THINKING IN PICTURES
with 2006 Updates from the Expanded Edition

Chapter 1: Autism and Visual Thought
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I THINK IN PICTURES. Words are like a second language to me. I translate both spoken and written words into full-color movies, complete with sound, which run like a VCR tape in my head. When somebody speaks to me, his words are instantly translated into pictures. Language-based thinkers often find this phenomenon difficult to understand, but in my job as an equipment designer for the livestock industry, visual thinking is a tremendous advantage.

Visual thinking has enabled me to build entire systems in my imagination. During my career I have designed all kinds of equipment, ranging from corrals for handling cattle on ranches to systems for handling cattle and hogs during veterinary procedures and slaughter. I have worked for many major livestock companies. In fact, one third of the cattle and hogs in the United States are handled in equipment I have designed. Some of the people I've worked for don't even know that their systems were designed by someone with autism. I value my ability to think visually, and I would never want to lose it.

One of the most profound mysteries of autism has been the remarkable ability of most autistic people to excel at visual spatial skills while performing so poorly at verbal skills. When I was a child and a teenager, I thought everybody thought in pictures. I had no idea that my thought processes were different. In fact, I did not realize the full extent of the differences until very recently. At meetings and at work I started asking other people detailed questions about how they accessed information from their memories. From their answers I learned that my visualization skills far exceeded those of most other people.

I credit my visualization abilities with helping me understand the animals I work with. Early in my career I used a camera to help give me the animals' perspective as they walked through a chute for their veterinary treatment. I would kneel down and take pictures through the chute from the cow's eye level. Using the photos, I was able to figure out which things scared the cattle, such as shadows and bright spots of sunlight. Back then I used black-and-white film, because twenty years ago scientists believed that cattle lacked color vision. Today, research has shown that cattle can see colors, but the photos provided the unique advantage of seeing the world through a cow's viewpoint. They helped me figure out why the animals refused to go in one chute but willingly walked through another.

Every design problem I've ever solved started with my ability to visualize and see the world in pictures. I started designing things as a child, when I was always experimenting with new kinds of kites and model airplanes. In elementary school I made a helicopter out

of a broken balsa-wood airplane. When I wound up the propeller, the helicopter flew straight up about a hundred feet. I also made bird-shaped paper kites, which I flew behind my bike. The kites were cut out from a single sheet of heavy drawing paper and flown with thread. I experimented with different ways of bending the wings to increase flying performance. Bending the tips of the wings up made the kite fly higher. Thirty years later, this same design started appearing on commercial aircraft.

Now, in my work, before I attempt any construction, I test-run the equipment in my imagination. I visualize my designs being used in every possible situation, with different sizes and breeds of cattle and in different weather conditions. Doing this enables me to correct mistakes prior to construction. Today, everyone is excited about the new virtual reality computer systems in which the user wears special goggles and is fully immersed in video game action. To me, these systems are like crude cartoons. My imagination works like the computer graphics programs that created the lifelike dinosaurs in Jurassic Park. When I do an equipment simulation in my imagination or work on an engineering problem, it is like seeing it on a videotape in my mind. I can view it from any angle, placing myself above or below the equipment and rotating it at the same time. I don't need a fancy graphics program that can produce three-dimensional design simulations. I can do it better and faster in my head.

I create new images all the time by taking many little parts of images I have in the video library in my imagination and piecing them together. I have video memories of every item I've ever worked with -- steel gates, fences, latches, concrete walls, and so forth. To create new designs, I retrieve bits and pieces from my memory and combine them into a new whole. My design ability keeps improving as I add more visual images to my library. I add video-like images from either actual experiences or translations of written information into pictures. I can visualize the operation of such things as squeeze chutes, truck loading ramps, and all different types of livestock equipment. The more I actually work with cattle and operate equipment, the stronger my visual memories become.

I first used my video library in one of my early livestock design projects, creating a dip vat and cattle-handling facility for John Wayne's Red River feed yard in Arizona. A dip vat is a long, narrow, seven-foot-deep swimming pool through which cattle move in single file. It is filled with pesticide to rid the animals of ticks, lice, and other external parasites. In 1978, existing dip vat designs were very poor. The animals often panicked because they were forced to slide into the vat down a steep, slick concrete decline. They would refuse to jump into the vat, and sometimes they would flip over backward and drown. The engineers who designed the slide never thought about why the cattle became so frightened.

The first thing I did when I arrived at the feedlot was to put myself inside the cattle's heads and look out through their eyes. Because their eyes are on the sides of their heads, cattle have wide-angle vision, so it was like walking through the facility with a wide-angle video camera. I had spent the past six years studying how cattle see their world and watching thousands move through different facilities all over Arizona, and it was

immediately obvious to me why they were scared. Those cattle must have felt as if they were being forced to jump down an airplane escape slide into the ocean.

Cattle are frightened by high contrasts of light and dark as well as by people and objects that move suddenly. I've seen cattle that were handled in two identical facilities easily walk through one and balk in the other. The only difference between the two facilities was their orientation to the sun. The cattle refused to move through the chute where the sun cast harsh shadows across it. Until I made this observation, nobody in the feedlot industry had been able to explain why one veterinary facility worked better than the other. It was a matter of observing the small details that made a big difference. To me, the dip vat problem was even more obvious.

My first step in designing a better system was collecting all the published information on existing dip vats. Before doing anything else, I always check out what is considered state-of-the-art so I don't waste time reinventing the wheel. Then I turned to livestock publications, which usually have very limited information, and my library of video memories, all of which contained bad designs. From experience with other types of equipment, such as unloading ramps for trucks, I had learned that cattle willingly walk down a ramp that has cleats to provide secure, non slip footing. Sliding causes them to panic and back up. The challenge was to design an entrance that would encourage the cattle to walk in voluntarily and plunge into the water, which was deep enough to submerge them completely, so that all the bugs, including those that collect in their ears, would be eliminated.

I started running three-dimensional visual simulations in my imagination. I experimented with different entrance designs and made the cattle walk through them in my imagination. Three images merged to form the final design: a memory of a dip vat in Yuma, Arizona, a portable vat I had seen in a magazine, and an entrance ramp I had seen on a restraint device at the Swift meat-packing plant in Tolleson, Arizona. The new dip vat entrance ramp was a modified version of the ramp I had seen there. My design contained three features that had never been used before: an entrance that would not scare the animals, an improved chemical filtration system, and the use of animal behavior principles to prevent the cattle from becoming overexcited when they left the vat.

The first thing I did was convert the ramp from steel to concrete. The final design had a concrete ramp on a twenty five-degree downward angle. Deep grooves in the concrete provided secure footing. The ramp appeared to enter the water gradually, but in reality it abruptly dropped away below the water's surface. The animals could not see the drop-off because the dip chemicals colored the water. When they stepped out over the water, they quietly fell in, because their center of gravity had passed the point of no return.

Before the vat was built, I tested the entrance design many times in my imagination. Many of the cowboys at the feedlot were skeptical and did not believe my design would work. After it was constructed, they modified it behind my back, because they were sure it was wrong. A metal sheet was installed over the non slip ramp, converting it back to an

old-fashioned slide entrance. The first day they used it, two cattle drowned because they panicked and flipped over backward.

When I saw the metal sheet, I made the cowboys take it out. They were flabbergasted when they saw that the ramp now worked perfectly. Each calf stepped out over the steep drop-off and quietly plopped into the water. I fondly refer to this design as "cattle walking on water."

Over the years, I have observed that many ranchers and cattle feeders think that the only way to induce animals to enter handling facilities is to force them in. The owners and managers of feedlots sometimes have a hard time comprehending that if devices such as dip vats and restraint chutes are properly designed, cattle will voluntarily enter them. I can imagine the sensations the animals would feel. If I had a calf's body and hooves, I would be very scared to step on a slippery metal ramp.

There were still problems I had to resolve after the animals left the dip vat. The platform where they exit is usually divided into two pens so that cattle can dry on one side while the other side is being filled. No one understood why the animals coming out of the dip vat would sometimes become excited, but I figured it was because they wanted to follow their drier buddies, not unlike children divided from their classmates on a playground. I installed a solid fence between the two pens to prevent the animals on one side from seeing the animals on the other side. It was a very simple solution, and it amazed me that nobody had ever thought of it before.

The system I designed for filtering and cleaning the cattle hair and other gook out of the dip vat was based on a swimming pool filtration system. My imagination scanned two specific swimming pool filters that I had operated, one on my Aunt Brecheen's ranch in Arizona and one at our home. To prevent water from splashing out of the dip vat, I copied the concrete coping overhang used on swimming pools. That idea, like many of my best designs, came to me very clearly just before I drifted off to sleep at night.

Being autistic, I don't naturally assimilate information that most people take for granted. Instead, I store information in my head as if it were on a CD-ROM disc. When I recall something I have learned, I replay the video in my imagination. The videos in my memory are always specific; for example, I remember handling cattle at the veterinary chute at Producer's Feedlot or McElhaney Cattle Company. I remember exactly how the animals behaved in that specific situation and how the chutes and other equipment were built. The exact construction of steel fenceposts and pipe rails in each case is also part of my visual memory. I can run these images over and over and study them to solve design problems.

If I let my mind wander, the video jumps in a kind of free association from fence construction to a particular welding shop where I've seen posts being cut and Old John, the welder, making gates. If I continue thinking about Old John welding a gate, the video image changes to a series of short scenes of building gates on several projects I've worked on. Each video memory triggers another in this associative fashion, and my

daydreams may wander far from the design problem. The next image may be of having a good time listening to John and the construction crew tell war stories, such as the time the backhoe dug into a nest of rattlesnakes and the machine was abandoned for two weeks because everybody was afraid to go near it.

This process of association is a good example of how my mind can wander off the subject. People with more severe autism have difficulty stopping endless associations. I am able to stop them and get my mind back on track. When I find my mind wandering too far away from a design problem I am trying to solve, I just tell myself to get back to the problem.

Interviews with autistic adults who have good speech and are able to articulate their thought processes indicate that most of them also think in visual images. More severely impaired people, who can speak but are unable to explain how they think, have highly associational thought patterns. Charles Hart, the author of "Without Reason", a book about his autistic son and brother, sums up his son's thinking in one sentence: "Ted's thought processes aren't logical, they're associational." This explains'~ Ted's statement "I'm not afraid of planes. That's why they fly so high." In his mind, planes fly high because he is not afraid of them; he combines two pieces of information, that planes fly high and that he is not afraid of heights.

Another indicator of visual thinking as the primary method of processing information is the remarkable ability many autistic people exhibit in solving jigsaw puzzles, finding their way around a city, or memorizing enormous amounts of information at a glance. My own thought patterns are similar to those described by A. R. Luria in *The Mind of a Mnemonist*. This book describes a man who worked as a newspaper reporter and could perform amazing feats of memory. Like me, the mnemonist had a visual image for everything he had heard or read. Luria writes, "For when he heard or read a word, it was at once converted into a visual image corresponding with the object the word signified for him." The great inventor Nikola Tesla was also a visual thinker. When he designed electric turbines for power generation, he built each turbine in his head. He operated it in his imagination and corrected faults. He said it did not matter whether the turbine was tested in his thoughts or in his shop; the results would be the same.

Early in my career I got into fights with other engineers at meat-packing plants. I couldn't imagine that they could be so stupid as not to see the mistakes on the drawing before the equipment was installed. Now I realize it was not stupidity but a lack of visualization skills. They literally could not see. I was fired from one company that manufactured meat-packing plant equipment because I fought with the engineers over a design which eventually caused the collapse of an overhead track that moved 1,200-pound beef carcasses from the end of a conveyor. As each carcass came off the conveyor, it dropped about three feet before it was abruptly halted by a chain attached to a trolley on the overhead track. The first time the machine was run, the track was pulled out of the ceiling. The employees fixed it by bolting it more securely and installing additional brackets. This only solved the problem temporarily, because the force of the carcasses jerking the chains was so great. Strengthening the overhead track was treating a symptom

of the problem rather than its cause. I tried to warn them. It was like bending a paper clip back and forth too many times. After a while it breaks.

Different Ways of Thinking

The idea that people have different thinking patterns is not new. Francis Galton, in *Inquiries into Human Faculty and Development*, wrote that while some people see vivid mental pictures, for others "the idea is not felt to be mental pictures, but rather symbols of facts. In people with low pictorial imagery, they would remember their breakfast table but they could not see it."

It wasn't until I went to college that I realized some people are completely verbal and think only in words. I first suspected this when I read an article in a science magazine about the development of tool use in prehistoric humans. Some renowned scientist speculated that humans had to develop language before they could develop tools. I thought this was ridiculous, and this article gave me the first inkling that my thought processes were truly different from those of many other people. When I invent things, I do not use language. Some other people think in vividly detailed pictures, but most think in a combination of words and vague, generalized pictures.

For example, many people see a generalized generic church rather than specific churches and steeples when they read or hear the word "steeple." Their thought patterns move from a general concept to specific examples. I used to become very frustrated when a verbal thinker could not understand something I was trying to express because he or she couldn't see the picture that was crystal clear to me. Further, my mind constantly revises general concepts as I add new information to my memory library. It's like getting a new version of software for the computer. My mind readily accepts the new "software," though I have observed that some people often do not readily accept new information.

Unlike those of most people, my thoughts move from video like, specific images to generalization and concepts. For example, my concept of dogs is inextricably linked to every dog I've ever known. It's as if I have a card catalog of dogs I have seen, complete with pictures, which continually grows as I add more examples to my video library. If I think about Great Danes, the first memory that pops into my head is Dansk, the Great Dane owned by the headmaster at my high school. The next Great Dane I visualize is Helga, who was Dansk's replacement. The next is my aunt's dog in Arizona, and my final image comes from an advertisement for Fitwell seat covers that featured that kind of dog. My memories usually appear in my imagination in strict chronological order, and the images I visualize are always specific. There is no generic, generalized Great Dane.

However, not all people with autism are highly visual thinkers, nor do they all process information this way. People throughout the world are on a continuum of visualization skills ranging from next to none, to seeing vague generalized pictures, to seeing semi-specific pictures, to seeing, as in my case, in very specific pictures.

I'm always forming new visual images when I invent new equipment or think of something novel and amusing. I can take images that I have seen, rearrange them, and create new pictures. For example, I can imagine what a dip vat would look like modeled on computer graphics by placing it on my memory of a friend's computer screen. Since his computer is not programmed to do the fancy 3-D rotary graphics, I take computer graphics I have seen on TV or in the movies and superimpose them in my memory. In my visual imagination the dip vat will appear in the kind of high quality computer graphics shown on Star Trek. I can then take a specific dip vat, such as the one at Red River, and redraw it on the computer screen in my mind. I can even duplicate the cartoonlike, three-dimensional skeletal image on the computer screen or imagine the dip vat as a videotape of the real thing.

Similarly, I learned how to draw engineering designs by closely observing a very talented draftsman when we worked together at the same feed yard construction company. David was able to render the most fabulous drawings effortlessly. After I left the company, I was forced to do all my own drafting. By studying David's drawings for many hours and photographing them in my memory, I was actually able to emulate David's drawing style. I laid some of his drawings out so I could look at them while I drew my first design. Then I drew my new plan and copied his style. After making three or four drawings, I no longer had to have his drawings out on the table. My video memory was now fully programmed. Copying designs is one thing, but after I drew the Red River drawings, I could not believe I had done them. At the time, I thought they were a gift from God. Another factor that helped me to learn to draw well was something as simple as using the same tools that David used. I used the same brand of pencil, and the ruler and straight edge forced me to slow down and trace the visual images in my imagination.

My artistic abilities became evident when I was in first and second grade. I had a good eye for color and painted watercolors of the beach. One time in fourth grade I modeled a lovely horse from clay. I just did it spontaneously, though I was not able to duplicate it. In high school and college I never attempted engineering drawing, but I learned the value of slowing down while drawing during a college art class. Our assignment had been to spend two hours drawing a picture of one of our shoes. The teacher insisted that the entire two hours be spent drawing that one shoe. I was amazed at how well my drawing came out. While my initial attempts at drafting were terrible, when I visualized myself as David, the draftsman, I'd automatically slow down.

Processing Nonvisual Information

Autistics have problems learning things that cannot be thought about in pictures. The easiest words for an autistic child to learn are nouns, because they directly relate to pictures. Highly verbal autistic children like I was can sometimes learn how to read with phonics. Written words were too abstract for me to remember, but I could laboriously remember the approximately fifty phonetic sounds and a few rules. Lower-functioning children often learn better by association, with the aid of word labels attached to objects in their environment. Some very impaired autistic children learn more easily if words are spelled out with plastic letters they can feel.

Spatial words such as "over" and "under" had no meaning for me until I had a visual image to fix them in my memory. Even now, when I hear the word "under" by itself, I automatically picture myself getting under the cafeteria tables at school during an air-raid drill, a common occurrence on the East Coast during the early fifties. The first memory that any single word triggers is almost always a childhood memory. I can remember the teacher telling us to be quiet and walking single-file into the cafeteria, where six or eight children huddled under each table. If I continue on the same train of thought, more and more associative memories of elementary school emerge. I can remember the teacher scolding me after I hit Alfred for putting dirt on my shoe. All of these memories play like videotapes in the VCR in my imagination. If I allow my mind to keep associating, it will wander a million miles away from the word "under," to submarines under the Antarctic and the Beatles song "Yellow Submarine." If I let my mind pause on the picture of the yellow submarine, I then hear the song. As I start humming the song and get to the part about people coming on board, my association switches to the gangway of a ship I saw in Australia.

I also visualize verbs. The word "jumping" triggers a memory of jumping hurdles at the mock Olympics held at my elementary school. Adverbs often trigger inappropriate images -- "quickly" reminds me of Nestle's Quik -- unless they are paired with a verb, which modifies my visual image. For example, "he ran quickly" triggers an animated image of Dick from the first-grade reading book running fast, and "he walked slowly" slows the image down. As a child, I left out words such as "is," "the," and "it," because they had no meaning by themselves. Similarly, words like "of," and "an" made no sense. Eventually I learned how to use them properly, because my parents always spoke correct English and I mimicked their speech patterns. To this day certain verb conjugations, such as "to be," are absolutely meaningless to me.

When I read, I translate written words into color movies or I simply store a photo of the written page to be read later. When I retrieve the material, I see a photocopy of the page in my imagination. I can then read it like a Teleprompter. It is likely that Raymond, the autistic savant depicted in the movie *Rain Man*, used a similar strategy to memorize telephone books, maps, and other information. He simply photocopied each page of the phone book into his memory. When he wanted to find a certain number, he just scanned pages of the phone book that were in his mind. To pull information out of my memory, I have to replay the video. Pulling facts up quickly is sometimes difficult, because I have to play bits of different videos until I find the right tape. This takes time.

When I am unable to convert text to pictures, it is usually because the text has no concrete meaning. Some philosophy books and articles about the cattle futures market are simply incomprehensible. It is much easier for me to understand written text that describes something that can be easily translated into pictures. The following sentence from a story in the February 21, 1994, issue of *Time* magazine, describing the Winter Olympics figure-skating championships, is a good example: "All the elements are in place -- the spotlights, the swelling waltzes and jazz tunes, the sequined sprites taking to the air." In my imagination I see the skating rink and skaters. However, if I ponder too long on the word "elements," I will make the inappropriate association of a periodic table

on the wall of my high school chemistry classroom. Pausing on the word "sprite" triggers an image of a Sprite can in my refrigerator instead of a pretty young skater.

Teachers who work with autistic children need to understand associative thought patterns. An autistic child will often use a word in an inappropriate manner. Sometimes these uses have a logical associative meaning and other times they don't. For example, an autistic child might say the word "dog" when he wants to go outside. The word "dog" is associated with going outside. In my own case, I can remember both logical and illogical use of inappropriate words. When I was six, I learned to say "prosecution." I had absolutely no idea what it meant, but it sounded nice when I said it, so I used it as an exclamation every time my kite hit the ground. I must have baffled more than a few people who heard me exclaim "Prosecution!" to my downward-spiraling kite.

Discussions with other autistic people reveal similar visual styles of thinking about tasks that most people do sequentially. An autistic man who composes music told me that he makes "sound pictures" using small pieces of other music to create new compositions. A computer programmer with autism told me that he sees the general pattern of the program tree. After he visualizes the skeleton for the program, he simply writes the code for each branch. I use similar methods when I review scientific literature and troubleshoot at meat plants. I take specific findings or observations and combine them to find new basic principles and general concepts.

My thinking pattern always starts with specifics and works toward generalization in an associational and nonsequential way. As if I were attempting to figure out what the picture on a jigsaw puzzle is when only one third of the puzzle is completed, I am able to fill in the missing pieces by scanning my video library. Chinese mathematicians who can make large calculations in their heads work the same way. At first they need an abacus, the Chinese calculator, which consists of rows of beads on wires in a frame. They make calculations by moving the rows of beads. When a mathematician becomes really skilled, he simply visualizes the abacus in his imagination and no longer needs a real one. The beads move on a visualized video abacus in his brain.

Abstract Thought

Growing up, I learned to convert abstract ideas into pictures as a way to understand them. I visualized concepts such as peace or honesty with symbolic images. I thought of peace as a dove, an Indian peace pipe, or TV or newsreel footage of the signing of a peace agreement. Honesty was represented by an image of placing one's hand on the Bible in court. A news report describing a person returning a wallet with all the money in it provided a picture of honest behavior.

The Lord's Prayer was incomprehensible until I broke it down into specific visual images. The power and the glory were represented by a semicircular rainbow and an electrical tower. These childhood visual images are still triggered every time I hear the Lord's Prayer. The words "thy will be done" had no meaning when I was a child, and today the meaning is still vague. Will is a hard concept to visualize. When I think about it, I

imagine God throwing a lightning bolt. Another adult with autism wrote that he visualized "Thou art in heaven" as God with an easel above the clouds. "Trespassing" was pictured as black and orange NO TRESPASSING signs. The word "Amen" at the end of the prayer was a mystery: a man at the end made no sense.

As a teenager and young adult I had to use concrete symbols to understand abstract concepts such as getting along with people and moving on to the next steps of my life, both of which were always difficult. I knew I did not fit in with my high school peers, and I was unable to figure out what I was doing wrong. No matter how hard I tried, they made fun of me. They called me "workhorse," "tape recorder," and "bones" because I was skinny. At the time I was able to figure out why they~ called me "workhorse" and "bones," but "tape recorder" puzzled me. Now I realize that I must have sounded like a tape recorder when I repeated things verbatim over and over. But back then I just could not figure out why I was such a social dud. I sought refuge in doing things I was good at, such as working on reroofing the barn or practicing my riding prior to a horse show. Personal relationships made absolutely no sense to me until I developed visual symbols of doors and windows. It was then that I started to understand concepts such as learning the give-and-take of a relationship. I still wonder what would have happened to me if I had not been able to visualize my way in the world.

The really big challenge for me was making the transition from high school to college. People with autism have tremendous difficulty with change. In order to deal with a major change such as leaving high school, I needed a way to rehearse it, acting out each phase in my life by walking through an actual door, window, or gate. When I was graduating from high school, I would go and sit on the roof of my dormitory and look up at the stars and think about how I would cope with leaving. It was there I discovered a little door that led to a bigger roof while my dormitory was being remodeled. While I was still living in this o1d New England house, a much larger building was being constructed over it. One day the carpenters tore out a section of the o1d roof next to my room. When I walked out, I was now able to look up into the partially finished new building. High on one side was a small wooden door that led to the new roof. The building was changing and it was now time for me to change too. I could relate to that. I had found the symbolic key.

When I was in college, I found another door to symbolize getting ready for graduation. It was a small metal trap door that went out onto the flat roof of the dormitory. I had to actually practice going through this door many times. When I finally graduated from Franklin Pierce, I walked through a third, very important door, on the library roof.

I no longer use actual physical doors or gates to symbolize each transition in my life. When I reread years of diary entries while writing this book, a clear pattern emerged. Each door or gate enabled me to move on to the next level. My life was a series of incremental steps. I am often asked what the single breakthrough was that enabled me to adapt to autism. There was no single breakthrough. It was a series of incremental improvements. My diary entries show very clearly that I was fully aware that when I mastered one door, it was only one step in a whole series.

April 22, 1970

Today everything is completed at Franklin Pierce College and it is now time to walk through the little door in the library. I ponder now about what I should leave as a message on the library roof for future people to find. I have reached the top of one step and I am now at the bottom step of graduate school. For the top of the building is the highest point on campus and I have gone as far as I can go now. I have conquered the summit of FPC. Higher ones still remain unchallenged. - Class 70

I went through the little door tonight and placed the plaque on the top of the library roof. I was not as nervous this time. I had been much more nervous in the past. Now I have already made it and the little door and the mountain had already been climbed. The conquering of this mountain is only the beginning for the next mountain.

The word commencement means beginning and the top of the library is the beginning of graduate school. It is human nature to strive, and this is why people will climb mountains. The reason why is that people strive to prove that they could do it.

After all, why should we send a man to the moon? The only real justification is that it is human nature to keep striving out. Man is never satisfied with one goal he keeps reaching. The real reason for going to the library roof was to prove that I could do it.

During my life I have been faced with five or six major doors or gates to go through. I graduated from Franklin Pierce, a small liberal arts college, in 1970, with a degree in psychology, and moved to Arizona to get a Ph.D. As I found myself getting less interested in psychology and more interested in cattle and animal science, I prepared myself for another big change in my life -- switching from a psychology major to an animal science major. On May 8, 1971, I wrote:

I feel as if I am being pulled more and more in the farm direction. I walked through the cattle chute gate but I am still holding on tightly to the gate post. The wind is blowing harder and harder and I feel that I will let go of the gate post and go back to the farm; at least for a while. Wind has played an important part in many of the doors. On the roof, the wind was blowing. Maybe this is a symbol that the next level that is reached is not ultimate and that I must keep moving on. At the party [a psychology department party] I felt completely out of place and it seems as if the wind is causing my hands to slip from the gate post so that I can ride free on the wind.

At that time I still struggled in the social arena, largely because I didn't have a concrete visual corollary for the abstraction known as "getting along with people." An image finally presented itself to me while I was washing the bay window in the cafeteria (students were required to do jobs in the dining room). I had no idea my job would take on symbolic significance when I started. The bay window consisted of three glass sliding doors enclosed by storm windows. To wash the inside of the bay window, I had to crawl through the sliding door. The door jammed while I was washing the inside panes, and I was imprisoned between the two windows. In order to get out without shattering the door,

I had to ease it back very carefully. It struck me that relationships operate the same way. They also shatter easily and have to be approached carefully. I then made a further association about how the careful opening of doors was related to establishing relationships in the first place. While I was trapped between the windows, it was almost impossible to communicate through the glass. Being autistic is like being trapped like this. The windows symbolized my feelings of disconnection from other people and helped me cope with the isolation. Throughout my life, door and window symbols have enabled me to make progress and connections that are unheard of for some people with autism.

In more severe cases of autism, the symbols are harder to understand and often appear to be totally unrelated to the things they represent. D. Park and P. Youderian described the use of visual symbols and numbers by Jessy Park, then a twelve-year-old autistic girl, to describe abstract concepts such as good and bad. Good things, such as rock music, were represented by drawings of four doors and no clouds. Jessy rated most classical music as pretty good, drawing two doors and two clouds. The spoken word was rated as very bad, with a rating of zero doors and four clouds. She had formed a visual rating system using doors and clouds to describe these abstract qualities. Jessy also had an elaborate system of good and bad numbers, though researchers have not been able to decipher her system fully.

Many people are totally baffled by autistic symbols, but to an autistic person they may provide the only tangible reality or understanding of the world. For example, "French toast" may mean happy if the child was happy while eating it. When the child visualizes a piece of French toast, he becomes happy. A visual image or word becomes associated with an experience. Clara Park, Jessy's mother, described her daughter's fascination with objects such as electric blanket controls and heaters. She had no idea why the objects were so important to Jessy, though she did observe that Jessy was happiest, and her voice was no longer a monotone, when she was thinking about her special things. Jessy was able to talk, but she was unable to tell people why her special things were important. Perhaps she associated electric blanket controls and heaters with warmth and security. The word "cricket" made her happy, and "partly heard song" meant "I don't know." The autistic mind works via these visual associations. At some point in Jessy's life, a partly heard song was associated with not knowing.

Ted Hart, a man with severe autism, has almost no ability to generalize and no flexibility in his behavior. His father, Charles, described how on one occasion Ted put wet clothes in the dresser after the dryer broke. He just went on to the next step in a clothes-washing sequence that he had learned by rote. He has no common sense. I would speculate that such rigid behavior and lack of ability to generalize may be partly due to having little or no ability to change or modify visual memories. Even though my memories of things are stored as individual specific memories, I am able to modify my mental images. For example, I can imagine a church painted in different colors or put the steeple of one church onto the roof of another; but when I hear somebody say the word "steeple," the first church that I see in my imagination is almost always a childhood memory and not a

church image that I have manipulated. This ability to modify images in my imagination helped me to learn how to generalize.

Today, I no longer need door symbols. Over the years I have built up enough real experiences and information from articles and books I have read to be able to make changes and take necessary steps as new situations present themselves. Plus, I have always been an avid reader, and I am driven to take in more and more information to add to my video library. A severely autistic computer programmer once said that reading was "taking in information." For me, it is like programming a computer.

Visual Thinking and Mental Imagery

Recent studies of patients with brain damage and of brain imaging indicate that visual and verbal thought may work via different brain systems. Recordings of blood flow in the brain indicate that when a person visualizes something such as walking through his neighborhood, blood flow increases dramatically in the visual cortex, in parts of the brain that are working hard. Studies of brain-damaged patients show that injury to the left posterior hemisphere can stop the generation of visual images from stored long-term memories, while language and verbal memory are not impaired. This indicates that visual imagery and verbal thought may depend on distinct neurological systems.

The visual system may also contain separate subsystems for mental imagery and image rotation. Image rotation skills appear to be located on the right side of the brain, whereas visual imagery is in the left rear of the brain. In autism, it is possible that the visual system has expanded to make up for verbal and sequencing deficits. The nervous system has a remarkable ability to compensate when it is damaged. Another part can take over for a damaged part.

Recent research by Dr. Pascual-Leone at the National Institutes of Health indicates that exercising a visual skill can make the brain's motor map expand. Research with musicians indicates that real practice on the piano and imagining playing the piano have the same effect on motor maps, as measured by brain scans. The motor maps expand during both real piano playing and mental imagery; random pushing of the keys has no effect. Athletes have also found that both mental practice and real practice can improve a motor skill. Research with patients with damage to the hippocampus has indicated that conscious memory of events and motor learning are separate neurological systems. A patient with hippocampal damage can learn a motor task and get better with practice, but each time he practices he will have no conscious memory of doing the task. The motor circuits become trained, but damage to the hippocampus prevents the formation of new conscious memories. Therefore, the motor circuits learn a new task, such as solving a simple mechanical puzzle, but the person does not remember seeing or doing the puzzle. With repeated practice, the person gets better and better at it, but each time the puzzle is presented, he says he has never seen it before.

I am fortunate in that I am able to build on my library of images and visualize solutions based on those pictures. However, most people with autism lead extremely limited lives,

in part because they cannot handle any deviation from their routine. For me, every experience builds on the visual memories I carry from prior experience, and in this way my world continues to grow.

About two years ago I made a personal breakthrough when I was hired to remodel a meat plant that used very cruel restraint methods during kosher slaughter. Prior to slaughter, live cattle were hung upside down by a chain attached to one back leg. It was so horrible I could not stand to watch it. The frantic bellows of terrified cattle could be heard in both the office and the parking lot. Sometimes an animal's back leg was broken during hoisting. This dreadful practice totally violated the humane intent of kosher slaughter. My job was to rip out this cruel system and replace it with a chute that would hold the animal in a standing position while the rabbi performed kosher slaughter. Done properly, the animal should remain calm and would not be frightened.

The new restraining chute was a narrow metal stall which held one steer. It was equipped with a yoke to hold the animal's head, a rear pusher gate to nudge the steer forward into the yoke, and a belly restraint which was raised under the belly like an elevator. To operate the restrainer, the operator had to push six hydraulic control levers in the proper sequence to move the entrance and discharge gates as well as the head- and body-positioning devices. The basic design of this chute had been around for about thirty years, but I added pressure-regulating devices and changed some critical dimensions to make it more comfortable for the animal and to prevent excessive pressure from being applied.

Prior to actually operating the chute at the plant, I ran it in the machine shop before it was shipped. Even though no cattle were present, I was able to program my visual and tactile memory with images of operating the chute. After running the empty chute for five minutes, I had accurate mental pictures of how the gates and other parts of the apparatus moved. I also had tactile memories of how the levers on this particular chute felt when pushed. Hydraulic valves are like musical instruments; different brands of valves have a different feel, just as different types of wind instruments do. Operating the controls in the machine shop enabled me to practice later via mental imagery. I had to visualize the actual controls on the chute and, in my imagination, watch my hands pushing the levers. I could feel in my mind how much force was needed to move the gates at different speeds. I rehearsed the procedure many times in my mind with different types of cattle entering the chute.

On the first day of operation at the plant, I was able to walk up to the chute and run it almost perfectly. It worked best when I operated the hydraulic levers unconsciously, like using my legs for walking. If I thought about the levers, I got all mixed up and pushed them the wrong way. I had to force myself to relax and just allow the restrainer to become part of my body, while completely forgetting about the levers. As each animal entered, I concentrated on moving the apparatus slowly and gently so as not to scare him. I watched his reactions so that I applied only enough pressure to hold him snugly. Excessive pressure would cause discomfort. If his ears were laid back against his head or he struggled, I knew I had squeezed him too hard. Animals are very sensitive to hydraulic equipment. They feel the smallest movement of the control levers.

Through the machine I reached out and held the animal. When I held his head in the yoke, I imagined placing my hands on his forehead and under his chin and gently easing him into position. Body boundaries seemed to disappear, and I had no awareness of pushing the levers. The rear pusher gate and head yoke became an extension of my hands.

People with autism sometimes have body boundary problems. They are unable to judge by feel where their body ends and the chair they are sitting on or the object they are holding begins, much like what happens when a person loses a limb but still experiences the feeling of the limb being there. In this case, the parts of the apparatus that held the animal felt as if they were a continuation of my own body, similar to the phantom limb effect. If I just concentrated on holding the animal gently and keeping him calm, I was able to run the restraining chute very skillfully.

During this intense period of concentration I no longer heard noise from the plant machinery. I didn't feel the sweltering Alabama summer heat, and everything seemed quiet and serene. It was almost a religious experience. It was my job to hold the animal gently, and it was the rabbi's job to perform the final deed. I was able to look at each animal, to hold him gently and make him as comfortable as possible during the last moments of his life. I had participated in the ancient slaughter ritual the way it was supposed to be. A new door had been opened. It felt like walking on water.

2006 Update to Chapter 1

Since I wrote Thinking in Pictures, brain imaging studies have provided more insights into how the brain of a person on the autism/Asperger spectrum processes information. Nancy Minshew at Carnegie Mellon University in Pittsburgh has found that normal brains tend to ignore the details while people on the autism spectrum tend to focus on the details instead of larger concepts. To view this phenomenon, she had normal, Asperger, and autistic people read sentences while they were in a scanner. The autistic brain was most active in the part of the brain that processes the individual words while the normal brain was most active in the part that analyzes the whole sentence. The Asperger brain was active in both areas. Eric Courchesne at the University of California in San Diego states that autism may be a disorder of brain circuit disconnections. This would affect the ability to integrate detailed information from lower parts of the brain where sensory based memories are stored with higher level information processing in the frontal cortex. Lower level processing systems may be spared or possibly enhanced. He discovered in an autistic person that the only parts of the brain that are normal are the visual cortex and the areas in the rear of the brain that store memories. This finding helps explain my visual thinking. Scans of autistic brains have indicated that the white matter in the frontal cortex is overgrown and abnormal. Dr. Courchesne explains that white matter is the brain's "computer cables" connecting up different parts of the brain while the gray matter forms the information processing circuits. Instead of growing normally and connecting various parts of the brain together, the autistic frontal cortex has excessive overgrowth much like a thicket of tangled computer cables. In the normal brain, reading a word and speaking a word are processed in different parts of the brain. Connecting circuits between these two

areas makes It possible to simultaneously process information from both of them. Both Courchesne and Minshew agree that a basic problem in both autistic and Asperger brains is a failure of the "computer cables" to fully connect together the many different localized brain systems. Local systems may have normal or enhanced internal connections but the long distance connections between the different local systems may be poor.

I am now going to use what I call visual symbol imagery to help you understand how the different parts of the normal brain communicate with each other. Think of the normal brain as a big corporate office building. All the different departments such as legal, accounting, advertising, sales, and the CEO's office are connected together by many communication systems such as e-mail, telephones, fax machines, and electronic messaging. The autistic/Asperger brain is like an office building where some of the interdepartmental communication systems are not hooked up. Minshew calls this underconnectivity in the brain. More systems would be hooked up in an Asperger brain than in the brain of a low-functioning individual. The great variability in autistic/ Asperger symptoms probably depends on which "cables" get connected and which "cables" do not get connected. Poor communication between brain departments is likely the cause of uneven skills. People on the spectrum are often good at one thing and bad at something else. To use the computer cable analogy, the limited number of good cables may connect up one area and leave the other areas with poor connections.

Develop Talents in Specialized Brains

When I wrote Thinking in Pictures I thought most people on the autism spectrum were visual thinkers like me. After talking to hundreds of families and individuals with autism or Asperger's, I have observed that there are actually different types of specialized brains. All people on the spectrum think in details, but there are three basic categories of specialized brains. Some individuals may be combinations of these categories.

1. Visual thinkers, like me, think in photographically specific images. There are degrees of specificity of visual thinking. I can test run a machine in my head with full motion. Interviews with nonautistic visual thinkers indicated that they can only visualize still images. These images may range in specificity from images of specific places to more vague conceptual images. Learning algebra was impossible and a foreign language was difficult. Highly specific visual thinkers should skip algebra and study more visual forms of math such as trigonometry or geometry. Children who are visual thinkers will often be good at drawing, other arts, and building things with building toys such as Lego's. Many children who are visual thinkers like maps, flags, and photographs. Visual thinkers are well suited to jobs in drafting, graphic design, training animals, auto mechanics, jewelry making, construction, and factory automation.
2. Music and math thinkers think in patterns. These people often excel at math, chess, and computer programming. Some of these individuals have explained to me that they see patterns and relationships between patterns and numbers instead of photographic images. As children they may play music by ear and be interested in music. Music and math minds often have careers in computer programming,

chemistry, statistics, engineering, music, and physics. Written language is not required for pattern thinking. The pre-literate Incas used complex bundles of knotted cords to keep track of taxes, labor, and trading among a thousand people.

3. Verbal logic thinkers think in word details. They often love history, foreign languages, weather statistics, and stock market reports. As children they often have a vast knowledge of sports scores. They are not visual thinkers and they are often poor at drawing. Children with speech delays are more likely to become visual or music and math thinkers. Many of these individuals had no speech delays, and they became word specialists. These individuals have found successful careers in language translation, journalism, accounting, speech therapy, special education, library work, or financial analysis.

Since brains on the autistic spectrum are specialized, there needs to be more educational emphasis on building up their strengths instead of just working on their deficits. Tutoring me in algebra was useless because there was nothing for me to visualize. If I have no picture, I have no thought. Unfortunately I never had an opportunity to try trigonometry or geometry. Teachers and parents need to develop the child's talents into skills that can eventually turn into satisfying jobs or hobbies.

Concept Formation

All individuals on the autism/Asperger spectrum have difficulties with forming concepts. Problems with conceptual thought occur in all of the specialized brain types. Conceptual thinking occurs in the frontal cortex. The frontal cortex is analogous to the CEO's office in a corporation. Researchers refer to frontal cortex deficits as problems with execution function. In normal brains, "computer cables" from all parts of the brain converge on the frontal cortex. The frontal cortex integrates information fi7om thinking, emotional, and sensory parts of the brain. The degree of difficulty in forming concepts is probably related to the number and type of 11 computer cables" that are not hooked up. Since my CEO's office has poor "computer" connections, I had to use the "graphic designers" in my "advertising department" to form concepts by associating visual details into categories. Scientific research supports my idea. Detailed visual and musical memories reside in the lower primary visual and auditory cortex and more conceptual thinking is in association areas where inputs from different parts of the brain are merged.

Categories are the beginning of concept formation. Nancy Minshew found that people with autism can easily sort objects into categories such as red or blue, but they have difficulty thinking up new categories for groups of common objects. If I put a variety of common things on a table such as staplers, pencils, books, an envelope, a clock, hats, golf balls, and a tennis racquet, and asked an individual with autism to pick out objects containing paper, they could do it. However, they often have difficulty when asked to make tip new categories. Teachers should work on teaching flexibility of thinking by playing a game where the autistic individual is asked to make up new categories for the objects like objects containing metal, or objects used in sports. Then the teacher should get the person to explain the reason for putting an object in a specific category.

When I was a child I originally categorized dogs from cats by size. That no longer worked when our neighbors got a small dachshund. I had to learn to categorize small dogs fi7om cats by finding a visual feature that all the dogs had and none of the cats had. All dogs, no matter how small, have the same nose. This is sensory-based thinking, not language-based. The animals could also be categorized by sound, barking versus meowing. A lower functioning person may categorize them by smell or touch because those senses provide more accurate information. Dividing information into distinct categories is a fundamental property of the nervous system. Studies with bees, rats, and monkeys all indicate that information is placed into categories with sharp boundaries. French scientists recorded signals from the frontal cortex of a monkey's brain while it was looking at computer generated images of dogs that gradually turned into cats. There was a distinct change in the brain signal when the category switched to cat. In the frontal cortex, the animal image was either a dog or a cat. When categorizing cats from dogs by size no longer worked for me, I had to form a new category of nose type. Research by Itzahak Fried at UCLA has shown that individual neurons learn to respond to specific categories. Recordings taken from patients undergoing brain surgery showed that one neuron may respond only to pictures of food and another neuron win respond only to pictures of animals. This neuron will not respond to pictures of people or objects. In another patient, a neuron in the hippocampus responded to pictures of a movie actress both in and out of costume but it did not respond to pictures of other women. The hippocampus is like the brain's file finder for locating information in stored memory.

Becoming More Normal

More knowledge makes me act more normal. Many people have commented to me that I act much less autistic now than I did ten years ago. A person who attended one of my talks in 2005 wrote on my evaluation, "I saw Temple in 1996, it was fun to see the poise and presentation manner she has gained over the years." My mind works Just like an Internet search engine that has been set to access only images. The more pictures I have stored in the Internet inside my brain the more templates I have of how to act in a new situation. More and more information can be placed in more and more categories. The categories can be placed in trees of master categories with many subcategories. For example, there are jokes that make people laugh and jokes that do not work.

There is then a subcategory of jokes that can only be told to close friends. When I was a teenager I was called "tape recorder" because I used scripted lines. As I gained experience, my conversation became less scripted because I could combine new information in new ways. To help understand the autistic brain I recommend that teachers and parents should play with an Internet search engine such as Google for images. It will give people who are more verbal thinkers an understanding into how visual associative thinking works. People with music and math minds have a search engine that finds associations between patterns and numbers.

The Asperger individual who is a verbal logic thinker uses verbal categories. For example, Dr. Minshew had an Asperger patient who had a bad side effect with a medication. Explaining the science of why he should try a different medication was

useless. However, he became willing to try a new medication after he was simply told, the pink pills made you sick and I want you to try the blue pills. He agreed to try the blue pills.

The more I learn, the more I realize more and more that how I think and feel is different. My thinking is different from a normal person, but it is also very different from the verbal logic nonvisual person with Asperger's. They create word categories instead of picture categories. The one common denominator of all autistic and Asperger thinking is that details are associated into categories to form a concept. Details are assembled into concepts like putting a jigsaw puzzle together. The picture on the puzzle can be seen when only 20 percent of the puzzle is put together, forming a big picture.

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