BOOKS: NEUROSCIENCE

Extraordinary Talents of Autistic Minds

Marian Sigman

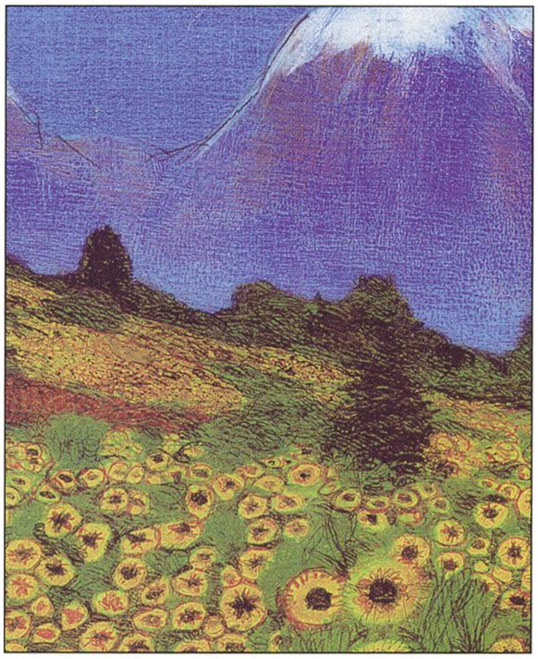
Bright Splinters of the Mind
A Personal Story of Research with Autistic Savants
by Beate Hermelin

Jessica Kingsley, Philadelphia, 2001. 192 pp. $49.95, £29.95. ISBN 1-85302-931-9. Paper, $19.95, £13.95. ISBN 1-85302-932-7.

Most individuals with autism show surprising variations in their abilities, with perceptual and cognitive skills usually surpassing verbal and social capacities. An aim of much research on autism over the last 40 years has been to identify the characteristics of these individuals that are attributable to their autism rather than to the mental retardation that usually accompanies it. Beate Hermelin, an honorary research professor at Goldsmith's College, University of London, has been a pioneer in such studies; her book with Neil O'Connor, *Psychological Experiments with Autistic Children* (Pergamon, Oxford, 1970), set the standards for behavioral research on autism. In *Bright Splinters of the Mind*, she reviews the findings of her research on "splinter skills," uncanny proclivities that are shown by a small number of individuals with autism. These abilities include the capacity to identify the day of the week of any date named over hundreds of years and to produce highly accurate and expressive pictorial representations (such as the painting reproduced here). Hermelin's research program is exceptional in that she studies groups of individuals skilled in a variety of domains, whereas previous work focused on single individuals or on only one skill domain.

The author and her collaborators sought to determine how the remarkable accomplishments of savants are achieved. The memory skills and strategies used by individuals having savant skills in different domains were explored by following the subjects as they performed a variety of tasks. The organizing hypothesis was that the thinking of individuals with autism is characterized by "weak central coherence" in which attention is primarily focused on components or details rather than integrated information. Such concentration on details may allow autistic savants to develop expertise in narrow areas of achievement. This expertise may then facilitate the acquisition of more global rules and techniques, allowing the individual to overcome the weak central coherence.

The strongest evidence for this theory emerges from a series of experiments with individuals who were able to solve difficult calendar calculations, create striking representational drawings, or perform musically. The skill of the calendar calculators (whose verbal IQs ranged from 40 to 80) seemed to depend somewhat on their memory for details; they were more accurate for the current year than other years and better for past dates than future dates. Perhaps the best example of this reliance on memory for noncentral components is the capacity of a musician with autism to reproduce faithfully both the melody and the harmonic chords in a piece of piano music. A skilled musician without autism was able to reconstruct some of the melody but was utterly unable to retain the harmony in this same piece of music.



Sunnier impression. This painting is one of several Hermelin discusses. It is brighter than the photograph from which it was developed. The moutain's contours have been softened, and the flowers have been given greater emphasis.

CREDIT: B. HERMELIN, *J. CHILD PSYCHOL. PSYCHIATRY* **40**, 1129 (1999)/COURTESY ASSOCIATION FOR CHILD PSYCHOLOGY AND PSYCHIATRY

The savants do not appear to have better memories in general. Rather, their memory capacities seem to be superior only for tasks that are directly involved in their area of strength. For example, the calendar calculators' memories for numbers or words were not better than those in a control group without the calendar skills matched on diagnosis and intelligence. Even their memories for dates were not superior unless they had just been involved in calculating the days of the week for these dates. Similarly, artists with autism (having IQs ranging from 38 to 78) did not have superior abilities to match or remember shapes despite the fact that they could draw both nonrepresentational and meaningful pictures better than members of a control group of matched nonartistic individuals with autism.

But a memory for details in specific areas is only a part of the savant skills: Hermelin demonstrates convincingly that savants are also able to master certain global rules and perspectives. For example, the calendar calculators used regularities in the calendar to determine days of the week more quickly and accurately than when the task administered did not involve such regularities. Artists with autism were able to use some of the pictorial devices that have been crucial to Western art. They employed linear perspective and reduced-size constancy as skillfully as a non-autistic control group of students admitted to art schools. A pianist with autism was able not only to reproduce but also to improvise traditional diatonic music as well as atonal music. In Hermelin's words, "The ability of musical savants was not confined to an outstanding musical memory but extended to the generation and invention of music."

Although the savants were able to use these general principles and techniques, they were rarely able to acknowledge or explain them. For example, only two of the eight calendar calculators acknowledged their use of regularities in the calendar despite extensive efforts by the investigators to tap this awareness. This is not surprising, given the limited verbal understanding and fluency that characterize many savant individuals and, in fact, most individuals with autism. In this light, it is interesting that only two savants with abilities in the verbal area were identified and studied, and both of these individuals were limited in their capacities. An autistic poet used fewer sound-based or rhythmic techniques than a non-autistic poet, and an autistic individual able to learn vocabulary and morphemes in many languages was unable to

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master the grammar of these languages.

Despite the extensive findings from this research program, many important questions remain: Why do some individuals with autism acquire savant skills while others do not? Is a person's particular area of expertise due to some inherent ability or to preferences in early childhood? What is the role of experience in fostering this expertise? Are the areas of the brain activated during the performance of savant skills similar to areas activated by these skills in non-autistic experts? Are there benefits or losses in other areas of life adjustment that accrue from the acquisition of these skills? Are individuals with autism more likely to develop savant skills in particular domains? With such questions in mind, future studies might focus on the development of the specialized interests, knowledge, and skills that are less elaborated than savant skills but more frequently shown by high-functioning individuals with autism. The author has set the stage for such an approach by determining that a group of musically naïve children with autism had superior pitch identification and memory when compared to a matched group of non-autistic children.

Hermelin's erudite account of this research on savant skills is absorbing and inspiring. Through an experimental approach and appropriate control groups, she has fashioned a robust methodological framework for such studies. Her work is also innovative and stimulating in that it draws on an appreciation of the abilities and strategies exploited by many of us in our efforts to acquire knowledge or undertake creative activities. *Bright Splinters of the Mind* is particularly welcome because it identifies characteristics not by analyzing the weaknesses of individuals with autism but rather by focusing on some of their very real strengths.

NOTA BENE: GENOMICS

Are You Ready?

"The genomic revolution is here: are you ready?" queries the latest exhibition at the American Museum of Natural History in New York City. Visitors may not be ready when they enter this ambitious offering, but perhaps they will be when they leave. Upon arriving, one sees a vial of DNA in a plinth—but reach out to pick up the vial and the hologram disappears, a fitting illustration of the invisible nature of the code of life.

The bases (green As, red Ts, yellow Gs, and blue Cs) constituting the entire human genome sequence scroll silently down a ceiling-to-floor screen. For those who do not have 11 months to watch the complete sequence pass by, its vast length is elegantly portrayed by three giant helical columns holding 140 copies of the Manhattan telephone directory. This is the number of volumes required if every letter and number in the directory were replaced by the 3.2 billion bases of a single strand of the double helix.

The most ambitious part of the exhibition seeks to explain how genes work. A series of wall panels take visitors on a journey through the eye into the cone cells (the color interpreters) of the retina. These panels describe how cone cells make opsin (a protein required for color vision) and how mutations in opsin cause red-green color blindness. Each step in the synthesis of opsin is rendered comprehensible thanks to a clever computer animation. Small children (perhaps the molecular biologists of tomorrow) watch mesmerized as a strand of messenger RNA shoots out of the cone cell nucleus and unites with the rotund factories (ribosomes) that will translate the mRNA into protein.

The Genomic Revolution
Rob DeSalle, Curator
American Museum of Natural History, New York. 26 May 2001 to 1 January 2002. www.amnh.org/exhibitions/genomics/

Nearby, a 576-square checkerboard that lights up in consecutive patterns of red, green, and yellow squares illustrates how DNA chips have been used to decipher which genes are switched on in breast cancer cells (red) but not in healthy breast epithelium (green). This display segues neatly into a frank discussion of the pros and cons of genetic testing through interviews with families battling inherited diseases. The story of two sisters with a family history of breast and ovarian cancer brings home the anguish that accompanies a decision to be tested—and the subsequent joy and sadness when one sister tests positive (she developed ovarian cancer a year later) and the other negative (she remained disease-free). Hope and heartache also feature in a description of attempts to use gene therapy to repair the defective DNA sequences that underlie hemophilia, Canavan disease, and severe combined immunodeficiency.

One of the most imaginative structures in the exhibition, and a great favorite with young museum goers, is the "mutation station" (left). A sculptor, an animator, and an electronics expert collaborated to create this vibrant model of a DNA double helix (representing part of a *Drosophila* gene). Base changes are introduced by twisting the illuminated, colored plastic rungs of the DNA ladder (the A-T and G-C base pairs of the gene). Each twist of a rung is accompanied by a color change, a sound reminiscent of a *Star Wars* light saber, and a display on an adjacent screen that indicates if the base change is a point mutation that results in a fruit fly with stunted wings or with a black body.

Equally innovative is the small laboratory where visitors, under the direction of a trained demonstrator, can prepare their own DNA from buccal cells of the cheek. There was no shortage of participants, who were perhaps lured by the eerie glow of the green, red, yellow, and blue luminescent laboratory tables (reminders of A, T, G, and C). A sold-out evening series of hands-on laboratory workshops (during which participants prepare their own DNA and watch it being sequenced) confirms the general public's fascination with molecular biology.

The final section tackles the arguments swirling around cloning, genetically modified organisms (GMOs), and genetic enhancement. The risks and benefits of GMOs are honestly debated in a comprehensive display that grapples with issues such as labeling foods containing GMOs, producing vaccines in plants, and the effects of GMOs on the environment.

Although the volume of information presented in *The Genomic Revolution* is overwhelming, everyone should leave this ambitious exhibition having learned something new.

—ORLA SMITH

CREDIT: DENIS FINNIN/AMNH