My Experiences as an Autistic Child and Review of Selected Literature

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Introduction

Did you ever wonder what an autistic child is thinking? I was a partially autistic child and I will try to provide you with some insight. I am now 36 years old and work as a consultant, designing livestock facilities for feedlots, ranches, and meat plants throughout the U.S. and abroad. I have also authored articles in both national and international livestock publications (Grandin, 1979, 1980a). At the present time I am doing research on animal behavior and neurophysiology and working on my doctorate in animal science at the University of Illinois.

In this paper I will describe my experiences and relate them to research findings. My first-hand experience with autism provided me with some clues which helped guide me through the vast library of scientific research and find some leads for research and therapy which could possibly benefit autistic children.

Brief Case History

At the age of $1\frac{1}{2}$ to 3 I had many of the standard autistic behaviors such as fixation on spinning objects, refusing to be touched or held, preferring to be alone, destructive behavior, temper tantrums, inability to speak, sensitivity to sudden noises, appearance of deafness, and an intense interest in odors. I was the first child in a family of four and my mother took me to a neurologist to be examined because I did not act like the little girls next door. The EEG and hearing test were normal at age 3. On the Rimland checklist (1971) I had many of the symptoms and would have scored +9 at age $1\frac{1}{2}$. The checklist was filled out by my mother in 1974. A score of +20 is classical autism or Kanner's syndrome. Only about 10 percent of children described as autistic fit in the closely defined Kanner's syndrome. There are metabolic differences between Kanner's syndrome and other types of autism (Rimland 1980).

At the age of 3 to $3\frac{1}{2}$ my behavior greatly improved, but I did not learn to speak until $3\frac{1}{2}$. At the age of 3 to 4 my behavior was more normal until I became tired. When I became tired, bouts of impulsive behavior would return. Throughout elementary school I had bouts of temper tantrums and I was hyperactive and refused to sit still. My third-grade teacher noticed that I would flinch when she touched me. At the age of 9

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and 12 I was given the Weschler IQ test and scored 120 and 137 respectively.

Speech Problem

When I finally started to speak the words were heavily stressed such as "bah" for "ball." I remember being able to understand everything that people said to me, but I could not speak back. Screaming and flapping my hands was the only way 1 could reply.

One day my mother wanted me to wear a hat when we were in the car. I logically thought to myself that the only way I could tell her that I did not want to wear the hat was to scream and throw it on the car floor. Since that failed to work I got the brilliant idea of throwing the hat out the window on the highway. I figured that she would just keep on driving and leave the hat behind.

Unfortunately, as the hat sailed out the window, mother attempted to grab it and swerved the car into a tractor trailer truck. The car was completely wrecked but fortunately no one was hurt. As the broken glass showered in around me I spoke a new word "ice" for broken glass. I can remember another instance when I started to speak normally. The speech therapist was working with me while a telephone repairman was causing the bell to ring repeatedly on the phone. Somehow this either distracted or stressed me and I asked in normal unstressed speech "make the bell stop ringing". I then relapsed back into my old limited and stressed vocabulary. (Grandin, 1980)

When I went to Vienna, Austria to present a paper on livestock handling (Grandin, 1981). I gained some new insights when I was confronted with the frustrations of not being able to communicate in German. The sound of people talking in a foreign language was gibberish, and I found myself reverting back to the simplified one word speech I had as a child. I tended to just retreat. In a restaurant I would simply say "tea", "ham", or just point at the menu. When I got lost on the street I wanted to scream; it was upsetting and frustrating. Learning pronunciation and parroting back the words is easy but I did not understand them.

Good at Visual Tasks

In college I was on the Dean's honor list, but getting through the foreign language requirement was difficult. I scraped by with Ds and Cs. Learning sequential things such as math was also very hard. My mind is completely visual and spatial work such as drawing is easy. I taught myself drafting in six months. I have designed big steel and concrete cattle facilities, but remembering a phone number or adding up numbers in my head is still difficult. I have to write them down. Every piece of information I have memorized is visual. If I have to remember an abstract concept I "see" the page of the book or my notes in my mind and "read" information from it. Melodies are the only things I can memorize without a visual image. I remember very little that I hear unless it is emotionally arousing or I can form a visual image. In class I take careful notes, because I would forget the auditory material. When I think about abstract concepts such as human relationships I use visual similes. For example, relationships between people are like a glass sliding door. The door must be opened gently, if it is kicked it may shatter. If I had to learn a foreign language, I would have to do it by reading, and make it visual. Lancioni (1983) found that pictures could be used to effectively communicate with autistic children. Damasio and Maurer (1978) report that autistics often process written language better than spoken. Even now I tend to mix up similar sounding words such as over and other, there and their and will often misspell words such as freight and receive. I get the ie mixed up, unless I write the words down. I also sometimes mix up right and left or clockwise and counter clockwise until I make a motion with my hand. I have to either see it or do it.

It has been ten years since I took a statistics course. When I tried to take one last year, I failed the first exam. I was unable to hold one piece of information in my mind while I manipulated another piece of information. I had difficulty translating the symbols and then manipulating the equation at the same time.

As a young child I was good at drawing and painting and both my mother and my teachers commented on it. Before I could read I spent hours looking at pictures in *Life* magazine. In the afternoon during rest period, I used to build all kinds of projects out of cardboard. Now as an adult I can visualize a project in my mind and then either build it or draw on a blueprint.

Studies of autistic children by many different researchers indicate the visual spatial nature of the autistic mind. Autistic and deaf children both handle numbers as if they were a visual display. They recall numbers from left to right instead of from first to last (Hermelin 1976). I imagine the numbers written down on a piece of paper in a horizontal row and read from left to right. Lockyer & Rutter (1970) found that autistic children were normal on the Weschler block design and object assembly test. "Scores on picture arrangement and coding were in the mentally retarded range." "It seems that autistic children perform badly on tests which require verbal or sequencing skills, even if the tests do not involve the use of speech." The pattern was most pronounced in children with poor language skills (Rutter, 1976).

Adult Test Results

During December 1982, I had a series of tests to determine my abilities and handicaps. Two of the tests were the Woodcock-Johnson Psycho-Educational Battery, Tests of Cognitive Ability and three subtests of the Hiskey-Nebraska Digits and Spatial Reasoning. These tests were chosen because I had not been previously exposed to them in psychology courses.

On the Spatial Reasoning test my performance was at the top of the norms. Blaylock (1982) who administered the tests concluded, "It appears that the ceiling of this subtest is probably too low to assess accurately her extraordinary spatial visualization ability." This test was untimed. On the Woodcock-Johnson, Spatial Relations my performance was lower because it was a timed highly speeded test. The items I solved were correct, but I did not finish enough items to get a superior score.

When I design equipment it takes time to form the visual image. The image gradually grows while I draw. At first the task of designing a cattle feedlot may seem complex, but then the pieces come together and it becomes simple. When the entire image is formed, I can place cattle and people in it and imagine how they will behave under different situations. I can rotate the image and make it move like a movie. I can't imagine what non-visual thinking would be like. The visual images are based on past experience. I visited many feedlots and actually worked with feedlot employees. From this, I gained a library of experience of what works and does not work. If I actually performed the job of handling cattle, I learned more than by just watching.

Many dyslexics find that "they need concrete direct experiences or very meaningful examples to comprehend" (Johnson, 1980). Blaylock (1982) reports "She has a highly visual, synthetic mind, which can integrate a large amount of material visually and which tends to apprehend information as visual wholes."

My performance on the Woodcock-Johnson subtests ranged from the 95th percentile to the 6th percentile. My scores were in the superior range for Memory for sentences, Picture Vocabulary and Antonyms-Synonyms. Memory for sentences was easy because I could make a visual image in my mind of the subject of the sentence. I did reasonably well on tests requiring short term memory for numbers (Memory for Digits - Hiskey-Nebraska, and Numbers reversed, Woodcock-Johnson) because I figured out a way to beat the test. I repeated the numbers out loud. If I had not been allowed to repeat the numbers out loud my scores would have been much lower.

Blaylock (1982) stated that four subtests on the Woodcock-Johnson provided valuable information about the nature of my learning disabilities. The subtests were Blending, Visual Auditory Learning, Analysis Synthesis and Concept Formation.

Performance on the Blending subtest was at the 2nd grade level. In the Blending subtest I had to identify a word that was slowly sounded out at the rate of one syllable per second. This subtest measures auditory memory. Performance on the Visual Auditory Learning subtest was also at the 2nd grade level. This test requires memorizing the meanings for arbitrary symbols such as ***4*** means horse. A series of symbols then has *to* be translated into English. The only symbols I could learn were ones where I could create a visual image. I learned that ***4*** means horse because I visualized a man riding a horse carrying a flag. Nouns were easier to learn than verbs.

On the Analysis Synthesis subtest I scored at the 4th grade level. This test requires identification of equivalents for various combinations of colored squares. It requires intense sustained concentration. I often have little lapses in concentration. These lapses have no effect on my ability to draw blueprints and design equipment but they make it extremely difficult to follow the sequence in a statistics lecture.

My performance on the Concept Formation subtest was also at the 4th grade level. This test requires "identification of the dimension or dimensions differentiating one set of colored shapes from another" (Blay-lock, 1982). I did poorly because I had to hold the concept (for example, large and yellow) in my short term memory while I looked at the cards to pick out the one that had the same concept. The problem was that I forgot the concept while I was looking for the answer. If I had been allowed to write down the concept I think I would have performed much better.

The Visual Attention Span subtest from the Hiskey-Nebraska was another test I performed poorly on. It required looking at a series of pictures. The next step was to pick the original pictures out from a large group of pictures and place them in the correct order. I was able to choose the correct pictures but I made errors in the order. Blaylock (1982) concludes, "The difficulty with sequencing appears to be related to the reversals of syllables noticed in reading". Another test I had difficulty with was the Oral Directions subtest of the Detroit Tests of Learning Aptitude. It provides a measure of concentration combined with short term recall of a sequence. It requires recall of a series of directions to write or draw with a pencil on specified figures on the test form. This task requires retaining information in short term memory while concentrating and performing the action. When I receive directions from a gasoline station I have to write them down if there are more than three roads or turns in the sequence. My difficulties on many of the subtests stemmed from the inability to hold one piece of information in my mind while I manipulated another piece of information. I have many dyslexic traits. Dyslexics have difficulty with sequential memory, foreign language, tend to mix up words like revolution and resolution and use visual strategies of recall (Johnson, 1980).

Manipulating a visual image is easy because it is only one "bit" of information regardless of size. Visualizing a single desk or visualizing an entire office building is still just one "bit".

Visual Thinking

Visual thinking is an asset for an equipment designer. I am able to "see" how all the parts of a project will fit together and see potential problems. It never ceases to amaze me how architects and engineers can make so many stupid mistakes in buildings. The academic requirements probably keep many visual thinkers out of these professions. Designing a piece of equipment with a sequential mind may be just as difficult for an engineer, as statistics equations are for me. The sequential thinker can't see the whole. I have observed many incidents in industry where a brilliant maintenance man with a high school education designs a piece of equipment after all the PhD engineers have failed. He may be an unrecognized visual thinker. There may be two basic kinds of thinking, visual and sequential. Society needs to recognize the value of people who think visually. Misinterpretation of psychological test results could label a brilliant visual thinker as below average in intelligence. Einstein was a visual thinker who failed his high school language requirement and relied on visual methods of study (Holton, 1971-72). Geschwind (1983) states that people with delayed left hemisphere growth have talents. If autism and dyslexia were prevented maybe the price would be turning potentially talented individuals into ones with mediocre talents.

Research with artificial intelligence may provide some insights. Until recently all computers used sequential methods to solve problems. Fahlman and Hinton (1983) described their "Boltzmann machine" at the National Conference on Artificial Intelligence. This computer has a "massively parallel" organization. The circuits work in parallel rather than sequentially. Visual thinking and' processing of information through many parallel circuits may be similar.

Right vs. Left Hemispheres

Autistics handle language like patients who have had their left hemisphere removed (Bartok et al, 1975). They lack the ability to handle long sequential information. Masland (1976) states that the right hemisphere is the preferred site for visually and factually presented patterns. Prior (1979) maintains that autistic children rely on their right cerebral hemisphere. In a normal adult, if the left side is damaged he can no longer speak or read. (Gazzaniga, 1982a). Visual spatial skills are on the right side. The brain is more plastic in children. If the left hemisphere is damaged verbal functions can be switched to the right hemisphere in children under two. As the child matures flexibility is lost (Milner, 1973). In a right handed person the left ear inputs into the right hemisphere. A recent study by Arnold and Schwartz (1983) destroys the simple theory that autistics are mainly right brain users. Non-autistic language impaired children have a left ear advantage on a dichotic listening task which indicates they have switched language processing to the right hemisphere. Autistic and normal children have a right ear advantage. The defect which causes autistic language problems may be different than the defect in non-autistic language impaired children.

In a noisy room I tend to turn and listen to conversations with my left ear. This is one indicator that my problems were both autistic and dyslexic. I have many dyslexic tendencies such as mixing up right and left. At the far ends of the spectrum dyslexia and autism probably have different sets of symptoms but in many children symptoms of both conditions occur. Circuits in the brain are all interconnected and many functions which were once thought to be localized are spread throughout the brain. If a particular circuit is damaged and function is disrupted, that does not mean that that particular circuit is the center of that function. If you started taking parts out of a TV set it would be wrong to assume that any single part you removed was the picture center because the picture stopped when it was taken out.

I was lucky to be born female because the brain of males is probably more lateralized than females (McGlone, 1977). The right hemisphere in girls may have a longer period of plasticity than in males (Witelson, 1976).

Women have less verbal impairment than men when the left hemisphere is removed (Landsell, 1973). The traditional view is that the right hemisphere perceives the whole gestalt, and the left hemisphere handles sequential and analytical information. Patients with split brains are able to do some verbal tasks in their right hemispheres (Zaidel, 1979). A patient who has had the connections between the two brain hemispheres surgically severed can solve a problem which is presented to his right hemisphere but he will deny having seen the problem, because the left hemisphere is needed in order to verbalize (Gazzaniga, 1982b).

The method a person uses to analyze sensory input will determine which hemisphere of the brain will be activated. Measurements of glucose metabolism with a PET scanner by Mazziotta (1982) revealed that most people used the right hemisphere when they discriminated musical tones or chores. A trained musician used the left hemisphere for the same task. When questioned, the musician said that he imagined seeing the musical notes on a staff. This analytical approach accounted for using the left side, instead of the right side which is traditionally associated with music.

As a young child I hummed constantly to myself and made little peeping noises. Even as an adult I often hum. Eight-year old autistic children have a tendency to prefer music which is another right brain activity. Autistic children preferred to turn on a speaker playing sung lyrics instead of turning on a speaker playing spoken lyrics of the same song (Blackstock, 1978). I can hear a song once or twice and reproduce the melody and pitch accurately. Autistic children can imitate tones as well as or better than normal children (Applebaum et al., 1979). Four out of five autistic children preferred listening to music from the "Sting" instead of looking at slides of city scenes. One autistic had a strong preference for the visual stimulus. Normal children had no preference (Kolko, 1980). Lorna King (1981) found that singing instructions to a 12-year-old autistic boy resulted in better communication and obeying of the instructions.

Is Autism Similar to Deprivation?

The behavior of an autistic child is similar to the behavior of an animal which has been raised in a deprived barren environment. Monkeys raised in total isolation would rock and engage in stereotyped behavior, whereas monkeys kept in single cages where they could see and hear other monkeys and were allowed four hours of play daily with another monkey, had a much lower frequency of abnormal behavior (Floeter & Greenough, 1979). Thirty-three percent of kittens which were blindfolded with cloth hoods at birth developed stereotyped walking by the fourth month of life (Korda, 1978). A child raised in a barren environment developed similar behaviors. Genie, a child who was kept under extreme sensory and emotional deprivation for $13^1/_2$ years, had many autistic behaviors. "Genie is an 'appositional' thinker, visually and tactily oriented, better at holistic than sequential analytic thinking" (Curtiss, 1977).

Research indicates that autistic children may have a defect in the circuits which integrate input from the different sense organs and the mechanisms of selective attention (Piggot, 1979; Prescott, 1967). The behavioral effects of hippocampal lesions, rearing animals in isolation, and cutting sensory pathways will both cause animals to self mutilate, engage in stereotyped movements and become hyperactive and hyper-excitable. The lesions were made in the lateral portion of the upper midbrain, involving the spinal and trigeminal pathways (Sprague et al., 1961, cited by Prescott, 1967). Autism may be caused by some kind of damage to the central nervous system which is responsible for "functionally" creating a deprived environment.

A restricted environment usually makes both people and animals more sensitive to stimuli and it can have a long-lasting effect. Dogs placed in isolated cages become hyper-excitable and their EEGs still showed indications of hyperexcitability six months after they have been placed in a normal environment (Melzack & Burns, 1965). Violent monkeys which had been reared in isolation had abnormal "spike" discharges in the limbic and cerebellar areas (Heath & Saltz-burg cited by Prescott, 1979). Autistic children also have a desynchronized EEG which indicates high arousal. As the environmental stimulation around them increases, the EEG becomes more desynchronized and stereotyped behavior is increased (Hutt et al., 1965). Experiments by Zubek et al. (1964, 1963) indicated that in humans restriction of patterned visual input enhanced tactile acuity and a shield worn on one arm for a week enhanced tactual acuity on the un-shielded arm.

Handling During Infancy

A variety of tactual, motor and kinesthetic stimulation is beneficial to young animals. Levine (1960) found that infant rats subjected to "both painful shocks and gentle handling enhance the development of normal stress responses in infant animals." Baby rats which were handled during infancy had a lower corticosterone response to various stressors than rats which had been shocked during infancy. Handling has a unique effect (Pfeifer et al., 1976). "Somato-sensory stimulation is probably a major stimulus for some of the effects of handling. No single common physical aspect of the various handling experiences appears to be responsible for all of the effects" (Greenough, 1982).

Touch Deprivation in Lab Animals

Harlow and Zimmerman (1959) reported that baby monkeys would choose a cloth mother surrogate which provided contact comfort over a wire surrogate which provided milk. When the monkey was frightened by a windup toy bear, it would run to the cloth surrogate and rub up against it and then return to explore the threatening stimulus. Monkeys raised with a wire surrogate would engage in autistic type behaviors and there would be no reduction in emotionality when confronted with the toy bear. Monkeys which were separated from their mothers will wrap their arms around themselves (Suomi, 1982).

Harlow also found that depriving a baby monkey of contact with either a real monkey mother or a cloth surrogate for the first eight months weakened its capacity for future affection. The deprived babies spent less time on the cloth surrogate when it was introduced at eight months, than monkeys raised with a surrogate since birth. Children restrained in large casts either became hyperactive, aggressive, and craved affection or they withdrew and avoided physical contact. Infants placed on a cradle board do not become hyperactive because they get vestibular and tactile input as they ride on the mother's back (Prescott, 1967).

Observations in Farm Animals

Suomi (1982) reported that young isolated monkeys which had stereotyped behavior and other behavior problems would sometimes be rehabilitated by a "therapist" monkey. The younger "therapist" monkey touched the isolated monkey and forced it to interact. The beneficial effect could possibly be due to a combination of tactual stimulation and increased motor activity.

The need for tactile stimulation is strong in piglets. Hartsock (1979) observed that piglets will lie up against a solid surface such as a wall or the side of the sow. The preference for lying against a solid surface is so great that some piglets prefer to lie against the wall even when there is a heat lamp in the center of the pen. They prefer the contact comfort over the heat lamp which would prevent them from dying of cold exposure. Adult and weanling pigs prefer to lie around the perimeter of a pen (Grandin, 1980c, Blackshaw, 1981). Some pigs when given a choice, prefer to sleep in a narrow stall instead of in an open pen. Montague (1978) recommends that babies be kept in a small snug cradle. Observations of autistic children also indicate that they tend to prefer to stay along the perimeter of a room (Hutt & Vaizey, 1966). Isolated monkeys in a deprived environment will go to the corner of the room (Suomi, 1982).

Farm and zoo animals which live singly or in small groups in a barren environment often develop stereotyped behaviors which are similar to an autistic child's behavior. Stereotyped behavior may be occurring to reduce arousal and stress. Dantzer and Mormede (1983) reported that hungry pigs would develop stereotyped chain pulling if they were intermittently fed small amounts of feed. Pigs which pulled the chain had lower corticosteral (stress hormone) levels compared to pigs that had no chain available to pull.

Damasio and Maurer (1978) believe that stereotyped ritualistic and compulsive behaviors are an adaptive response of a "disturbed biological system" attempting to achieve homeostasis.

On many modern farms veal calves are kept in small narrow stalls. They can get up and lie down but they are unable to turn around. The calves tolerate these housing systems provided they are able to touch each other. Veal calves kept in stalls with solid walls which prevented both visual and tactile stimuli become hypersensitive to stimuli, whereas veal calves kept in stalls with low side walls which enable them to touch and groom each other were usually not hypersensitive.

I visited two identical swine farms where the pigs were raised indoors in buildings. At one farm the pigs were hyperexcitable, and on the other farm they came up to be petted. On the hyperexcitable farm the employees spent less time with the animals. A study done by Hemsworth et al. (1981) with sows showed that the sows had slightly more piglets per litter on farms where they were accustomed to human contact. This was tested by the experimenter placing his hand near a sow's face and measuring her withdrawal reaction. Hemsworth and Beilhartz (1979) and Hemsworth et al. (1977) also found that "rearing boars without physical contact with other pigs could be detrimental to their subsequent reproductive performance." Nosing behavior was reduced in pigs raised without physical contact during the period of 3 weeks to 7 months of age.

Effects of Tactile Deprivation in Humans

Many observers have reported that babies raised in institutions fail to thrive unless they receive cuddling. Research has shown that tactile and kinesthetic stimulation has a beneficial effect on premature infants (Rausch, 1981, White & Labara, 1976, Solkoff et al., 1969). Provence and Lipton (1962) found that institutionalized babies reacted abnormally when they were held during the second month of life and they started rocking at 5 to 8 months of age. They were uncuddly and they were not pliable in the arms of an adult. Increasing the amount of tactile stimulation even after many months of deficient mothering greatly improved many of these infants.

My mother told me that when I was an infant she felt "snubbed" because I did not want to be cuddled at 3-4 months of age. This is one of the early symptoms of autism

(Rimland, 1971). I was her first child and she did not know enough to just hold me anyway even if I did not like it. Mother also reported that as a 3 to 4-month old baby I slept too long and was a "good" baby who rarely cried or fussed. Sleeping excessively is a way of withdrawing., Patten and Gardner (1963) and Provence and Lipton (1962) both report that babies who don't receive enough cuddling and tactile stimulation would sleep excessively.

Institutionalized infants who are deprived excessively will even withdraw from self stimulation. Spitz (1962) found that deprived infants will not self stimulate the genitals unless they have received a minimal level of normal tactile stimulation from the caretaker. Once this minimal level has been reached, excessive self stimulation may occur unless adequate amounts of hugging and other tactile stimulation are received from adults. McGray (1978) found that excessive masturbation in 4-, 7-, and 8-year-old children stopped abruptly when nonsexual tactile contact with the parents increased.

Deprivation of tactile stimuli will cause hyperactivity, autistic behavior, violence, and aggression (Prescott, 1975). Even negative body contact is better than none (Hollander, 1970). Prescott (1967) states that violence may be related to inadequate somatosensory stimulation.

My Tactile Experiences

From age 3 to 10 I was raised by a governess who almost never hugged or touched either me or my sister. This situation further deprived me of tactile stimulation. When I was 5 years old I craved deep pressure and would daydream about mechanical devices which I could get into and be held by them. I liked wrapping myself in a blanket or getting under sofa cushions, but that did not apply enough pressure. I wanted more pressure. At the age of 81 liked to wear cardboard posters like a sandwich because I enjoyed the pressure of the boards against my body.

Ayres (1979) states that children with sensory integration dysfunction crave tactile stimulation. Autistic children prefer (proximal) sensory stimulation such as touching, tasting and smelling to distance (distal) sensory stimulation of hearing or seeing (Kootz, Marinelli and Cohen, 1981; Schoper, 1965). Recent research by Masterton and Biederman (1983) indicates that autistic children rely on proprioception instead of vision to control reaching. Normal and retarded children rely on vision. Preference for the distal sense increases with increasing mental age. This suggests that the near-receptor senses develop first (Murphy, 1982).

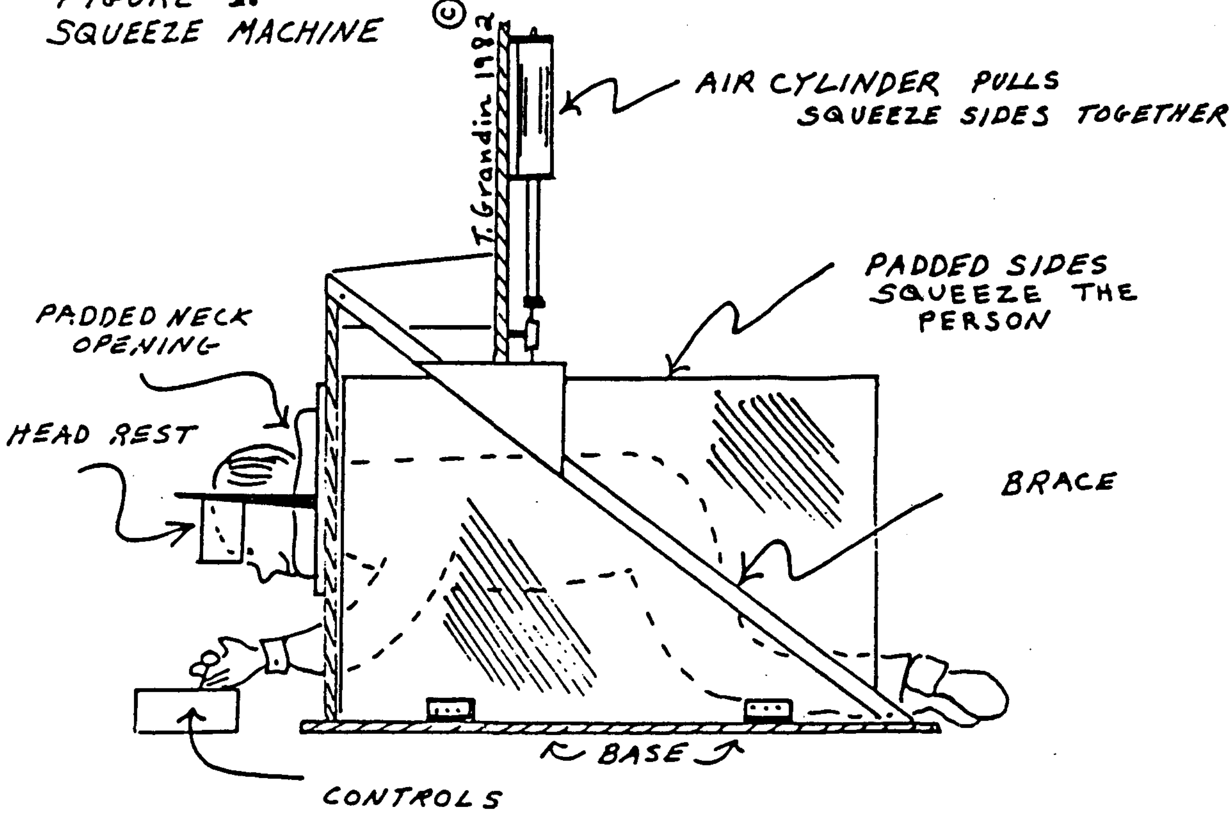
As a child I wanted to feel the comfort of being held, but then I would shrink away for fear of losing control and being engulfed when people hugged me. At the age of 18 I built a squeezing machine. It took a long time to learn to accept the feeling of being held and not try to pull away from the squeezing machine. I could barely tolerate being touched, and I would stiffen up, flinch, and jerk away. One day about twelve years ago, Siamese cat's reaction to me changed after I had used the squeeze machine. This cat used to run from me, but after using the machine I learned to pet the cat more gently and he decided to stay with me. I had to be comforted myself before I could give comfort to the cat.

I have found from my own experiences with the squeeze machine that I almost never feel aggressive after using it. In order to learn to relate to people better I first had to learn how to receive comfort from the soothing pressure of the squeeze machine. Twelve years ago I wrote, "I realize that unless I can accept the squeeze machine I will never be able to bestow love on another human being" (Grandin, 1970, unpublished). When handling cattle, I often touch the animals because it helps me to be gentle with them. "Touching the cattle is very important. If I never touch or stroke the animals, it would become easy to shove or kick them around" (Grandin, 1974 unpublished).

Squeeze Machine Description

The squeeze machine (Figure 1) (Grandin, 1983) is completely lined with foam rubber. It squeezes the user very firmly, yet it is soothing and comforting. The foam rubber lined sides are designed to conform to the user's body so there are no pressure points. When you get in it, the pressure is all encompassing and very soothing. The machine creates an environment that is soothing and relaxing, but at the same time the brain

FIGURE 1.
SQUEEZE MACHINE



is receiving a large amount of input from the pressure. The machine is also equipped with an automatic pulsator so that the squeeze pressure can be rhythmically applied.

Once the squeeze machine was activated, I could not stiffen and shrink away from the pressure. If I tried to flinch or pull away the squeeze would just keep embracing me. I could not avoid the soothing pressure unless I turned off the machine and got out of it. One thing that is extremely important the user of the machine must have complete control over it. He should be able to operate the controls himself and be able to release the squeeze pressure whenever he wants.

The squeeze machine has two foam rubber padded sides which are hinged at the bottom to form a V shape. The person gets in between the two sides in a hands and knees position. The squeeze pressure is applied along both sides of the person's body. The V shape supports the body and the user can completely relax and let the sides hold him up. The machine also has a foam padded headrest and a padded neck opening which is covered with soft flannel. The neck opening, when closed around the neck, also enhances the feeling of being surrounded and contained by the embrace of the squeeze.

The reason the hands and knees position was used is because much greater pressure can be comfortably applied along the sides of the body than against the chest or back. The machine can squeeze the person very tightly and still be comforting. It is stimulating and relaxing at the same time. Pressure applied by the machine activates the pressure receptors from nearly every nerve branch which originates from the spinal cord.

The machine is powered by a small air compressor which operates the squeeze sides by pulling them together with an air cylinder. Since the machine is air powered it will apply a constant pressure even if the user shifts position. A pressure relief valve can be adjusted to control the maximum amount of pressure the machine can apply. The user controls the squeeze by pushing a lever. The machine can be easily constructed by anybody with basic carpentry skills. All of the parts are easily obtainable from lumber yards and local suppliers of air cylinders and valves for industry (Grandin, 1980).

Effect of Squeeze Machine on Nervousness

I have kept records on how often I used the squeeze machine, my reaction to it, and how I felt each day; depressed, nervous, *etc.* The desire to use the machine and the relaxing effect is related to levels of nervousness. The nervousness feels like a constant state of "stage fright" nerves started at puberty. Maybe if I had received more tactile stimulation as a child the nerves would not have occurred (see Anxiety section). During periods of high nervousness the squeeze machine had the greatest relaxing and soothing effect. Krauss (1981) found that deep pressure stimulation may have the most relaxing effect on high anxiety subjects. Librium and Valium had almost no effect on my nervousness.

The effect of the squeeze machine is also correlated with my menstrual cycle. The desire to use the machine and its effect is usually greatest immediately after menstruation and during the middle of the cycle. Periods of nervousness follow a similar cycle. It is possible that these effects could be due to complex interactions between endorphins and other hormones. The stress hormone ACTH and endorphin are derived from the same precursor molecule (Guille-min et al., 1977). Two years ago I started taking 50 mg of Tofranil daily. The Tofranil controls the nerves. Even though I don't need the machine to relieve nervousness anymore, I find that if I stop using it I become more aggressive and sometimes have nasty thoughts and bad dreams. Using it makes me feel gentle, and helps me to have a gentler attitude.

Chemistry of Touch

Touching and tactile stimulation cause distinct biochemical changes in central nervous system. Sakai et al. (1979) found that adult cats which were cuddled responded with a higher internal body temperature and nucleotides in the cerebral spinal fluid changes. Cyclic AMP rose and cyclic GMP fell. Injections of endorphins into humans create a feeling of warmth (Kline & Lehmann, 1978). Experiments conducted by Panksepp et al. (1980) indicate that endorphins are directly involved with the contact comfort response of direct somatosensory stimulation in the chick. Endorphins are "morphine-like substances which occur in the brain." The comfort response is partially blocked by naloxone (endorphine blocker) and it is enhanced by morphine injections. The comfort response is completely blocked by drugs which are antagonists to endorphins, acetylcholine and serotonin (Panksepp et al., 1980). This indicates that serotonin and acetylcholine pathways are also involved. Receptor sites on synapses for endorphins are very numerous in the limbic system. They are also involved in creating euphoria in the hippocampus, amydala, cing-ulate gyrus fornix, and areas involved with smell (Snyder, 1977). Verebrey et al. (1978) suggested that a certain level of endorphins is necessary in order to maintain psychological homeostasis. Injections of endorphins directly into the brain can induce stereotyped behavior (Iwamoto et al., 1977). Panksepp (1981) suggests that autistic children may have excessive amounts of endorphins.

Regular usage of the squeeze machine may help maintain an adequate number of endorphin and other receptor sites in the brain. I speculate that neurotransmitters involved in tactile stimulation such as endorphins and their respective receptor sites on the synapses will increase in numbers gradually in response to a tactile stimulus and gradually decrease in numbers if the stimulus is removed. Maybe a lack of tactile stimulation changes the levels of neurotransmitters in the brain.

Research by Lake et al. (1977) revealed that autistic children have increased levels of Norepinephrine compared to Epinephrine in the blood. Normal people have the opposite ratio of greater amounts of Epinephrine compared to Norepinephrine (Woodman et al., 1978). It would be interesting to find out if increasing tactile stimulation would change the abnormal biochemistry.

Cholinesterase Inhibitors and Contact Comfort

The pleasant comforting effect of the squeeze machine may also be inhibited by cholinesterase inhibiting substances which increase acetycholine levels. Five years ago I was heavily exposed to the organophos-phorus pesticide (Stauffer Chemical Imidan) in a cattle dipping vat (Grandin, 1978). The drug acted as an antidepressant, made me cranky and bad tempered, but it greatly reduced my "stage fright" nerves for over three years. For two years after exposure I seldom desired to use the squeeze machine. My sex drive was initially decreased and then it increased over pre-exposure levels during the two-year period. Maybe the mechanism is similar to Naloxone. The drug Naloxone blocks the action of endorphins and inhibits the comfort response in animals (Panksepp, 1980), but it induces the sex drive in sexually inactive rats. Injections of a synthetic analog of Met-Enkepholin in the brain inhibited copulation (Gessa et al., 1979). Men on opiates have decreased libido and decreased testosterone levels (Verebey et al., 1978). This research suggests that sex drive and the "comfort" response work on separate but related mechanisms. If a person gets adequate "contact comfort" this could possibly inhibit aberrant or excessive sex behavior.

Effects of Touch and Deep Pressure

King (1979) and Ayres (1979) both report that light touch has an alerting effect and firm pressure has a calming effect. Patients in a coma experience a reduction in blood pressure when touched by another human being (Lynch, 1977). Rubbing and pinching a cat's paw decreases tonic activity in the dorsal column nuclei and the somatosensory cortex (Melzack et al., 1969). Kumazawa (1963) reports that pinching a rabbit's skin with rubber padded clips on 1 to 8 areas of the body will create a "deactivated" EEG pattern and the rabbit will have relaxed muscle tone and appear drowsy. When the clips were first applied the EEG showed patterns of arousal for 10 seconds. EEG readings were taken from electrodes implanted in the hippocampus, anterior cortex and reticular formation. Takagi and Koba-gasi (1956) found that when pressure is applied to both sides of a person's body metabolic rate usually falls, oxygen consumption decreases, pulse rate is lowered and muscle tone decreases. In a hot room about 30c bilateral pressure inhibits sweating. They also found that there were large individual differences between subjects. Electrical readings taken from rabbit limb muscle indicated that pinching the skin decreased electrical discharges (Takagi, 1956).
Tests conducted by Kirsten Krauss (1982) at the University of Minnesota indicated that the squeeze machine tends to lower some metabolic functions. Out of 40 normal college students, 62 percent liked the squeeze machine and found it to be relaxing (Gran-din, 1970). The squeeze machine applies pressure to the body areas most sensitive for eliciting the "Skin Pressure Reflex" in man (Takagi & Kobagasi, 1956). Some people find that the squeeze machine is relaxing for the first 10 or 15 minutes and then it becomes annoying. Kumazawa (1966) found that rabbits with deactivated EEG's in response to clips on the skin would become aroused after about 10 minutes. The deactivation effect wore off. There may be an optimal level of stimulation. If the rabbit was in a drowsy state, 1 to 5 clips had a deactivating effect whereas 7 to 10 clips sometimes had an arousing effect. The deactivating effect of the clips also decreased in a hot or a cold room. I find the squeeze machine is less effective on hot summer days or if the room is cold.

Trainers of show cattle always touch an animal firmly; if the animal is tickled it is likely to kick. I have tamed Brahman cross and Hereford calves by confining them in a squeeze chute and petting them all over. Monkeys and pigs will also become inactive and quiet by stroking or scratching the flank of a pig or the eyes and thorax of a monkey (Marcuse & Moore, 1944; Foley, 1938). V shaped restraining chutes are used for restraining cattle, pigs, and sheep on farms and in meat packing plants. Pigs restrained in a V shaped trough with their legs protruding through the open bottom appear to fall asleep within 15 minutes. Teitlebaum (1982a) found that bandaging the torso of a cat would cause its rear end to topple over. The hind quarters would appear to be disconnected from the forequarters and head. In pigs stroking the belly will cause the animal to roll over. A similar response has been reported in the rabbit. Ratner (1958) reports that a rabbit placed on its back in a V shaped trough will usually remain motionless for up to 20 minutes. Ratner also mentioned that tame animals are less likely to remain motionless.

This may be similar to the pressure hypnosis response described by Takagi (1956). The restraining chute must be sturdy and it must hold the animal firmly. Otherwise, the animal will fight and attempt to escape. "If a handling procedure is fumbled, the animal may become aroused and it may need more people and the adoption of a more severe technique to restrain it" (Ewbank, 1968). Cats placed in a sturdy box for travel will quiet down and sleep. The same cat placed in a flimsy box will keep trying to claw its way out. I have observed a similar effect on carnival rides. If the equipment is in good repair and does not feel rickety, the people are less likely to become alarmed. On rides such as the Round Up which restrain the riders by centrifugal force, I find that I can relax and enjoy the restraint provided that all the bolts on the ride have been tightened and I can't feel the steel structure flex. If the structure flexes or rattles, I become scared and start holding on.

I observed an older puppy which was withdrawn and unsocialized to people. It would run and cower in a corner and nobody could touch it. The dog's behavior changed after it got seriously injured in an accident and people petted it while it was taken to the vet. After the accident it started approaching people and it would seek out people it had avoided before. This may be similar to the holding therapy described by Henderson et al. (1973). He claims that hyperactive children have improved greatly. Hyperactive children are held and soothed until they stop resisting. (Arnold & Sheridan, 1980). Rimland (1981, personal communication) described a study conducted in 1920 where an autistic child's behavior was improved by holding the child. Gampel (1980) in New York has also had success by holding an autistic child or adult and applying strong tactile stimulation to the face. A firm prompting procedure which involves physically guiding the bodies of autistic children during a task suppressed aberrant behavior (Hung et al., 1979).

Sensory Effects of Touch and Pressure

If I remain completely still in the squeeze machine, it becomes difficult to differentiate my body boundary and sometimes I feel that I am floating. The feeling of floating has also been reported by other people who have used the squeeze machine. Increasing the pressure so slowly that I cannot perceive the pressure increase creates a wave of sensation which is comforting and relaxing. I feel a similar effect on carnival rides during initial acceleration. Especially on rides such as the Rotor or the Round Up which hold standing riders in place by centrifugal force along the perimeter of a wheel or inside a barrel. In the squeeze machine, while the pressure is slowly increasing and when carnival rides start accelerating, the feeling is a pure sensation rather than pressure. Both the squeeze machine and the carnival rides apply intense somato sensory input. The rides also apply vestibular input. The squeeze machine is soothing and relaxing but at the same time it stimulates many pressure receptors.

There may be a common basis for all perception. Hearing and touch have many similarities. The very slow application of the pressure may confuse the brain. Von Bekesy (1950) and Gescheider (1965) found that people could project skin sensations out into space. They could locate sounds in a room via vibrations from artificial cochleas against each forearm. The forearms became crude "auditory nerves." People can also "see" via hundreds of tiny vibrators against the back which are hooked up to a TV camera. Sighted people report that at first the pattern translated from the TV camera to the vibrators feels like a wave of sensation. After a short while they start to "see" the patterns in their heads. Blind subjects trained to use the vibrator can still "see" with the device regardless of where it is placed on the body. There is a change in how the central nervous system perceives the vibration in a trained person. Evoked potentials are different in untrained and trained subjects (Bach-Y-Rita, 1982). Maybe there is a common mechanism which turns sensation into perception. Grandin (1970) reviews studies on sensory interaction and the similarity of how different senses process stimuli.

Tactile Defense

On the Ayres' (1979) checklist for tactual defense I had 9 out of 15 items at the age of 10. I did not like finger painting and preferred to paint with a brush. As a baby I resisted being touched and when I became a little older I can remember stiffening, flinching, and pulling away from relatives when they hugged me. It was an approach-avoid situation.

I wanted to feel the comfort of being held but I would shrink away for fear of losing control and becoming engulfed, in an overwhelming wave of stimulation. A 7-year-old autistic boy responded to the squeeze machine in this manner. He appeared to sort of enjoy the pressure but then he would release the pressure and start crying.

Tactile defensive behavior and hypersensitive behavior are very similar. Wool clothing is still intolerable for me. Many factually defensive people cannot tolerate rough fabrics against their skin (Ayres, 1979). I am still very ticklish and it is difficult for doctors to examine me. Staying still for the air puff glaucoma test or for wax removal from my ears is very difficult. Several doctors have told me that I am one of the most difficult people to examine. When the skin is anesthetized with a local anesthetic, I have no problem staying still. As a child I did not like the feeling of my legs or arms touching each other, and I wore pajamas instead of nightgowns. I liked clothes that applied pressure around my neck such as turtle neck sweaters. Damasio and Maurer (1978) theorize that autistic children have a defect in the mechanisms of attention and alerting. Dunn and Fisher (1983) state that this may account for factually defensive behavior.

Under and Over Sensitivity to Stimuli

Ritvo (1970), Ayres (1979) and Ornitz (1976) stated that autistic children are over responsive to some stimuli and under sensitive of other stimuli.

Tactile defensiveness is probably one aspect of an overall impairment in the integration of incoming sensory input. An example of hypersensitivity is James and Barry's (1980) experiment on the reaction of autistic children to visual stimulation. In normal subjects the respiratory response becomes habituated and they have a smaller response in the vascular system than autistics. An example of decreased sensitivity is that autistics have an inadequate galvanic skin response in response to visual and auditory stimulation (Bernal & Miller, 1970). As a young child I was very sensitive to sudden loud noises, but I was able to tune out continuous noises. I hated balloons at parties because I feared the sudden noise of one popping. I still have a strong startle reaction to noises such as gunshot or a balloon popping.

Selective Attention

The over- or under-responsiveness to stimuli may be due to a defect in the ability to selectively attend to a stimuli. Dogs kept in isolation also had difficulties with selective attention (Melzack and Burns, 1965). When an autistic child is engaged in a stereotyped behavior he usually becomes less responsive to an outside stimuli. Autistics cannot handle simultaneous stimuli (Ritvo, 1970), and they attend to only one aspect of a compound visual and auditory stimulus. They use the sensory modality which they selected in a previous preference test (Kolko, 1980). They have a choice of either self stimulating and screening out all outside stimuli or becoming overwhelmed with many simultaneous stimuli. Physiological and behavioral measurements conducted by Kootz et al. (1982) suggest that autistic children avoid stimulation and resort to self stimulating behaviors to "flood sensory receptors, and insist on an unchanging environment". This is similar to the behavior of babies Krauss (1981) found that newborn babies will avert their gaze if they are overloaded with stimulation.

I also liked to sit for hours humming to myself and twirling objects or dribbling sand through my hands at the beach. I remember studying the sand intently as if I was a scientist looking at a specimen under the microscope. I remember minutely observing how the sand flowed, or how long a jar lid would spin when propelled at different speeds. My mind was actively engaged in these activities. I was fixated on them and ignored everything else (Grandin, 1980).

In a busy airport I can easily screen out all the outside stimuli and read, but I still find it nearly impossible to converse on the phone. I can't screen out the airport background noise and listen to the phone at the same time. My hearing acuity is normal, but I prefer to use the special amplified phones for the deaf at the airport. Rosenblum et al. (1980) states that an autistic child may ignore a loud noise but attend to the sound of crinkling cellophane. I dislike listening to TV or radio that has static. Levels of static which most people would probably ignore, greatly annoy me. The noise and confusion at birthday parties disturbed me as a young child. The party noise was like a great massive wave of confusion. At parties I often became upset and had a tantrum. Kootz et al. (1981) states that autistic children "are overwhelmed by environmental stimulation and unable to focus on pertinent stimuli".

Hyperactive boys also have a defect in selective attention. This was determined by measuring evoked potentials during an auditory signal detection task (Loiselle et al., 1980). Reacting to insignificant stimuli as if they were large stimuli could be due to damage in the reticular activating system (Luria, 1970). Stereotyped behavior can be induced by injecting amphetamines (Groves, 1977; Cole, 1978). Blindfolding a cat which had been injected with amphetamine reduced stereotyped behavior because sensory input was restricted (Stevens et al., 1977).

A defect in selective attention is possibly evident in my reaction to noise while I am on the phone. In a noisy place I will start yelling louder and louder and louder when I cannot hear. Experiments conducted by Nober and Simmons (1981) revealed that when autistic children are distracted by either white noise or delayed auditory feedback they spoke up to 8 dB louder than normal children. In high school while playing with delayed auditory feedback in the language lab, I found myself yelling louder and louder at the echo.

Autistic Fixations

In the fourth grade, I drove my family nearly crazy with constant talking about election posters, buttons, and bumper stickers. I also used to ask questions constantly and had been nicknamed "chatterbox" in elementary school. Question-asking and constant conversation on a particular topic has been reported in other children who were diagnosed as autistic at an early age and then recovered normal speech (Wether-by et al., 1981). The tendency to be fixated on one subject continued until I was a young adult in my twenties. The higher my arousal level the greater the tendency I had to fixate. Sahakian (1978) reports that the so-called paradoxical effect of amphetamines on hyperactive children is not really paradoxical. The drug improves concentration by making the child perseverate on the task. Biochemical changes caused by swimming through the dip vat reduced both the "stage fright" nerves and the tendency to become fixated on one subject. Tofranil has the same effect. Prior to my exposure to organophosphate, my tendency to fixate on one subject was greater.

CNS Development

In the human baby, mylinization of the central nervous system is only complete to the brain stem. A huge amount of development takes place after birth (Moore, 1979). Touch is one of the first systems to mylinate and become functional (Huss, 1977). In newborn human babies, puppies, kittens and adult patients with severe Parkinson's disease, vestibular and kinesthetic inputs can be de-activated by pressure on the face, scalp and neck. Wrapping a bandage around the head and neck will cause the head to drop back (back fall reaction). This reaction does not occur in mature, undamaged humans or animals (Teitlebaum, 1982a). The bandage back fall reaction illustrates the dominance of tactile input over vestibular and kinesthetic input in an immature or damaged central nervous system.

In the developmentally disabled the degree of disability can be predicted by response to a tactile vibration stimulus. The greater the disability the more the child will have an increased heartbeat in response to a vibration stimulus on the calf (Bernston, 1983).

Neural development occurs in stages and if a sense organ is damaged during a critical developmental period, the corresponding areas of the brain will be damaged (Greenough & Juraska, 1979a). Both the thalamus and the cortex in the mouse have a critical period when removal of the vibrissae (whiskers) will cause damage (Woolsey et al., 1979). There may also be a sensitive period for the effects of environmental complexity on hippocampal dentrate gyrus organization (Fiala et al., 1978). In humans, mylinization of the hippocampus may extend beyond puberty (Reisman, 1979). Maybe defects in integrating incoming stimuli are partially responsible for damaging the hippocampus or other brain areas in autism.

Defects in my development were first apparent at 6 months of age. By the age of 3 and 4 many of the autistic behaviors subsided but I still had bouts of impulsive behavior when I got tired. As I grew older the impulsive bouts became fewer and fewer. The doctor said, "I don't know why she got sick and I don't know why she got well." Maybe my central nervous system possibly in the hippocampal area matured and repaired itself.

Central Nervous System Problems in Autism

Possibly autism mimics the damaging effects of early sensory deprivation due to an immature or damaged nervous system. Anatomical abnormalities are often present in both autism and dyslexia (Galaburda & Kemper, 1979; Hauser et al., 1975). Dys-lexics have an abnormality in the language areas in the left hemisphere. Duffy (1981) has developed a method for mapping electrical activity in the brain. It can detect abnormalities in the brains of dyslexics who have normal CT scans. Hier et al. (1979) report that CT scans of 9 out of 16 autistic children had reversed symmetry in the posterior language region. The majority of mentally retarded and neurological control patients had a wider left region. A carefully controlled CT scan study by Campbell et al. (1982) revealed that an identifiable subgroup of autistic patients had enlarged ventricles, but T Tests failed to show any relationships between ventricle size and clinical variables. The subjects were autistic children 2 to 7 years old with no history of seizures or gross neurological problems. Gillberg and Svend-sen (1983) found gross abnormalities in the CT scans of 26 percent of the autistics. Their findings indicated that the brain abnormalities found were related to the autistic syndrome itself and not to the degree of mental retardation.

Autistic children with flattened out left brain ventricles may have damage in the hippocampus (Reisman, 1979). The hippocampus receives input from all sensory systems and it is one of the last structures to mylinate (Moore, 1979). Lesions in this area make the subject more distractible, and he will either respond immediately to a stimulus or become fixated on a stimulus. Hippocampal damage will cause perseveration in animals.

Ayres (1979) reported that autistic children are often fearful of rapid movements at first and then become fixated on them. I have had this type of experience. When I first saw the Rotor at age 16, I was afraid to ride on it. I panicked the first time I tried the Rotor. After an initial period of panic I found that I enjoyed it and wanted to go on it over and over again.

Immature CNS

Under or over-sensitivity to stimuli in autistic children is an immature perceptual experience (Prior, 1979). Ritvo (1970) and Ornitz (1976) reported that autistics had an immature sleep pattern. Another indicator that bouts of stereotyped behavior occur in an immature nervous system is Ritvo's (1968) observation that normal babies will have a bout of stereotyped flapping when they are startled. Thelen (1979) reported on extensive observations of rhythmical stereotyped behaviors in normal infants. As the babies mature the stereotypes decrease and finally stop. Thelen proposes that the rhythmical stereotypes are manifestations of incomplete cortical control due to an immature nervous system. "As maturation enlarges processing capacity, stereotyped behavior is replaced with more variable and goal directed activity. But the neural substrate for stereotyped responses still remains, as it can be seen from the number of movements that remain in the repertoire at one year of age."

Evoked Potential Variability

"In children, complete development of higher cortical function depends on the integrity of the lower areas" (Wetherby et al., 1981). One sign of either immaturity or damage to the central nervous system is variability in evoked response, measured with an EEG. Rosenblum et al. (1980), Student and Sohmer (1978) and Tanguay et al. (1982) report that brain stem transmission time is longer in autistics and the evoked potential is more variable. Auditory stimuli were used to evoke the response in these studies. There may be a defect in the first or second synapses of the auditory system (Rosenblum et al., 1980). When auditory and visual stimuli are presented simultaneously the visual evoked response in autistic children is more variable than in normal children (Small, 1971). Lelord et al. (1973) measured auditory-evoked responses in normal and autistic children following an auditory stimulus which was followed by a light flash. In normal children the evoked response was stable and regular and in autistics it was irregular and variable. This finding may indicate that there is a defect in the integration between auditory and visual pathways in autistic children. Tanguay et al. (1982) conclude that abnormalities in brainstem evoked responses may have three possible effects on the cause of autistic handicaps.

1. No causal effect. The defects in the brain stem may have been caused by defects in higher centers.
2. The brain stem pathology may distort auditory input and impair language learning.
3. The brain stem pathology may distort sensory input and cause abnormal development late maturing cortical system.

Autistic subjects 8 to 24 years old with normal hearing have indications of a central auditory nervous system dysfunction in the language dominant hemisphere, inferred from dichotic tests in subjects with echolalia. When subjects previously diagnosed as autistic recovered and spoke normally the dichotic test results became normal. The dichotic test results in one subject of central auditory function were consistent with language improvement over a year (Wetherby et al., 1982). This indicates the possibility that brain abnormalities may not be detectable in people who have recovered or partially recovered from autism.

Maturation defects may be partially responsible for the sensory deprivation like effects of autism. The sensory deprivation like effects of autism may also account for the lack of emotional response in autistic children. People that are blind from birth and have their sight restored or use the vibration TV camera vision device, can learn to use visual information but they don't get any emotional satisfaction from it. Bach-Y-Rita (1982) reported that blind people could "see" their wives with the vibration device. They could "see" all the features of their wife's face but there was no emotional response. Maybe the "emotion circuits" fail to connect properly, in a similar manner in autistic children.

Stimulation Activates the Brain

Gevins (1982) found that diffuse electrical activity occurs throughout the brain in response to stimuli. The brain is most alert and responsive to stimuli when it has an optimum level of tonic electrical activity (Grandin, 1970). Research by Phelps et al. (1981) on brain glucose metabolism indicates that as a visual stimulus becomes more complex, more areas of the brain are activated. Looking out a window at a park activates more brain areas than looking at a white light. A complex scene can increase glucose metabolism 60 percent in the primary visual cortex (Greenberg et al., 1981).

When a person counts out loud or reads out loud more brain areas are activated than counting or reading silently (Lassen et al., 1978). Some of the additional areas activated are face, tongue, and mouth somato-sensory motex cortex, upper premotor cortex, Broca's area, and the visual association area. When I design a project, I often talk to myself when drawing the blueprints. It helps me to organize my thoughts. As a child I used to tell stories to myself out loud. Speaking out loud made my thoughts seem more concrete and real. Counting out loud activates supplementary motor areas where input from the visual and auditory senses converge (Orgogozo & Larsen, 1979). Maybe talking out loud helped me to visualize my thoughts. In lectures taking notes helps me to retain the material. I much prefer reading to listening. The act of taking notes would also serve to activate more brain areas. Lassen et al. (1978) states that the more effort which is put into a task the more brain areas are activated. Dynamic movements such as operating a typewriter activate more areas than steady muscular contraction. I learned reading by reading out loud and sounding out the words. In college Freshman English class I flunked the section on diagramming sentences, but I could write good term papers because I wrote sentences that sounded correct. Both my parents spoke grammatically correct English and if I was not sure of the correct grammar in a sentence I would read it out loud to see if it sounded "right".

Vestibular System

Vestibular stimulation is important in the treatment of many developmental disorders because the vestibular nuclei is the first part of the central nervous system which starts to mylinate after birth (Moore, 1979). It sends both excitatory and inhibitory pathways to the brain, and if the vestibular system is underdeveloped the hippocampus will also be underdeveloped. A dysfunction in the circuitry of the vestibular system to the central connections may be responsible for the strange sensoriomotor behavior of autistic children (Ornitz, 1976).

Sensory integration therapy is based on the concept that stimulation of the vestibular system and other sense modalities will help the immature or damaged nervous system to develop. Both visual and vestibular input from the semicircular canals in the ear activate the same neural units in the vestibular nuclei (Waespe et al., 1981). The same neural units are activated by both vestibular stimulation and visual stimulation of rotating stripes. Takagi (1956) found that in the rabbit nystagmus of the eyes can be affected by pressure stimulation on the skin. This is just one more example which illustrates how the different sense modalities interact.

Vestibular Problems in Autistics

Autistic children have diminished post rotary nystagmus after their vestibular system is stimulated by whirling around (Ritvo, 1970; Piggot, 1979). The nystagmus is only inhibited when the child is whirled in a lighted room; in a dark room the autistic child has a normal amount of post rotary nystagmus. This finding indicates a defect in the integration of visual and vestibular stimulation.

Ayres and Tickle (1980) observed that children who are hypersensitive to stimuli with some post rotary nystagmus respond better to sensory integration therapy than hyposensitive children with little or no post rotary nystagmus. A recent paper by Bhatara et al. (1981) objectively demonstrates the beneficial effects of vestibular stimulation. Hyperactive boys were spun in a chair twice weekly and all three planes of the vestibular system were stimulated. Boys who received the vestibular stimulation had improved behavior in school. The teachers who evaluated them did not know which boys received the vestibular treatment. After 10 years of age the vestibular stimulation had little effect. The nervous system may have matured and became less sensitive to the vestibular input. In mentally retarded persons vestibular stimulation applied by rocking 13 to 22 year old people reduced the incidence of stereotyped rocking behavior (Bonnadonna, 1981).

Fifty-nine percent of autistic children will whirl around often (Ornitz, 1976). I can remember winding up the chains on the swings and then letting them unwind quickly. I enjoyed the sensation of being dizzy and I liked to watch the room or the trees spin after making myself dizzy. I became dizzy and enjoyed it. When I was 6 and 71 used to spend the entire recess period playing over and over on a coaster which slid on an overhead track. At the age of 16, I liked the Rotor carnival ride because it applied the most intense pressure and vestibular stimulation. Six months ago I went to a carnival and tried many rides. The Rotor makes me and most other people more dizzy than most other rides. I could not walk straight after getting off of it. Maybe one of the reasons I recovered was because my vestibular system still responded. Possibly carnival rides such as the Rotor would be useful in treating developmental disorders. Vestibular stimulation may speed up maturation of the nervous system. Fox (1971) reports that puppies subjected to many different kinds of sensory input had significantly larger vestibular neurons than dogs in the control group. Some of the treatments in the stimulated group was rotary stimulation, head tilting and cutaneous stimulation from brushing.

Beneficial Effects of Enriched Environments

Increasing environmental stimulation accelerates mylinization, whereas a lack of stimulation delays it (Levin & Alpert, 1959). Complex stimulation produced more diffuse effects on brain growth and improved memory better than stimuli applied to just one sense modality. Baby rats exposed to visual and auditory stimuli and exercise on a treadmill had more diffuse central nervous system changes than rats exposed to visual stimulation alone (Myslivecek & Stipek, 1979).

One method of measuring brain development is to count the increased numbers of dendrites and the number and size of the synapses. Dendrites are neural connections which branch out from the cell body and connect with other circuits in the brain. Stimulating complex environments usually increase the growth of dendrites and synapses. Isolated environments inhibit growth. A basic principle is that the brain is more plastic in a young animal or baby than in an adult. Environmental stimulation will have a more beneficial effect on a young animal. Placing newly weaned rats in either an isolated or an enriched environment produced wider dendritic branching and more dendritic intersections in the hippocampal granule cells (Fiala, Joyce & Greenough, 1978). The hippocampus is an area which may be damaged in autistic children. Maybe these findings help explain why subjects diagnosed as autistic which had recovered had extensive therapy and language training starting at ages 3 or 5 (Wetherby et al., 1981).

Even in the adult animal the brain still has capacity for growth. There is an excellent review of brain growth research in Greenough and Juraska (1979a). In adult rats, animals trained in mazes and handled daily had more dendritic branching in the occipital cortex than control rats which were only handled daily (Greenough et al., 1979). "These results are among the first to indicate plasticity at the neuronal level in the adult rat."

Environment and the Tactile System

Recent research conducted by Temple Grandin, William T. Greenough and Stanley S. Curtis at the University of Illinois has yielded some unexpected preliminary results. Weanling pigs were raised in either a complex enriched environment or a simple unstimu-lating environment. The complex environment consisted of putting twelve pigs together in a group. They were housed outdoors in a pen with an adjoining house bedded with straw. Each day they were provided with new toys to play with, and they were petted and handled for 15 to 30 minutes. The simple environment group was housed indoors, in small 4 ft. by 4 ft. pens. Two pigs were placed in each pen and lighting and temperature were kept constant. These pigs were not handled and they did not receive toys.

The hypothesis was that the pigs in the enriched environment would have more dendritic branching and a thicker cortical depth in the somatosensory cortex that corresponds with the end of the snout. A large portion of the pig's brain is allocated to the snout (Adrian, 1943). Measurements of cortical depth and dendritic branching were made on 12 animals. The preliminary results indicated that the pigs from the simple environment may have a deeper cortical depth and more dendritic branching than the complex environment group. There was a lot of variation between animals and the difference between the groups approached statistical significance. More research is needed to verify our preliminary finding.

The pigs in the simple environment may have actually physically stimulated the ends of their noses more than the pigs in the complex environment. The simple environment pigs appeared to crave tactile stimulation. They unscrewed bolts in the pens and they rushed up and bit the water hose during pen washing. When the feeders were cleaned they vigorously mouthed the experimenter's hands. Pigs in the complex environment could be easily pushed away during feeder cleaning. W.T. Greenough suggests that the complex environment may have diverted the animal's attention away from the tactile modality. The tactile modality may have been more dominant in the visually and auditorially bland simple environment.

A possible similarity between autistic children and animals in a barren environment is that they both may rely more on the phylo-genetically older and earlier maturing tactile, proprioceptive and vestibular systems instead of the distal senses of seeing and hearing. The proximal senses may provide more stable input so the autistic child self stimulates via these modalities to block out a flood of input from distal modalities with malfunctioning immature circuits. I find that I still am annoyed by noise in the environment. The sound of motors running such as a loud vent fan irritates me.

Repair of Circuit Damage

The brain has the capacity to repair damage or make new circuits around the damaged area. "Both immature and mature nerve cells can sprout 'extra' axon terminals to fill postsynaptic sites which have been vacated due to damage elsewhere" (Greenough, 1982). Fuchs (1982) reports that when inputs to the hippocampus are cut in animals, new connections tend to grow back into the area. Experiments with brain damaged rats indicate that placing them in a stimulating environment with toys enabled them to perform better in a maze. Compared to brain damaged rats housed alone in regular cages (Will et al., 1976).

If a young kitten has its eyes sutured shut, it will become functionally blind. If it is forced to use a previously sutured eye, by covering the good eye it will recover more function (Dews & Wiesel, 1970). If the input from one organ is destroyed, areas of the brain involved with processing input from another modality may expand. Dendrites increased in density in the auditory cortex of young rats that had been blinded or had had their whiskers removed (Ryago et al., 1975). When some of the whiskers are damaged in baby mice, the corresponding areas in the somotosensory cortex disappear. Areas which correspond to the remaining functional whiskers expand into areas that had previously corresponded with the missing whiskers (Woolsey & Winn, 1976). An enriched environment with complex stimulation will help speed recovery of stroke victims. Socialization and good health is not sufficient (Bach-Y-Rita, 1982). In order for a brain damaged person to recover he must actively participate.

The central nervous system is very plastic and has a tremendous capacity to reorganize and make "sense" out of disordered or mixed up and input from the periphery. Brinkman (1983) found that the central nervous system of the monkey can learn to move the animal's arms after the major arm nerves were cut and then reconnected to the wrong major muscles. Within ten months the monkeys regained near normal use of their arms and hands.

How Brain Circuits Develop

Greenough and Juraska (1979b) explain how a developing brain controls the development of its synapses. "Recent work suggests that synapses actively used in behavior are preserved while other less active connections disappear. As experience activates those cells (nerve cells), connections that are regularly used may be preserved while other less active connections that are regularly used may be preserved, the unused synapses may be lost, evidence suggests that more are lost if the environment doesn't provide enough stimulation to the child or adult brain." The brain tends to be somewhat disorganized at birth and the environment directs its growth by both pruning off unused synapses and growing new ones.

Galaburda (1983) reports that dyslexics who have a delay of the onset of speech have disordered neuronal migration and a more primitive neural architecture in the left hemisphere. The right hemisphere becomes more developed. "Impaired development of the left cortex in dyslexia could allow for a successful competition for available connectional sites by neurons arising in the right hemisphere. This condition could then result in diminished neuronal death on the right side and the formation of larger neural circuits having right hemisphere functions." This could explain the anecdotal evidence that a large number of dyslexics have left handedness and excellent visual-spatial and musical abilities.

Environmental stimulation affects many brain areas. The Purkinje cells are involved in vestibular and visual interaction (Waespe et al., 1981). Pysh and Weiss (1979) found that exercise during the late post-natal period increased the number of dendrites in the Purkinje cells in the cerebellum in mice. Floeter and Greenough (1979) found that there was more dendritic branching in the Purkinje area in colony reared monkeys compared to paired monkeys or isolated monkeys. The isolated and paired monkeys had no significant differences in dendrite growth but their behavior was different. The isolated monkeys had more autistic behaviors than the paired monkeys. Since the colony reared monkeys had a greater opportunity for motor activity than the other two groups, this could account for the increased dendritic branching in the Purkinje area. The area of the brain which was damaged in the "autistic" animals has not been discovered.

Stimulation or a lack of stimulation causes both changes in the anatomy and changes in the sensitivity of various brain areas to neurotransmitters. For example, deprivation of vision in cats will decrease the number of synaptic vesicles in the synaptic terminals (Garey & Petigrew, 1974). The number of vesicles is one factor which determines how a synapse will react. Plasticity can occur in two basic ways: changes in anatomy and changes in neurotransmitter levels and receptor site sensitivity. Damasio and Maurer (1978) suggest that autism is related to a neuromediator defect in area of dopaminergic mesencephalic neurons. A neuromediator or modulator is a substance that changes the sensitivity of synapses to a neurotransmitter.

Central Nervous System Subsystems

As mentioned earlier in this paper we must not fall into the trap of claiming that we have localized the sole function of a certain part of the brain. Just because a certain behavior stops when a certain part is destroyed does not mean that the destroyed area is the center of that particular function. It simply means that the destroyed area is involved somewhere in the circuit.

Research conducted by Phillip Teitlebaum at the University of Illinois disproves the principle of localization of function. In humans and rats adult recovery from brain damage recapitulates infantile ontogeny (Teitlebaum, 1977). Most occupational therapists are familiar with the fact that recovery from hemi-plagia in human adults follows the same stages as the development of normal voluntary grasping in newborn infants (Twitchell, 1970). Bach-Y-Rita (1982) cited work done by P. Wall on "unmasking" of unused circuits after an injury. As an animal or person matures certain circuits are suppressed. Humans with brain injuries will have an immature "toe curl reflex." The immature "toe curl" circuit was "unmasked" when the more mature circuits were damaged. The brain injured person can learn to use the "unmasked" circuits. In monkeys which had been deafferented (incoming) sensory nerves cut there was evidence of reorganization in the somatosensory cortex within one week.

Teitlebaum (1977, 1980, 1982b and 1983) extends this principle to many central nervous system functions. After you read the following outline of Teitlebaum's research it should become apparent that his principles may help science to understand autism and unravel the many conflicting reports in the literature.

Movement subsystems are the building blocks of behavior. They can be identified by damaging parts of the brain such as the lateral hypothalamus or by administering drugs which selectively shut down certain subsystems. Partial transection of the central nervous system by lesions or drugs enables the subsystems to be identified as the animals recover. Examples of movement subsystems in the rat are posteral support, locomotion, scanning, orientation and mouthing.

The drugs morphine and haloperidol selectively shut down different complimentary movement subsystems. Rats treated with either of these drugs will be cataleptic. Superficially they appear the same but the two drugs affect the animal's central nervous system differently.

A rat treated with haloperidol has an operating posteral support system but the other subsystems are shut down. It will right itself when dropped but will become behaviorally inert when it returns to a balanced position. The morphine treated rat has a functional locomotor system but the posteral support and other systems are shut down. It will respond to stimuli with bursts of locomotor activity.

Subsystems in an animal with a lateral hypothalamic lesion recover in a cephalo-caudal order. The lower systems recover first. The order of recovery is: support system, horizontal head scanning, circling, forward locomotion, and vertical head scanning. A rat without vertical head scanning will become stuck in a corner. During recovery there is conflict between the different subsystems. In rats exaggerated bending occurs when scanning has recovered but the forward locomotor system is still shut off.

The subsystem idea also applies to recovery of normal eating after brain damage. The same sequence of behaviors which occurs during recovery also occurs during development from infancy. The first stage of recovery in a rat with lateral hypothalamic lesions is consumption of soft palatable foods; the last stage of recovery is drinking water. A human baby will not drink plain water unless it is flavored.

Breaking complex behavior down into subsystems helps to explain normal exploratory behavior. The combination of different subsystems interacting with each other will produce complex behavior. The different subsystems interact both cooperatively and antagonistically. When the central nervous system is damaged the different subsystems may recover at different rates. It is likely that these are not discreet stages of recovery. Teitlebaum (1983) states that we must not fall into the perceptual trap of labelling recovery in terms of stages. The stages of "composite aggregates formed by the differential rates of recovery of eating and drinking".

Subsystem Concept Applied to Learning, Language and Emotion

The subsystem concept can also be applied to learning. A dog with lateral hypothalamic lesions will not respond to a sound as a conditioned stimulus until it has recovered (Teitlebaum, 1977). The modalities that can be conditioned may follow the same sequence of recovery after brain damage as the development of the different modalities in an infant. The order of recovery is: kinesthetic and vestibular first, tactile second, and visual third. Russian investigators found that human babies could be conditioned with a vestibular stimulus at an earlier age than with a visual stimulus.

Subsystems are also evident in the relationship between the sensory modalities and certain types of aversive stimuli. A rat will associate flavored water with feeling ill, but it will not associate a light or sound stimulus with illness (Teitlebaum, 1977). The proximal senses mature earlier and respond to learning first.

Subsystems may be involved in the development of language phonemes. Discriminating language sounds does not operate on a continuous basis (Greenough, 1982). There is a distinct difference in the threshold when the brain distinguishes a p from a b sound. William O'Neill, University of Rochester discovered that bats use phonemes for echo location. There is a subsystem of neurons that respond to frequency and another subsystem which respond to the intervals between sounds.

Emotions are not integrated in a decerebrate cat. It will exhibit fragments of emotion. Teitlebaum states "the decerebrate cat will often show signs of contentment purring, while hissing and growling with rage." Maybe emotions have subsystems like movement. Recent research by Ekman et al. (1983) reinforces the idea of emotion subsystems. Old theories of emotion proposed that autonomic activity was undifferentiated for all emotions. In Ekman's study he discovered that the autonomic nervous system responds differentially to different emotions.

Autistic Subsystems

Young et al. (1982) state "An autistic child becomes increasingly excited by environmental stimulation and manifests it through more frequent stereotypes and behavior fragments, accompanied by an inability to complete behavioral sequences". If this observation is interpreted with the subsystem model the various subsystems may become disassociated when the child becomes excited. Young et al. (1982) reviewed studies on the effect of stimulants on animals. A relatively low dose increases activity, stereotypes and circling. Further dose increases cause a shift to isolated species typical motor acts which occur outside their usual context. Maybe this principle explains why an autistic child will suddenly throw a fork for no apparent reason.

My mother wrote in her diary that when I was 3 years old I would suddenly jump up and spit on the floor. After spitting I would apologize and clean it up. Erratic behaviors increased as the day progressed and I became bored or tired.

Benefits of Motor Activity

In many of the brain development experiments an increased opportunity for motor activity was a common denominator in the enriched environment condition. Animals with greater opportunities for exercise and motor activity grew more dendrites. Motor stimulation has a beneficial effect on autistic children. Walters and Walters (1980) found that jogging decreased self stimulation and watching TV did not decrease self stimulation in autistic children.

When I was three my parents hired a governess. One of the good things she did was to play lots of ball games and marching around the piano. She devoted hours of attention to me and encouraged motor activities. Ornitz (1976) reported that autistic children learn by manipulating objects and get cues via motor feedback. Even as an adult I find that it is easier to learn about something if I can actually do it instead of watching. When I first started designing cattle handling facilities I went to the feedlots and actually worked with the feedlot employees. I have a very strong desire to operate the equipment and handle the animals myself. Things that I physically participate in I remember and retain the best.

Motor activity may play a role in the prevention of autistic behavior. Monkeys raised on moving mother surrogates had fewer behavior problems. Monkeys raised on stationary surrogates developed stereotyped rocking, fearfulness, and impaired heterosexual and social relationships (Prescott, 1967; Mason, 1966; Prescot, 1979). The Eastman and Mason (1975) study showed that monkeys raised with mechanical moving surrogates looked through a peephole longer at another monkey, compared with monkeys which were raised with identical stationary surrogates. The monkeys raised with stationary surrogates were more sensitive to stimulus differences. In experiments by Wood et al. (1979) monkeys raised with cloth surrogates had more autistic type behaviors than monkeys raised with dog mothers. The monkeys with dog mothers directed more activities towards the environment. In 3- to 4-month-old human babies studies by Korner and Thoman (1972) suggest that vestibular and proprioceptive stimulation are the major components of the soothing effect which occurs when a mother attends her infant. Contact comfort may play only a minor role in the soothing effect.

Rhythmic Effects

Research by Condon and Sander (1974), indicated that normal human babies move in rhythm with adult speech. Lorna King (1981, personal communication) states that many children with learning disabilities are unable to copy a rhythmic clapping pattern. The speech problems in autistic children could be partially caused by a defective rhythm sense. Condon (1981) states that autistic children had a left right delay in their body movements. This could partially account for their inability to attend to stimuli.

Both as a child and as an adult I have difficulty keeping in time with a rhythm. At a concert where people are clapping in time with the music I have to follow another person sitting beside me. I can keep a rhythm moderately well by myself, but it is extremely difficult to synchronize my rhythmic motions with other people or with a musical accompaniment. Hermelin (1976) reports that the motor and kinesthetic systems of autistic children appear to be intact. More recent research indicates that autistic children have disturbances in motility (Damasir and Maurer, 1978). They report that some autistic children can not handle two motor tasks at the same time. In my own case, I can perform one motor activity very well. When I operate hydraulic equipment such as a backhoe I can work one lever at a time perfectly. What I can not do is coordinate the movement of two or more levers at once. I compensate by operating the levers sequentially in rapid succession. In sports, I was able to reach the level of a good intermediate but I lack the fine coordination to become expert in a sport such as tennis or skiing.

The conclusion that can be deducted from my experiences and the research literature is that some autistics are not able to coordinate the various movement subsystems. Individual subsystems or groups of subsystems can function independently but there is a defect in the system that integrates the subsystems.

Neural Oscillators

Experiments with animals indicate that the central nervous system has neural oscillators which control rhythmic motion such as swimming and walking. The central pattern generators can operate without peripheral (Selverston, 1980; Delcomyn, 1980). Rhythmical motions in young human babies are generated centrally in the nervous system (Thelen, 1979). When a normal infant is startled it will have transient bursts of hand flapping (Ritvo et al., 1968).

Possible evidence for a central pattern generator is shown in Ritvo's (1968) observation of autistic children. Autistic children oscillated at a constant rate and the frequency did not change when the emotional state changed. Oscillating objects such as a pencil or hand flapping occurred at 2.91 to 1.93 hertz. The frequency of body rocking was much slower and it varied from 30 rocks per minute (0.49 hz) to 90 rocks per minute (1.53 hz). Body rocking was at a different frequency range than the other repetitive behaviors. Ayres (1980) suggests that there may be different central pattern generators for different behaviors. The autistic child may have difficulty integrating his central pattern generator with incoming stimuli. The central pattern generator may work fine by itself, but the child is unable to synchronize her internal rhythm with the environment.

Rhythmic stimulation is soothing to babies. Crying babies were quieted most effectively when they were rocked at 90 rocks per minute compared to 30 or 60 rocks per minute (Vrugt & Pederson, 1973). The higher rate decreased heart rate and induced a more regular breathing pattern. Freeman et al. (1976) found that repetitive stimulation had a reinforcing effect on autistic children. Autistic children preferred higher levels of photic and rocking stimulation compared to retarded children. Autistic children preferred 50 rocks per minute in a rocking chair compared to 30 or 40 rocks per minute. King (1979) reports that slow rhythmic movements are soothing to autistic children. In her therapy program she uses swings which oscillate at a rate of 10 to 12 times per minute (Lorna King personal communication). It is interesting that the rate which the autistic children prefer is faster than the rate which is quieting to them.

Two years ago I installed all airoperated controls on the squeeze machine to replace older ones which worked with solenoid switches. Prior to the modification I could adjust the pulsator so that the machine would rhythmically squeeze at a top speed of one squeeze and release cycle 20 times per minute. When the new control panel was built the engineer made a mistake and installed an undersized cycle speed control. The new panel has a top speed of only 10 cycles per minute. At first I did not like it and I ordered a new part to speed up the cycle. After using it for one week I found that limiting the cycle rate was probably beneficial. I decided to keep the undersized speed control which would act as a governor on the cycle rate. Even though I preferred 20 cycles per minute, I found that the slower rate had a more stabilizing effect on my nerves and disposition. The rate that is preferred may not be the most beneficial. At the time I made my decision to limit the cycle rate to 10 cycles per minute, I did not know that Lorna King used this same cycle rate when she uses swings in her therapy program.

Autistics Like Intense Stimulation

I liked intense stimulation when I was young. Maybe the desire for intense stimulation is what causes some autistic children to self mutilate. Ayers (1979) reported that hyperactive and autistic children prefer stimuli which could be perceived as painful to a normal child. When I first started using the squeeze machine at age 18,1 preferred more pressure than I like now. Now I prefer half as much pressure as I preferred ten years ago. The desire for intense stimulation attracted me to the carnival rides. I liked the Rotor best because it provided the most intense vestibular and pressure stimulation. Now I prefer rides which are less intense and apply less pressure and vestibular stimulation. I have always hated frightening rides. Earlier in this paper I related my first experiences with speaking. I spoke a few words when I was subjected to a strong stimulus such as a car wreck or a constantly ringing phone. In a rat whose brain lateral hypothalmus is lesioned the behavior patterns are still there but it can't self activate them. If a strong stimulus is applied such as pinching the animal's tail an aphagic rat can be induced to eat. Teitlebaum (1983, personal communication) suggested that a certain level of tonic arousal is necessary for normal behavior. A strong external stimulus would elevate the level of tonic arousal.

At concerts I like light shows. The combination of visual and auditory stimulation holds my attention. I am intense about my work. When I get started on designing and supervising the construction of a stockyard or corral I get going with a one track mind and I don't stop until the job is finished. I prefer to devote all my efforts to one project before starting another. The tendency to have a one track mind has diminished during the last few years. If I try to do too many things at once I am likely to become confused.

Autism may have some of the same effects as sensory deprivation, or raising an animal in a deprived environment. An animal or person placed in a sensory deprivation chamber craves any type of stimulation. A person will push a lever repeatedly to get stimulation from random light or sound patterns. A rat in sensory deprivation will work just as hard pushing a lever for environmental stimulation as a rat with an electrode in its pleasure center. If the deprived nervous system can't get stimulation from an outside source then self stimulation will start.

An autistic child presented with a varied task performed better and was better behaved (Dunlop & Koegal, 1980). The varied task prevented boredom. Intense sensory input can improve the behavior of an autistic person. A 26-year-old mute autistic woman with an IQ of 22 was treated by being held by the experimenter and strong tactile stimulation was applied to her face. On children, the child is held between the therapist's knees and the stimulation is applied and eye contact is forced (Gampel, 1980).

Anxiety at Puberty

When I reached puberty, I had bouts of impulsive behavior and the "stage fright" nerves began. This could be partially caused by the increase in norepinephrine activity in the brain which occurs at puberty (Young, 1979). The feeling was just like being in a state of stage fright all the time. The "stage fright" nerves became worse as the day progressed and the hours of two to four in the afternoon were the worst. About nine to ten o'clock at night the nerves subsided. The "stage fright" nerves are more like a hypersensitivity than anxiety. Maybe this accounts for the fact the Librium and Valium did not provide relief.

Stimuli which would be insignificant to most people would create a full blown stress reaction, with rapid heart beat, sweating, etc. When the phone rang or when I checked the mail I would have a "stage fright" nerve attack for fear I would get a bad phone call. After I swam through the dip vat, the organophosphates greatly reduced the "nerves".

Another interesting thing about the nerves was that it appears that reactions to certain stimuli can become sensitized as a young child but the full blown reaction did not occur until after puberty. From age 7 to 161 had recurring bouts of pinworms. The intermittent itching from the worms annoyed me as a young child and my parents failed to treat them until they were well established. Prior to puberty the itching was merely annoying. After puberty the itching would illicit a full scale stress reaction with all the physiological signs such as rapid heart beat and sweating. An intermittent itch would be totally insignificant to most adults but in me it created the same reaction as being chased by a mugger.

On the other hand, rats which had been handled early in life had less stereotyped behavior in response to amphetamine injections than controls which were not handled (Schreiber et al., 1978). Rats which had been handled as babies and returned to the nest with the mother present had reduced amphetamine-induced stereotype as adults than babies which were handled and then returned to the nest with the mother absent. Maybe if I had received more tactile, vestibular and deep pressure stimulation as a child the hypersensitivity would have been reduced at puberty.

Young et al. (1982) suggest that there may be a deficit in the regulation of noradrenergic activity in autism. The noreadrenergic system may alternate between too much or too little activity. "The sequential stages of over-alerting might be evident as over-reaction to minor stimuli; impaired discrimination and evaluation of stimuli; rushes of anxiety; disorganization of behavior; and avoidance of stimuli; particularly novelty, by withdrawing into oneself." Like the pigs in Dantzer and Mormedem's (1983) experiment autistic children perform stereotyped behavior to reduce arousal. Lake et al. (1977) found that autistic children have increased levels of norepinephrine in the blood.

At puberty I was desperate for relief from the "stage fright" nerves. At the age of 16,1 discovered that going on the Rotor carnival ride provided relief. The intense stimulation provided temporary relief. The nerves were also temporarily alleviated by intense activities such as galloping on a horse or strenuous physical labor. I either fought the nerves by doing an intense activity or simply retreated and avoided stimulation. During the worst attacks of "stage fright" nerves my tendency to fixate on a topic increased. Over and over again I would talk on the same subject. My behavior was similar to the perseveration of rats on amphetamines.

At age 17, I visited my aunt's ranch and watched cattle being handled in a squeeze chute. I noticed that some of the animals appeared to relax after the squeeze was applied. A few days later when I had a bad nerve attack I tried getting in the cattle chute and found that it provided relief for several hours. The squeeze machine that I built is based on the design of a cattle squeeze chute. Now I had a practical device that I could use every day. Using the squeeze machine helped to control the nerves but it was more like aspirin instead of a cure. If I had used it as a child it may have helped prevent the problem by inducing changes in my central nervous system.

Zentall (1979) speculates that an autistic child's disordered behaviors may be an attempt to mediate biological differences in arousal with environmental conditions. He brings forth the concept of optimal stimulation. This principle is evident in animals. Blindfolding normal kittens at birth induces stereotyped walking (Korda, 1978), but blindfolding cats drugged with amphetamine reduces stereotyped behavior (Steven et al., 1977).

Organophosphate Effect Wears Off

The effect of the organophosphate started wearing off about two years ago. The effect lasted for almost three years. When the "nerves" started to return I found that using the squeeze machine helped to control them, until a disastrous stressful event occurred two years ago. A small skin cancer had grown on my eyelid and the doctor was unable to explain to me why my entire eye was red and inflamed.

On Friday, November 6th 1981, I could not sleep and I would wake up at 3 in the morning with my heart pounding. I became fixated on the irritation in my eye, and everytime I felt a little pain or itch a panic attack would start. I became paranoid about going blind. This was the most serious nerve attack in my life. Since I am a visual person the thought of going blind is the thing I fear most. During the day I was totally depressed. Using the squeeze machine had no effect.

A week later I started taking a small dose of 50mg of Tofranil (Imipramine) daily. The drug had a positive effect within 48 hours, and it took six days for the side effects to wear off. I got the idea of trying Tofranil (antidepressant) from articles in Science News and Psychology Today by Wender and Klein (1981) and Klein (1980). Sheehan et al. (1980) reported successfully treating patients with endogenous anxiety and panic attacks with imipramine or phenelzine. Prior treatment of these patients with minor tranquilizers had little or no effect. Most patients needed 150mg or more of Imipramine per day. Zelnik et al. (1982) reported similar good results using a lower 75mg dose of Imipramine. Recent work by Piatt et al. (1983) indicates that antidepressants such as Imipramine mimic adaptation to long term stress. Campbell et al. 1971 conducted a study on the effects of Imipramine in autistic and schizophrenic children. The doses ranged from 12.5mg to 75mg day. Out of 10 children the drug made five children worse and three children markedly improved. Campbell concludes that the drug merits further study in mute, retarded autistic children with little psychotic symptomatology.

Even though my eye was still inflamed the drug stopped the nervousness and the paranoia about going blind. The nerve attack seemed like a kind of super sensitivity to stimuli which would be insignificant to most people. After being on the drug for two days I found that my heart would still pound at night if I heard a little noise like a dog scratching on a door. The fear of blindness was gone now, but the sound of the dog scratching still aroused my system. Maybe the paranoia and the hypersensitivity are different subsystems which were differentially affected by the Imipramine.

The nerve attack seemed like it was triggered by a "metabolic switch". I had had the eye problem for a week before the nerve attack started. All of a sudden something changed in my body and the nerve attack started. The eye irritation was constant and it seemed like it kept arousing my system. I was able to handle the arousal from the itching because it occurred intermittently and I would be free from it for a period of months.

I have now been on Trofanil for two years and the nerve attacks are 90 percent controlled. The only relapse I have had was during an extremely emotionally arousing event when some new equipment I designed was being started up at a meat packing plant. For two to three weeks afterwards I was nervous. In mice a single highly stressful event can change central nervous system biochemistry semipermanently. Once a mouse was defeated in a fight it never became dominant and a single defeat reduced the analgesic effect of morphine for 6 months (Miczek, 1983).

In February 1982,1 tried cutting back on the Tofranil. When I reduced drug dosage I found that the heart pounding at night started to return. After 2 weeks of taking 50mg every other day, the depressed feelings returned. Within three days after resuming 50mg daily, the depression and heart pounding subsided. I have to manage my condition like a diabetic controlling his sugar intake and insulin. Now that my nerves have been brought under control, I find that the squeeze machine tends to have a stabilizing effect and helps me to relax.

The brain has endorphin receptors, and possibly has receptors which are activated by various psychoactive drugs. Candace Pert has speculated that the brain may have receptors for Valium. I speculate that the brain has receptors for an organophosphate like substance. Both Tofranil, a tricyclic antidepressant and certain organo-phosphates may bind to the receptor.

The new frontiers in treating disorders of the brain will be discovered in the laboratories of biological and physiological scientists, and not on the psychiatrist's couch. As research progresses, the findings will probably indicate that many mental disorders whueh were previously thought to be due to some vague "psychic injury" are real physiological problems which can be either cured or controlled. Exciting research is being conducted on the brain. The knowledge gained from this new research needs to be applied in the "field".

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