was postulated, with compensatory growth in the right brain as a result of impaired development or actual injury to the left brain.

This finding may account as well for the high male : female ratio in other disorders, including autism itself since left hemisphere dysfunction is often seen in autism (Treffert 2005, 2006a). Other conditions, such as dyslexia, delayed speech and stuttering, also have a male predominance in incidence, which may be a manifestation of the same left hemisphere growth interference in the prenatal period described above.

**(c) Savant skills typically occur in an intriguingly narrow range of special abilities**

Considering all the abilities in the human repertoire, it is interesting that savant skills generally narrow to five general categories: *music*, usually performance, most often piano, with perfect pitch, although composing in the absence of performing has been reported as has been playing multiple instruments (as many as 22); *art*, usually drawing, painting or sculpting; *calendar calculating* (curiously an obscure skill in most persons); *mathematics*, including lightning calculating or the ability to compute prime numbers, for example, in the absence of other simple arithmetic abilities; and *mechanical* or *spatial skills*, including the capacity to measure distances precisely without benefit of instruments, the ability to construct complex models or structures with painstaking accuracy or the mastery of map making and direction finding.

Other skills have been reported less often, including: prodigious language (poly-glot) facility; unusual sensory discrimination in smell, touch or vision including synaesthesia; perfect appreciation of passing time without benefit of a clock; and outstanding knowledge in specific fields such as neurophysiology, statistics or navigation. In Rimland's (1978) sample of 543 children with special skills, musical ability was the most frequently reported skill followed by memory, art, pseudo-verbal abilities, mathematics, maps and directions, coordination, calendar calculating and extrasensory perception. Hyperlexia, which

is distinguished by precocity rather than age-independent level of skill, has also been frequently reported in autism (Grigorenko *et al.* 2002).

Generally, a single special skill exists but, in some instances, several skills exist simultaneously. Rimland & Fein (1988) noted that the incidence of multiple skills appeared to be higher in savants with autism than in savants with other developmental disabilities. Whatever the special skill, it is always associated with prodigious memory. Some observers list memory as a separate special skill; however, prodigious memory is an ability all savants possess cutting across all of the skill areas as a shared, integral part of the syndrome itself. Several investigators have shown that memory alone cannot fully account for savant abilities, particularly calendar calculating and musical skills (Nettlebeck & Young 1999; Hermelin 2001). Formal testing for eidetic imagery shows that phenomenon to be present in some, but certainly not all, savants and when present it may exist more as a marker of brain damage than being central to savant abilities (Bender *et al.* 1968; Giray & Barclay 1977).

**(d) There is a spectrum of savant skills**

The most common are *splinter skills*, which include obsessive preoccupation with, and memorization of, music and sports trivia, license plate numbers, maps, historical facts or obscure items such as vacuum cleaner motor sounds, for example. *Talented savants* are those cognitively impaired persons in whom the musical, artistic or other special abilities are more prominent and highly honed, usually within an area of single expertise and are very conspicuous when viewed in contrast to overall disability. *Prodigious savant* is a term reserved for those extraordinarily rare individuals for whom the special skill is so outstanding that it would be spectacular even if it were to occur in a non-impaired person. There are, from my experience, probably fewer than 100 *known* prodigious savants living worldwide at the present time who would meet that very high threshold of savant ability.

**(e) The special skills are always accompanied by prodigious memory**

Whatever the special abilities, a remarkable memory of a unique and uniform type welds the condition together. Terms such as automatic, mechanical, concrete and habit-like have been applied to this extraordinary memory. Down (1887) used the term 'verbal adhesion'; Critchley (1979) used the term 'exultation of memory' or 'memory without reckoning'; Tredgold (1914) used the term 'automatic'; and Barr (1898) characterized his patient with prodigious memory as 'an exaggerated form of habit'. Such unconscious memory suggests what Mishkin *et al.* (1984) referred to as non-conscious 'habit' formation rather than a 'semantic' memory system. They proposed two different neural circuits for these two different types of memory: a higher level corticolimbic circuit for semantic memory and a lower level cortico-striatal circuit for the more primitive habit memory, which is sometimes referred to as procedural or implicit memory. Savant memory is characteristically very deep, but exceedingly narrow, within the confines of the accompanying special skill.

**(f) Savant syndrome can be congenital or it can be acquired**

Most often savant skills emerge in childhood, superimposed on some underlying developmental disability present at birth. However, 'acquired' savant skills can also appear, when none were previously present, in neurotypical individuals following brain injury or disease later in infancy, childhood or adult life (Lythgoe *et al.* 2005; Treffert 2006a). Recent reports of savant-type abilities emerging in previously healthy elderly persons with fronto-temporal dementia have been particularly intriguing (Miller *et al.* 1998, 2000; Hou *et al.* 2000). The prospect of dormant potential triggered, or released, by CNS injury existing within each person has far-reaching implications, as discussed elsewhere in this volume.

An important question is whether special skills are found in first-degree relatives of savants. Two studies, one with 25 savants and another with 51 subjects, showed relatives with special skills in *some* but certainly not all cases (Duckett 1976; Young 1995). Another study of 23 relatives of carefully studied savants found only one family member with special skills (LaFontaine 1974).

Young (1995) travelled to a number of countries and met with 51 savants and their families, completing the largest study performed on savants to date using uniform history taking and standardized psychological testing. Forty-one savants carried a diagnosis of autism and the remainder some other type of intellectual disability: 12 were rated as prodigious savants; 20 were rated as talented; and the remaining 19 had splinter skills. The savants in this series of cases had the following elements in common: neurological impairment with idiosyncratic and divergent intellectual ability; language and intellectual impairments consistent with autism; intense interest and preoccupation with particular areas of ability; rule-based, rigid and highly structured skills lacking critical aspects of creativity and cognitive flexibility; preserved neurological capacity to process information relating to the particular skills; a well-developed declarative memory; a family history of similar skills in some, but not all, cases but even in the absence of a history of a specific skill, there was a familial predisposition towards high achievement; and a climate of support, encouragement and reinforcement from families, case workers, teachers, caretakers and others.

**(g) Savant skills do not fade or disappear; rather a pattern of replication to improvisation to creation is often seen**

The case of Nadia, who lost her special art skills when exposed to traditional schooling, raised the prospect of a 'dreaded trade-off' of savant skills for acquisition of better language, communication and daily living skills (Selfe 1978). But experience has shown that such loss of special skills is the exception rather than the rule in savant syndrome. Instead, with continued use, the special abilities either persist at the same level or actually increase.

Now that I have had an opportunity to follow the unfolding of savant abilities in some individuals for nearly 30 years, I have seen a pattern of progression of

savant abilities in a number of prodigious savants particularly that ends in the capacity to be creative. In the light of these observations, I would revise my original comments in my book *Extraordinary people* that savants certainly demonstrated remarkable talent, and stunning replication abilities, but were not very creative. I was wrong.

The pattern I have observed begins with spectacular, literal *replication* of things seen or heard. Leslie Lemke, for example, played back Tchaikovsky's first piano concerto flawlessly at age 14, having heard it for the first time as a theme song to a television movie. From there Leslie moved, over time, from literal *replication* (which he can still do) to *improvisation*, seemingly having become bored with *just* reproducing what he has heard. In recent years, Leslie has moved now to *creation* of entirely new songs that he composes, plays and sings. This pattern of *replication* to *improvisation* to *creation* has been demonstrated in other musical savants. A well-known Japanese musical savant's ability as a *composer* demonstrates decisively that savants can be creative; his 40 *original* pieces on two internationally popular CDs forcefully document that ability (Cameron 1998).

That same transition can be seen in artistic savants. For example, Stephen Wiltshire can certainly *replicate* in stunning fashion what he sees as demonstrated in a recent documentary film clip, when, after a 45 min helicopter ride over Rome, he completed, in a three-day drawing marathon, an impeccably accurate drawing, on a five and half yard canvas. It captures with precision the many square miles he has seen street by street, building by building and column by column. A blueprint of the coliseum, superimposed on his drawing, shows an astonishing accurate replication. That clip can be seen at [www.savantsyndrome.com](http://www.savantsyndrome.com). However, Stephen can also *improvise* in his drawings, and he can also *create* scenes of his choosing. He has several art books published, and now has his own art gallery in London, which displays his various drawing styles (Wiltshire 1987, 1991).

There are other examples of this same replication to improvisation to creation pattern that space prohibits describing here. However, they are documented in *Extraordinary people* and on the savant syndrome website in detail.

**(h) No single theory can explain all savants**

Since Down's first description of savant syndrome, numerous theories have been put forth to explain this astonishing juxtaposition of ability and disability in the same person. Space precludes outlining those here but I do discuss them in detail in *Extraordinary people*. In the 'How do they do it?' chapter in that book, I outline in detail as well my speculation, based on observation, imaging and neuropsychological studies of a number of savants, that one mechanism in some savants, whether congenital or acquired, is left brain dysfunction with right brain compensation, a form of 'paradoxical functional facilitation' as described by Kapur (1996). Brink (1980) raised that possibility with a case in which left brain injury in a child gave rise to some mechanical and other savant skills. Miller's recent work with persons with fronto-temporal dementia (FTD) in whom savant skills surfaced, sometimes at a prodigious

level, adds impetus to that speculation (Miller *et al.* 1998, 2000). Those studies led him to conclude that 'loss of function in the left anterior lobe may lead to facilitation of artistic or musical skills'. Hou *et al.* (2000) stated it this way: 'The anatomic substrate for the savant syndrome may involve loss of function in the left temporal lobe with enhanced function of the posterior neocortex'.

Other current theories, including genetic, cognitive and neural, will be explored in other contributions to this volume.

#### 4. 'TRAINING THE TALENT': SUCCESSFUL EDUCATIONAL APPROACHES

Aetiologic considerations aside, what is the best approach to the savant and his or her special skills? Phillips framed the controversy in 1930 when he stated: 'The problem of treatment comes next...is it better to eliminate the defects or train the talent?' Experience has provided a clear answer—'train the talent'! And as one does so, some of the 'defect' subsides. The special talent, in fact, becomes a conduit towards normalization, using the unique savant skills to achieve better socialization, language acquisition and independence, all without the trade-off or loss of special abilities for those valuable gains in other areas of functioning. The special skills can be used as a way of engaging attention of the savant, and rather than seeing the special abilities as frivolous, they can be used as a form of expression with the goal of channelling those abilities more usefully.

Clark (2001) developed a savant skill curriculum using a combination of successful strategies currently employed in the education of gifted children (enrichment, acceleration and mentorship) and autism education (visual supports and social stories) in an attempt to channel and apply, usefully, the often non-functional obsessive savant and splinter skills of a group of students with autism. This special curriculum proved highly successful in the functional application of savant skills and an overall reduction in the level of autistic behaviours in many subjects. Improvements in behaviour, social skills and academic self-efficacy were reported, along with gain in the communication skills of some subjects.

Donnelly & Altman (1994) noted that increasing numbers of 'gifted students with autism' are now being included in gifted and talented classrooms with non-disabled gifted peers. Accompanying elements are an adult mentor in the field of their talent, individual counselling and small-group social skills training.

Some specialized schools are emerging as well. For example, Soundscape Centre in Surrey, England began operating in 2003 as the only specialized educational facility in the world uniquely dedicated to the needs and potential of persons with sight loss and special musical abilities, including musical savants. Orion Academy ([www.orionacademy.org](http://www.orionacademy.org)) in Moraga, California, USA specializes in providing a positive educational experience for high school students with Asperger's syndrome. Hope University ([www.hopeu.com](http://www.hopeu.com)) in Anaheim, California is a fine arts facility for adults with developmental disabilities. Its mission is to

'train the talents and diminish the disability' through the use of fine arts therapy including visual arts, music, dance, drama and storytelling.

Dr Temple Grandin is well known as an international authority in her field of animal science. She is also well known for her books including *Thinking in pictures* (1995) and *Translating with animals* (2005). She is also autistic. Another recent book, *Developing talents: careers for individuals with Asperger syndrome and high-functioning autism* (Grandin & Duffy 2004), is an excellent, practical resource for discovering, nurturing and 'training the talent' so that many persons on the autistic spectrum can enjoy the important experience of work and 'the satisfaction of contributing to their families and their communities, of being independent and economically self-sufficient'. This book outlines methods of helping children 'develop their natural talents' using 'drawing, writing, building models, programming computers' and similar skills to help build a 'portfolio' of skills that can help in the search for a meaningful work experience.

The book helps persons on the autistic spectrum, and their family members, teachers, counsellors and others to better understand and develop the career planning process for these special persons with special skills.

#### 5. FUTURE DIRECTIONS

No model of brain function, including memory, will be complete until it can account for, and fully incorporate, the rare but spectacular condition of savant syndrome. In the past decade, particularly, much progress has been made towards explaining this jarring juxtaposition of ability and disability, but many unanswered questions remain. However, interest in this fascinating condition is accelerating, especially since the discovery of savant-type skills in previously unimpaired older persons with FTD and other acquired savant instances. This finding has far-reaching implications regarding buried potential in some or, perhaps, all of us.

Advanced technologies will help in those investigations. Computed tomography (CT) and MRI provide stunningly high-resolution images of all the brain architecture, surface and deep, permitting detailed inspection of brain *structure*. However, studies of brain *function*, such as positron emission tomography (PET), single photon emission CT (SPECT) or functional MRI, are much more informative regarding savant syndrome, and, indeed, autism itself, since these newer techniques provide information about the brain at work, rather than simply viewing brain architecture. An even more recent imaging technique is diffusion tensor imaging, based on measuring water flow within neurons, which provides graphic images of brain *connectivity* between the brain hemispheres, within the brain hemispheres and between upper cortical and lower brain stem structures. A related technique, diffusion tensor tracking, provides a direct visual view of the actual fibre tracks, or wiring, of the brain in great detail.

One of the drawbacks to savant functional imaging research, especially art and music performance skills, has been the necessary immobilization of the subject

when doing the imaging. Near-infrared spectroscopy, which measures haemoglobin, uses an infrared cap which the patient can wear while 'at work' performing music or painting or drawing, for example. Also there have been many advances in electroencephalographic techniques, including magnetoencephalography, which provides a great deal of additional information beyond the usual electroencephalographic findings.

Detailed, standardized neuropsychological test results can then be correlated with the imaging findings in savants in sufficiently large samples to move away from what have been so many single subject, anecdotal reports. Control groups of non-impaired persons can be assembled to compare and contrast findings in both groups. Beyond that, since the interface between genius, prodigies and savants is an important, and in some ways a very narrow one, those persons should be included also in these multidisciplinary, multimodality, compare and contrast studies. Such studies can shed light on the debate regarding general intelligence versus separate intelligences. Some researchers suggest that savants provide a unique window into the creative process itself. From studies already completed, important information has already emerged regarding brain function, brain plasticity, CNS compensation, recruitment and repair.

Savant syndrome, both in the congenital and acquired types, provides compelling evidence of remarkable brain plasticity. Indeed, brain plasticity will be a central aspect of all neuroscience research in the decades ahead. Until fairly recently, there has been what Dodge (2007), in his book *The brain that changes itself*, calls 'neurologic nihilism'. This was a generally pessimistic view of the ability of neuronal tissue to regenerate and rewire itself in the face of injury or disease. The concept of one brain area being 'recruited' to take over the function of some other damaged area, paradoxical functional facilitation (Kapur 1996), is central to explaining savant syndrome. Some argue that the 'recruitment' of abilities is actually a 'release' phenomenon of already existing, but dormant, abilities as opposed to the compensatory development of new skills. In the case of right brain versus left brain capacity, some have referred to that substitution as a release 'from the tyranny' of the left, or dominant, hemisphere.

But there is more to savant syndrome than genes, circuitry and the brain's marvellous intricacy. As important as those matters are in terms of scientific interest, there is also much we can learn from savant syndrome from the human interest perspective provided by these remarkable people, and the equally remarkable and dedicated families, caretakers, teachers and therapists who surround them. For human potential consists of more than neurons and synapses. It also comprises, and is propelled along by, the vital forces of encouragement and reinforcement that flow from the unconditional love, belief, support and determination of those families and friends who not only care for the savant, but care about him or her as well.

At a 1964 meeting of the American Psychiatric Association, a discussant concluded, with respect to the 'calculating twins', that the importance of the savant 'lies in our inability to explain him; he stands as a landmark of our own ignorance and the phenomenon

of the idiot savant exists as a challenge to our capabilities' (Horwitz *et al.* 1965). But savant syndrome is less now a 'landmark to our ignorance' than 44 years ago. More progress has been made in the past 15 years in better understanding and explaining savant syndrome than in the previous 100 years. Also, that important inquiry continues, with the prospect of propelling us along further than we have ever been in unravelling the mystery of these extraordinary people and their remarkable abilities. Moreover, in that process, we can also learn more about ourselves, explore the 'challenge to our capabilities' and uncover the hidden potential—the little Rain man—that resides, perhaps, within us all.

## REFERENCES

- Barr, M. W. 1898 Some notes on echolalia, with the report of an extraordinary case. *J. Nerv. Ment. Dis.* **25**, 20–30. (doi:10.1097/00005053-189801000-00002)
- Bender, M. B., Feldman, M. & Sobin, A. J. 1968 Palinopsia. *Brain* **91**, 321–338. (doi:10.1093/brain/91.2.321)
- Brink, T. 1980 Idiot savant with unusual mechanical ability. *Am. J. Psychiatry* **137**, 250–251.
- Cameron, L. 1998 *The music of light: the extraordinary story of Hikari and Kenzaburo Oe*. New York, NY: Free Press.
- Clark, T. 2001 The application of savant and splinter skills in the autistic population through curriculum design: a longitudinal multiple replication case study. PhD thesis, School of Education Studies, The University of New South Wales, Sydney, Australia.
- Critchley, M. 1979 *The divine banquet of the brain*. New York, NY: Raven Press.
- Dodge, N. 2007 *The brain that changes itself*. New York, NY: Penguin.
- Donnelly, J. A. & Altman, R. 1994 The autistic savant: recognizing and serving the gifted student with autism. *Roeper Rev.* **16**, 252–255.
- Down, J. L. 1887 *On some mental affections of childhood and youth*. London, UK: Churchill.
- DSM-III 1980 *Diagnostic and statistical manual of mental disorders*. Washington, DC: American Psychiatric Association.
- Duckett, J. 1976 Idiot-savants: superspecialization in mentally retarded persons. Doctoral thesis, Department of Special Education, University of Texas in Austin.
- Geschwind, N. & Galaburda, A. M. 1987 *Cerebral lateralization: biological mechanisms, associations, and pathology*. Cambridge, MA: MIT Press.
- Giray, E. F. & Barclay, A. G. 1977 Eidetic imagery; longitudinal results in brain-damaged children. *Am. J. Ment. Defic.* **82**, 311–314.
- Grandin, T. 1995 *Thinking in pictures and other reports from my life with autism*. New York, NY: Vintage Books.
- Grandin, T. 2005 *Animals in translation: using the mysteries of autism to decode animal behavior*. New York, NY: Scribner.
- Grandin, T. & Duffy, K. 2004 *Developing talents: careers for individuals with Asperger syndrome and high functioning autism*. Shawnee Mission, KS: Autism Asperger Publishing Company.
- Grigorenko, E. L., Klin, A., Pauls, D. L., Senft, R., Hooper, C. & Volkmar, F. 2002 A descriptive study of hyperlexia in a clinically referred sample of children with developmental delays. *J. Autism Dev. Disord.* **32**, 3–12. (doi:10.1023/A:1017995805511)
- Heaton, P. & Wallace, G. L. 2004 Annotation: the savant syndrome. *Child Psychol. Psychiatr.* **45**, 899–911. (doi:10.1111/j.1469-7610.2004.t01-1-00284.x)

- Hermelin, B. 2001 *Bright splinters of the mind*. London, UK: Jessica Kingsley Publishers.
- Hill, A. L. 1977 Idiot savants: rate of incidence. *Percept. Mot. Skills* **44**, 161–162.
- Hill, A. L. 1978 Savants: mentally retarded individuals with special skills. In *International review of research in mental retardation* (ed. N. Ellis), pp. 277–298. New York, NY: Academic Press.
- Horwitz, W. A., Kestenbaum, C., Person, E. & Jarvik, L. 1965 Identical twins—'idiot savants'—calendar calculators. *Am. J. Psychiatry* **121**, 1075.
- Hou, C., Miller, B., Cummings, J., Goldberg, M., Mychack, P., Bottino, B. & Benson, F. 2000 Artistic savants. *Neuropsychiatry Neuropsychol. Behav. Neurol.* **13**, 29–38.
- Kanner, L. 1944 Infantile autism. *J. Pediatr.* **25**, 200–217.
- Kapur, N. 1996 Paradoxical functional facilitation in brain-behavior research: a critical. *Rev. Brain* **119**, 1775–1790. (doi:10.1093/brain/119.5.1775)
- LaFontaine, L. 1974 Divergent abilities in the idiot savant. Doctoral thesis, School of Education, Boston University in Boston.
- Lythgoe, M., Pollak, T., Kalmas, M., de Hann, M. & Chong, W. K. 2005 Obsessive, prolific artistic output following subarachnoid hemorrhage. *Neurology* **64**, 397–398.
- Miller, B. L., Cummings, J., Mishkin, F., Boone, K., Prince, F., Ponton, M. & Cotman, C. 1998 Emergence of artistic talent in fronto-temporal dementia. *Neurology* **51**, 978–982.
- Miller, B. L., Boone, K., Cummings, L. R. & Mishkin, F. 2000 Functional correlates of musical and visual ability in frontotemporal dementia. *Br. J. Psychiatry* **176**, 458–463. (doi:10.1192/bjp.176.5.458)
- Mishkin, M., Malamut, B. & Bachevalier, J. 1984 Memories and habits: two neural systems. In *Neurobiology of learning and memory* (eds G. Lynch, J. L. MacGaugh & N. M. Weinberger), pp. 65–77. New York, NY: Guilford Press.
- Mortiz, K. P. 1783 *Gnothi Sauton oder Magazin der Erfahrungsseelenkunde als ein Lesebuch für Gelehrte and Ungelehrte*. Berlin, Germany: Mylius.
- Nettlebeck, T. & Young, R. 1999 Savant syndrome. *Int. Rev. Res. Ment. Retard.* **22**, 137–173. (doi:10.1016/S0074-7750(08)60133-0)
- Peek, F. & Hanson, L. L. 2008 *The life and message of the real rain man*. New York, NY: Dude Publishing.
- Phillips, A. 1930 Talented imbeciles. *Psychol. Clin.* **18**, 246–255.
- Rimland, B. 1978 Savant capabilities of autistic children and their cognitive implications. In *Cognitive defects in the development of mental illness* (ed. G. Serban), pp. 43–65. New York, NY: Brunner/Mazel.
- Rimland, B. & Fein, D. A. 1988 Special talents of autistic savants. In *The exceptional brain: neuropsychology of talent and special abilities* (eds L. K. Obler & D. A. Fine), pp. 474–492. New York, NY: Guilford Press.
- Rush, B. 1789 Account of a wonderful talent for arithmetical calculation in an African slave, living in Virginia. *Am. Mus.* **5**, 62–63.
- Saloviita, T., Ruusila, L. & Ruusila, U. 2000 Incidence of savant skills in Finland. *Percept. Mot. Skills* **91**, 120–122. (doi:10.2466/PMS.91.5.120-122)
- Scripture, E. W. 1891 Arithmetical prodigies. *Am. J. Psychol.* **4**, 1–59. (doi:10.2307/1411838)
- Selfe, L. 1978 *Nadia: a case of extraordinary drawing ability in an autistic child*. New York, NY: Academic Press.
- Tredgold, A. F. 1914 *Mental deficiency*. New York, NY: William Wood.
- Treffert, D. A. 1988 The idiot savant: a review of the syndrome. *Am. J. Psychiatry* **145**, 563–572.
- Treffert, D. A. 2005 The savant syndrome in autistic disorder. In *Recent developments in autism research* (ed. M. F. Casanova), pp. 27–55. New York, NY: Nova Science Publishers.
- Treffert, D. A. 2006a *Extraordinary people: understanding savant syndrome*. Omaha, NE: iUniverse, Inc.
- Treffert, D. A. 2006b Dr Down and 'developmental disorders'. *J. Autism Dev. Disord.* **36**, 965–966. (doi:10.1007/s10803-006-0183-1)
- Viscott, D. S. 1969 A musical idiot savant. *Psychiatry* **32**, 494–515.
- Wiltshire, S. 1987 *Drawings*. London, UK: J. M. Dent and Sons.
- Wiltshire, S. 1991 *Floating cities*. New York, NY: Summit Books.
- Young, R. 1995 Savant syndrome: processes underlying extraordinary abilities. PhD thesis, University of Adelaide, Adelaide, South Australia.