

Development
and Brain
Systems
in Autism

Edited by
Marcel Adam Just
and Kevin A. Pelphrey



Psychology Press

Development and Brain Systems in Autism

This volume covers several perspectives on autism which bring together the most recent scientific views of the nature of this disorder. A number of themes organize major developments and emerging areas in autism:

- Cognitive and neural systems development: how autism arises in the behavior and thought of very young children.
- Discovering brain mechanisms underlying social and cognitive deficits in autism: how we can explain “social awkwardness” and poor language comprehension in terms of malfunctions of brain mechanisms, revealed by fMRI studies of people with autism.
- Integrating information about genes, brain, and biological mechanisms with behavioral evidence.
- Linking the science of autism with lives lived: how the new information about autism impacts people with autism and real-world considerations.

Marcel Adam Just is the D. O. Hebb Professor of Psychology at Carnegie Mellon University. His brain-imaging research investigates the biological mechanisms underlying the altered psychological processes in autism. His autism research has made several fundamental discoveries concerning differences in brain function, including findings of alterations in synchronization, in white matter communication tracts, and in the balance of frontal versus posterior activation.

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Section I
Lives Lived with Autism

1

My Experience with Visual Thinking and Sensory Oversensitivity

The Need for Research on Sensory Problems

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My mind works like Google for images. When somebody asks me about something, it is the verbal equivalent of typing words into a search engine. Words serve only as the index tabs on all the visual images in my memory. People ask me, “How do you think?” I tell them that the basic way to understand my way of thinking is to give me a noun as a key word. For example, I will tell you how I access my memory for the word *ring*. The first picture that flashed into my mind triggered by the word *ring* was the ring in the movie *The Lord of the Rings*. Then I saw my aunt out at her ranch reading *The Hobbit*, which was her favorite book. (*The Hobbit* is the first book in the *The Lord of the Rings* series.) Then I saw all kinds of pictures from the good times I had when I visited my aunt’s ranch as a teenager. My associative way of thinking jumped from the word *ring* to my aunt’s ranch. If one were to analyze my thoughts by listing the “key word index tabs,” it would seem to be disorganized, but if the pictures were displayed there would be an associative logic (Table 1.1).

My mind has the same associative logic that a search engine has. When I first started doing computer searches, I thought Google and other search

TABLE 1.1 List of Associations

Words List	Pictures List
Ring	The ring in the movie <i>The Lord of the Rings</i>
Ranch	Aunt Ann at the ranch reading her favorite book, <i>The Hobbit</i>
Gate	I built a gate on the ranch
Pickup Truck	I learned to drive on the ranch in a pickup truck
Model Rockets	I flew model rockets on the ranch

engines worked the same way as my mind. There are different associative branches. The word *ring* could have gone down a different branch: A ring can also be a riding ring. Then I would have been in the horse file in my mind. This brings up another totally different set of pictures. I see the riding ring I rode in high school, and the riding ring my assistant Mark built on the 126 acres that I own. If my mind stays in the riding ring file, I start to see images of horse shows, Grand Prix jumping, and other horse events that I have attended.

PHOTO REALISTIC PICTURES

All the images that flash into my mind are photo realistic images. They are not abstract. Pictures come into my memory sequentially like a series of slides flashed onto a screen. The images that are remembered the most clearly are the things that I really pay attention to, pictures that I use in my PowerPoint lectures (often they come up first), and the things that really interest me. I do not remember every hotel room I have visited because hotel rooms are way down low on my list of interests.

I visited the set where HBO was making a movie about me. I did not use my camera to take pictures, and I was not given pictures taken by somebody else. The clearest pictures I have in my memory are the things that grabbed my attention. I was fascinated by how they made fake stuff look real. An old airplane hangar was used as a sound stage. I have no memory of the hangar doors because I never attended to them. There was a small set of a chute at a meat plant. It looked like the wall was real concrete, but it was just painted plywood. I have a clear picture in my mind of looking at the edge of the fake wall and seeing that it was just paint on thin plywood. I was also fascinated by the lever system that operated a fake mechanical cow. I can see clear pictures of the cables that operated it.

The airplane hangar movie stage was a place I was highly interested in. I visited it for a relatively short time, about two hours. When I flip through my memories, I get clear pictures of about four things that I looked at intensely. It is like I took snapshots with the camera in my mind. The places where I remember the most accurate pictures of the entire place are places where I have spent a lot of time. To form a really accurate picture of a big place, I have

to spend lots of time looking at each part of it to download a series of many snapshots.

PUTTING THE PIECES TOGETHER

When I first visited a big meat plant back in the 1970s, I thought that the place was so complicated. How did the plant manager understand how to manage something that was so complex? I visited the Swift Plant in Arizona every Tuesday for three years. After about six months of Tuesday afternoons standing and looking at the plant, I understood it. It became simple because I could replay a video of the entire plant in my mind. My mind had taken all the individual snapshots and put them together to form the whole place. It was like putting puzzle pieces together.

The first few Tuesdays, my attention zeroed in on details that most people would consider not important, such as a little cart for moving 55-gallon drums. The more pieces I downloaded into my mind, the better I understood. After 20 to 25 Tuesday afternoons, I had the entire plant downloaded into my memory, and this complicated place seemed really simple. I was then able to turn on the video camera in my imagination and walk through the entire plant from one end to the other.

The problem with my kind of thinking is that it takes time. After I get my “computer” loaded with lots of experiences, I can really think with it. My experience on the movie set was similar to an early visit to the meat plant. The movie set had lots of cool stuff I had never seen before, but I was there for such a short time that I could only get a few really clear “pictures” in my mind. When I see new things, it is like having a narrow lens camera that shoots pictures of details I am interested in.

DOING DESIGN WORK

My ability to think in pictures really helped me in my design work. When I design cattle handling facilities, I can test-run equipment in my mind like a 3-D virtual reality system. I thought that all designers were able to do this. It took me three years to learn how to do cattle handling facility design. The first step in my training was to visit lots of feedlots and handle cattle in many different facilities. I had to get detailed knowledge of design features that worked and ones that did not. One feedlot would have a wonderful loading ramp, but their sorting pens were bad. Another had efficient sorting pens, but the loading ramp was laid out wrong. I spent three years just downloading into my mind stuff that worked and stuff that did not. When I designed a new facility, I took the good bits and recombined these together into a new system. I describe how I did this in the first chapter of *Thinking in Pictures* (Grandin, 1996). In my earlier writing, I stated that my ability to do drawing sort of appeared like magic after I bought the same drafting tools that were used by a very talented

draftsman that I had observed. The ability to do the drawing did appear like magic, but now I realize that it was based on three years of filling up the internet inside my head with images.

LEARNING TO READ DRAWINGS

When I first looked at an architectural drawing, I had difficulty relating the lines on the drawing with the real structure. I had to teach myself that a square on a drawing was a concrete column by walking through the meat plant with a complete layout drawing. I spent days walking through the plant with the drawings until I could relate every line on the drawing with a real piece of equipment or structural part of the building. A square drawn on the plans was a concrete column; a big circle was the water tower. At first, the lines on the drawing were too abstract to have meaning. I had to spend a great deal of time programming my brain, and when all the pieces of information came together my drawing ability magically appeared. Now I can look at drawings and see the finished structure.

FORMING CATEGORIES

How does my mind form a concept when I have all these detailed specific pictures in my mind? I sort them into categories. Neuroscience research has shown that the brain sorts sensory-based information into categories (Freedman, Riesenhuber, Poggio, & Miller, 2001). Even an insect brain can create categories (Giurfa, Zhang, Jenett, Menzel, & Srinivasan, 2001). It is like having file folders in the brain. Many times in my lectures, I have explained how I learned to differentiate a cat from a dog. I first used *size* to categorize dogs from cats. That worked well until our next-door neighbor got a Dachshund. I spent hours trying to figure out why the Dachshund could really be a dog when it was so small. After I studied the Dachshund, I found a visual feature that she shared with all the big dogs. Even though her nose was small, it looked exactly the same as the nose on our golden retriever. I had to make a new category of *nose shape*. Dogs and cats could also be separated into categories by sound or smell; dogs bark and cats meow. It was putting sensory-based information into categories.

FILLING UP MY BRAIN'S INTERNET

At the age of 65, I can think so much better than at age 20. The reason my thinking is more efficient now is because I have downloaded so much knowledge into my brain. This provides lots of information for my Google search engine to surf through the internet inside my mind. Nancy Minshew and others have hypothesized that autistic thinking is bottom-up instead of top-down (e.g., Minshew, Meyer, & Goldstein, 2002). I agree with this concept. For me to understand

something, I have to compare it to an experience that I have in memory. I travel to many places and I read many books and newspapers. The more I learn, the more efficient my thinking. Dr. Tony Attwood, a specialist on Asperger syndrome, stated in one of his lectures that the “Aspie” is always looking for more and more knowledge. Several parents have also told me that their child has told them that he has to take in information so he can understand the world.

HOW I THINK ABOUT ABSTRACT CONCEPTS

Unless I can see a photo realistic picture in my mind, I have no thoughts. When I was little and learned The Lord’s Prayer, it was incomprehensible. When I said “the power and the Glory,” I saw a rainbow with an electric power tower at the end of it. Now at the age of 65, I have so many more pictures in the internet of my mind that I can understand more abstract things. To provide an example for this chapter, I opened up the dictionary, closed my eyes, and put my pencil on the page. It landed on the word *disqualify*. To understand this word, I have to retrieve from my memory specific examples of somebody being disqualified. I remember reading in the paper that students cannot get government scholarships if they have been arrested for doing drugs. In another article, I read about a brilliant illegal immigrant who won a scholarship but he could not get the money because he was illegal. Without specific examples, I would have no idea what *disqualify* meant. One of the reasons I have to read so much is because it would be impossible for me to understand a word like *disqualify* unless I had either experienced being disqualified from some activity or had read about specific examples.

PATTERN THINKING

My thoughts are in photo realistic pictures but I do have some ability to think in patterns. To recall the memories of the movie set, I walk around in the airplane hangar sound stage in my mind. I see some stuff very detailed, like the meat plant chute set, but often parts are vague. I did not have time to download all the new stuff in that place. However, I can make a decent map of the basic layout of the hangar, the food tent, and the office. The meat plant set was on the far right and the fake mechanical cow was in the back right-hand corner. Across the back part of the hangar was carpentry and welding equipment, and a large set of my apartment was in the middle of the hangar to the left. When I walked out the hangar door and turned left, there was a concession stand that had free chili. I can draw a fairly accurate map of the hangar and tell you where major sets and equipment were located ([Figure 1.1](#)).

I do not have a clear image in my mind of the welders or carpentry tools. I never looked at them because they were ordinary things that were not new and interesting. I was downloading the cool stuff, but I was able to tell you where most of the shop tools were located. I think the ability to make a map is

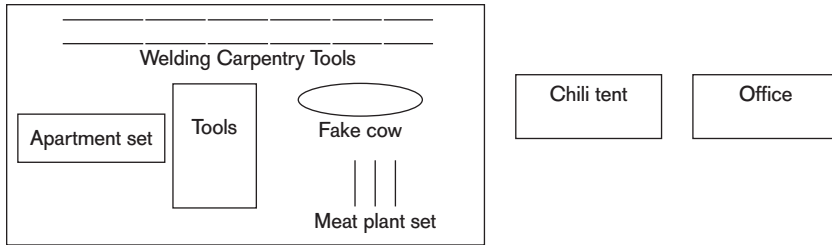


Figure 1.1 Schematic map of the movie set I toured, recalled from memory.

a separate skill compared to retrieving picture files. In fact, I have learned by reading many first-person accounts and interviewing people on the spectrum that there are three different types of specialized autistic minds.

TYPES OF SPECIALIZED THINKING

People on the spectrum have uneven skills. I am a visual thinker and doing algebra in school was impossible for me. I never got to try geometry or trigonometry because I kept failing algebra. When I have talked about my math problems at lectures, I have found five or six cases of children who failed algebra but they could do geometry really well. Some of these individuals can do the math in their heads with no written calculation. I often tell teachers that their minds work differently, and they do not need to do the step-by-step work. Based on books I have read and interviews with many people, I think there are three different autism mind types:

1. Visual Thinkers: They think in photo realistic pictures and are often terrible at algebra. I have talked to many visual thinkers who were bad at algebra. This description fits me.
2. Pattern Thinkers: They excel in math and are often musically gifted. They think in more abstract patterns instead of photo realistic pictures. Daniel Tammet and Jerry Newport are both pattern thinkers and numbers savants. To learn more about their method of specialized thinking, you can read *Born on a Blue Day* (Tammet, 2006) and *Mozart and the Whale* (Newport & Newport, 2007). Pattern thinkers are often weak in reading and English composition.
3. Word Thinkers: They are not visual thinkers and their math skills are only average. A typical word-type thinker is a person with Asperger's who loves history and knows every baseball statistic.

In all three of these cases, the person has an area of strength and an area of weakness. One trait that all the types have in common is that they attend to details and put details together to form whole concepts.

SENSORY SENSITIVITIES

Sensory oversensitivity can be extremely debilitating for many people on the autism spectrum. I know people on the spectrum who cannot tolerate a normal office or sporting event because the sound hurts their ears. There is a huge need for more research on sensory abnormalities in autism.

Sensory problems are extremely variable. When I was a child, loud noises hurt my ears like a dentist drill hitting a nerve. I hated balloons popping and the sound of the school bell was torture. As a child, when people talked directly to me, I could understand what they said. When grownups were talking fast among themselves, it sounded like gibberish. All I could hear were vowel sounds. It sounded like “oo-aa-oo-uu-a.” My speech teacher slowly enunciated the hard consonant sounds. She would enunciate a word like *cup* by saying “cc u pp.” Today I still have problems hearing differences between hard consonants, such as in *cat* or *bat*. I have to figure out the word by context. It is unlikely that my friend is talking about a pet bat. She would be telling me about her pet cat.

I also have problems with scratchy wool clothes. Even today I must have soft clothes against my skin. Some of my friends on the autism spectrum have even worse problems with wearing scratchy clothes. One lady told me that socks with a rough texture caused a burning sensation. Several mothers have told me that their children often take their socks or clothes off. This is probably due to sensory oversensitivity. I have found that some brands of T-shirts are rough and scratchy and others are soft. Even though all the shirts are 100% cotton, some are comfortable, and some T-shirts cannot be worn. One mother told me that her child could tolerate only one brand of very soft socks.

Some people have visual oversensitivity problems, and they cannot tolerate fluorescent lights because they can see the 60-cycle flicker. Donna Williams writes about this problem in her books *Somebody*, *Somewhere* and *Autism: An Inside Out Approach* (Williams, 1994, 1996). There is an old study that showed that florescent lights increased repetitive behavior in individuals with autism (Coleman, Frankel, Ritvoe, & Freeman, 1976). I had a dyslexic student who could not tolerate fluorescents. She told me that the room pulsed like a disco. She was greatly helped by the Irlen-colored lenses. Scientific studies show that they work for some people (Evans & Joseph, 2002; Lightstone, Lightstone, & Wilkins, 1999). Other interventions that helped her were using an LCD laptop computer screen and printing all her work on tan paper. She told me the print vibrated less on the laptop screen compared to a TV-type computer screen.

SENSORY RESEARCH REQUIREMENTS

When research is done on problems with sensory oversensitivity, subjects should be assigned to treatments based on their sensory problems, not just the

autism diagnosis. Autism is so variable; one person will have horrible visual processing problems and another will have problems with sound sensitivity. If you had 20 subjects labeled “autistic,” maybe only three would be helped by the Irlen lenses, but those three would be really helped. Irlen lenses are not going to help me. I do not have visual processing problems. People with visual processing problems are almost never photo realistic visual thinkers. Donna Williams and Tito Mukhopadhyay both use auditory representations in their thinking (Mukhopadhyay, 2008; Williams, 1994). Since their visual systems are so dysfunctional, their memories are all audio files. People with visual processing problems do not think in photo realistic pictures, but they are often pattern thinkers. My dyslexic student absolutely could not draw, but she passed the Mensa IQ test. She is definitely a pattern thinker.

Sensory oversensitivity is an area that should be a top research subject. Many people on the autism spectrum are not able to hold jobs or socialize due to sensory oversensitivity. I am pleased that researchers are now doing research on sensory oversensitivity. Why did it take so long for researchers to really start paying attention to sensory problems? I think this is due to difficulties that people may have imagining an alternate reality that they do not experience. Maybe the reason why social brain systems have been researched so much is because social interactions are the most important experience that the neurotypical person experiences. Now is the time to change the emphasis in neuroscience research in autism from looking at social mechanisms in the brain to researching sensory issues. A person on the autism spectrum can never learn to be social if social environments, such as restaurants, sound like being inside the speaker at a rock concert.

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