Perspectives on Education from a Person on the Autism Spectrum

by Temple Grandin

Today I am an associate professor of animal sciences at Colorado State University, but during the sixties I was a bored high school student who seldom studied. I was constantly teased and miserable, but my salvation was Mr. Carlock, my science teacher. Projects I undertook in his science lab provided a refuge away from the pressure cooker of teenage social life. Friendships were formed through shared interests in electronics, model rockets, and riding horses. The students who were interested in those specialized activities were not the individuals who did the teasing.

I failed to study because I had no goal after high school until Mr. Carlock's projects got me interested in science. The goal of becoming a scientist gave me the motivation to study. I cannot emphasize enough the importance of Mr. Carlock's mentoring. During the past twenty years I have lectured on autism at several hundred meetings. Inevitably, in discussions with parents, teachers, and specialists at those meetings, I discover that high-functioning autistic and Asperger's students who go into successful careers had teachers who motivated them to succeed.

Skills Are Uneven

Like many students on the autism-Asperger's spectrum, I had uneven skills. Although algebra was impossible, courses in which I could use my visual-thinking skills were easy. For me to think, I have to create pictures in my imagination. If somebody says, "Think about spinach," I see Popeye the sailor eating spinach, spinach salad at a local restaurant, and bags of spinach at my local grocery store. There is no spinach concept. I see spinach in specific places that I can identify. My mind searches for images the way the Internet search engine Google does. Even abstract concepts, such as democracy, appear to me as images. I visualize images of activities associated with democracy—ballot boxes, voting booths, the U.S. Senate, and a childhood club in which we voted on the type of soda

we would drink during a sleep-out in a tent. Algebra was impossible because there was no way I could use my visual method of thinking to understand it. There was no way to make pictures.

Visual thinking has made me very good at my chosen career—designing livestock equipment. Half the cattle in North America are handled in equipment I have designed. I can test-run equipment in my head like a virtual-reality computer program. When I was in high school I did not know that other students could not do that. In my book *Thinking in Pictures*, I describe visual thinking in more detail (Grandin 2006). In many people, visual thinking may be covered up by language. In some Alzheimer's patients, in fact, art talent emerges when the frontal cortex and verbal-thinking parts are destroyed (Miller, Cummings, and Mishkin 1998).

When I decided to study, there were two kinds of classes: those I could do easily, and the impossible. Algebra and foreign language were hopeless. Classes such as English, history, biology, psychology, neuroscience, and animal science were easy. In college I got through math with B's because in the 1960s finite math was taught, and probability and matrices were easier to visualize. A math teacher, Mr. Dion, also tutored me. In graduate school I had to be tutored in statistics, and I got A's and B's in all my other graduate courses.

Visual Thinking

Visual thinkers like me are good at hands-on work. My math education was not handled well. Because I kept failing algebra, I was never given an opportunity to try trigonometry or geometry. I could have learned trigonometry functions by making model suspension bridges and calculating the strength of the model bridge when the cables were placed at different angles. The real fun would have begun when the calculations could be tested by placing varying amounts of weight on the span. If my calculations on the design of the cables were correct, the bridge would have been able to hold a specified amount of weight. If they were wrong, the bridge would have broken. Hands-on experiments are a good way to teach math to a visual thinker.

Word problems in math were very difficult for me. I could easily learn how to calculate a specific type of trigonometry function for bridge cables, but to figure out how to manipulate the symbols for a different type of problem was very difficult. To learn statistics, I sat down with a tutor and designed specific experiments that could be analyzed with a particular statistical test. I had to do it this way because my mind forms principles by learning from lots of specific examples.

I designed a different experiment for each type of statistical test. I cannot think about experimental design in the abstract. For chi-square, I designed a specific experiment that had discrete variables. For analysis

of variance, I designed an experiment with one discrete variable and one continuous variable. A simple example of a discrete variable might be a breed of cattle, say Angus or Charolais, and a continuous variable might be weight gain. The hypothesis could be that Charolais cattle will gain more weight during a sixty-day feeding trial than will Angus cattle.

It is impossible for me to conceptualize research experiments unless I have a concrete example such as weight gain and different breeds of cattle. I made up about twenty-five different types of experiments to go with each type of test. When I have to do statistics, I refer to my notebook and find an experiment that can serve as an appropriate template. I am able to relate the structure of the cattle experiment to another experiment that uses one discrete and one continuous variable. An example would be testing the hypothesis that crows make louder sounds than chickadees. In this case, the species of bird is a discrete variable and the volume of sound is a continuous variable.

Develop Strengths

I have just discussed how to help individuals who share my propensity for visual learning in mathematics. However, I became successful in my career not because I "overcame a math deficit" but because I developed my area of strength—visualization. Too often, special educators put so much emphasis on deficits that they forget the importance of developing a child's talents. For example, from a young age, both my teachers and parents encouraged my ability in art.

Children with autism or Asperger's often fixate on one thing. Despair over the fixation will do no good; learning is better served by using the fixation as a tool in teaching. For example, if a child likes trains, the teacher should consider having the child read about trains and do mathematics with trains.

When I first wrote *Thinking in Pictures* I thought that everybody on the autism spectrum was a visual thinker. Now I know that is not the case. From talking to many high-functioning people on the spectrum, I have learned that most individuals on the autism spectrum have specialized brains. Some are terrible at visual thinking and others are whizzes at translating a foreign language. I asked many individuals how they think, and discovered three basic thinking types:

Visual Thinkers—similar to my thinking style.

Pattern Thinkers—good at music and math. They think in patterns and relationships between numbers instead of pictures, and they are often good at chess. They think in patterns instead of specific photographic images, the way I do.

Word Specialists—usually poor at visual thinking but will know every sport or weather statistic. Their favorite subjects in school are often history and foreign language.

Those thinking styles also occur in individuals with dyslexia, ADHD, and other learning problems.

Teaching Concepts

I am an associative thinker; I do not think in a linear, step-by-step fashion. Associative thinking can get off the subject. For example, when I think about spinach, the pictures in my imagination may shift to a salad bar in a restaurant and a person I met there. If I had a conversation with that person about wolf behavior, then my mind might shift categories and I might start thinking about wolves, with specific wolf images popping into my mind.

To form concepts, I place pictures of different images into categories and subcategories within categories. The more facts and experiences I can download into my memory, the better I can think; there is more information for my internal search engine to find. I put lots of little visual details together to form categories of information. Brain-scan studies conducted by Just et al. (2004) showed that the brain of an individual with autism is activated by details, while the normal brain loses the details.

Dr. Nancy Minshew, an autism researcher, found that children on the autism spectrum have difficulty making up new categories for objects (Minshew, Merger, and Goldstein 2002). However, flexibility of thinking can be taught. One way to develop this flexibility is to lay out a group of objects, such as a stapler, tape, pencil, calculator, book, and golf ball. Ask the student to make up new categories for objects, such as "contains plastic" or "used for office work." Concepts such as good behavior and bad behavior can be understood by placing images of good and bad behavior into the appropriate category. According to many brain researchers, forming categories is a fundamental way in which the brain organizes information (Freidman et al. 2001; Just et al. 2004; Quinoga et al. 2005).

Hands-on Experience

I am concerned when music, woodshop, auto mechanics, and elective classes are no longer offered at schools. Those are the types of courses in which many students who have uneven skills will excel and make themselves employable in good jobs. It is my opinion that the ultimate success of a high school program should be measured by looking at outcomes. One good outcome is getting into college and graduating. For

students who do not go to college, a good outcome is getting and keeping a job that enables a good standard of living. A bad outcome would be getting in trouble with the law or being forced to take a series of menial, dead-end jobs. I am offering specific practical outcomes since I am a visual thinker and don't think in lofty, abstract theory.

Barriers to Success

I am concerned that many talented people end up in low-paying, dead-end jobs because their areas of strength were never developed. If Einstein were born today, he might be driving a truck. Einstein did not speak until age three; he was a patent clerk in the Swiss patent office when he wrote his famous paper on relativity. Would a physics journal accept a paper from an unknown clerk today? Several famous scientists, musicians, engineers, and artists had learning problems or were on the autism spectrum (Grandin 2006; Ledgin 2002; West 1991; Wheelwright and Baron-Cohen 2001).

It is good that schools are raising standards, but I am concerned about children who, like me, have uneven skills. I was given an opportunity to get into college because the dean recognized my potential. Throughout my professional life I had to get in through the back door. I failed the Graduate Record Exam in math, and I was accepted into graduate school only because a faculty member at the University of Illinois, Stan Curtis, was willing to work with me. Getting through statistics required lots of tutoring. In my other classes I got A's and B's.

One size does not fit all. Different people have different types of thinking. A good example is the controversy over phonics versus whole-word teaching methods for teaching reading. I was a phonics learner, but often children on the autism spectrum learn best by memorizing whole words. The really good teachers try different methods and use the one that works for a particular child.

I want to end by saying that really good teachers are worth their weight in gold. One reason I have been successful is because I had great teachers.

Further Reading

On Autism/Asperger's/Dyslexia and Creativity

Grandin, T. 1996. *Thinking in Pictures*. Exp. ed. New York: Vintage, 2006.

Ledgin, N. 2002. *Asperger's and Self-Esteem*. Arlington, Tex.: Future Horizons. This book profiles famous scientists and musicians who probably had Asperger's.

West, T. G. 1991. *In the Mind's Eye*. Amherst, N.Y.: Prometheus Books. Profiles ten famous visual thinkers who had learning difficulties.

Wheelwright, S., and S. Baron-Cohen. 2001. "The Link between Autism and Skills such as Engineering, Math, Physics, and Computing." *Autism* 5: 223–227.

Neuroscience Studies That Provide Insights into Different Ways of Thinking

Freidman, D. J., M. Riesenhuber, T. Poggio, and E. K. Muller. 2001. "Categorical Representation of Visual Stimuli in the Primate Frontal Cortex." *Science* 291: 312–315. This study shows how the brain puts images into categories with clear-cut boundaries.

Just, M. A., J. L. Cherkassky, T. A. Keller, and N. J. Minshew. 2004. "Cortical Activation and Synchronization during Sentence Completion in High-Functioning Autism: Evidence of Under-connectivity." *Brain* 127: 1811–1821. The autistic brain responds to the details of words, and the normal brain responds to the whole sentence and drops the details.

Miller, B. L., J. Cummings, and F. Mishkin. 1998. "Emergence of Art Talent in Frontal-temporal Dementia." *Neurology* 51: 978–981. When Alzheimer's disease destroys the frontal cortex and language parts of the brain, art talent emerges in some patients.

Minshew, N. J., J. Meger, and G. Goldstein. 2002. "Abstract Reasoning in Autism: A Dissociation between Concept Formation and Concept Identification." *Neuropsychology* 16: 327–334. People with autism can identify categories but have difficulty inventing new categories.

Quinoga, R. Q., L. Reddy, G. Kreinen, C. Koch, and I. Fried. 2005. "Invariant Visual Representation by a Single Neuron in the Human Brain." *Nature* 435: 1102–1107. A single neuron became the repository of knowledge in one category. In this patient it was a famous actress.

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