Imitation, the Mirror Neuron System, and Autism

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1 CEC ☑ QUIZ
CLINICAL MEDICINE

Human beings are hard-wired for two kinds[1] of imitation, which surface quite early in life. The first type is readily seen by the person and known as "perceptually transparent." Let us say Mom raises her hand to wave "bye-bye." The child can see his own hand and wave "bye-bye" too. The second type of imitation, "perceptually opaque," is difficult to understand how it is accomplished, especially considering we're talking about infants. If the mother opens her mouth and sticks out her tongue, the baby copies her actions. The baby cannot see his own face or his tongue, or even comprehend that he too has a mouth and tongue, but he can copy the action. Incredible. And yet, it is a fairly common occurrence in a growing, healthy, young child.

Chartrand[2] reported that this automatic mimicry (imitation of actions, speech, mannerisms, tone of voice, and/or body positions) actually "creates affiliation" for the other person. Chartrand refers to this as the "Chameleon Effect." Lakin[3] proposed that this nonverbal, non-intentional behavior of mimicry is the "social glue" that helps us foster rapport with others.

What happens if a child has poor eye contact, poor social skills, poor language skills, very limited empathy, repetitive self-stimulatory (aka, "self-stimming") behavior, obsesses over certain subjects and ignores important subjects? That child is most likely diagnosed as having autism. Ramachandran[4] stated there is one other characteristic (*in my opinion, one that is often over looked*) in the child who has autism: He/she has "difficulty miming other people's actions."

WHY ARE IMITATIVE SKILLS A PROBLEM FOR CHILDREN WHO HAVE AUTISM?

Before we go any further, we need to understand an event that changed neuroscience. In Parvo, Italy, 1992, Rizzolatti[4] and other neurophysiologists were studying individual neurons in a macaque's ventral premotor area. They watched as a neuron in a specialized area fired off when the macaque picked up a peanut : "tic, tic, tic... tic, tic, tic." It did not make sense to them. This was not the motor area or the sensory area corresponding to the hand or the arm or the mouth of the macaque—this was the premotor area. They continued to assess that neuron and other neurons in the same area and saw consistent results. They still did not understand why those neurons

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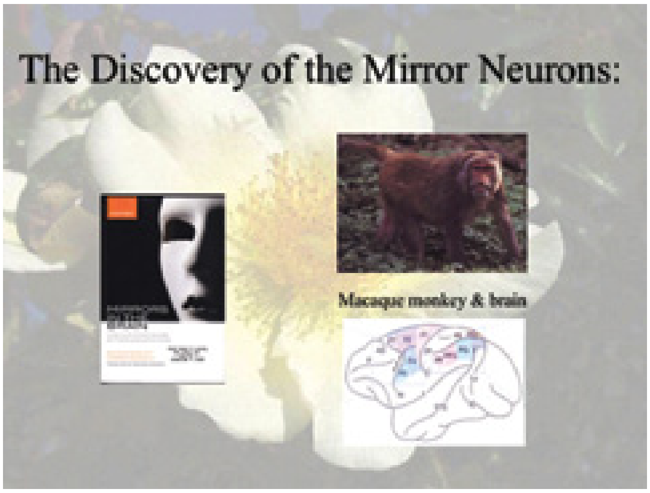
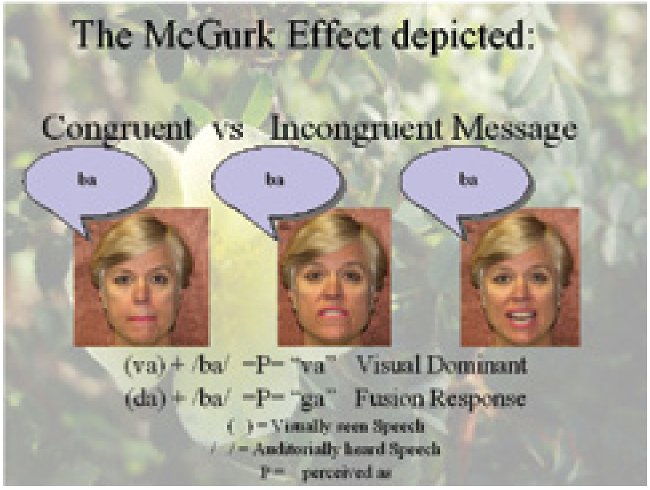
were firing up. One day a fortuitous accident occurred: A scientist picked up the peanut that was in front of the macaque while the probes were still deep inside the macaque’s brain and measuring the data. Those same neurons fired up again: “tic, tic, tic...tic, tic, tic.” What happened? Whether the macaque performed the action or saw the action, those particular neurons fired up. They considered the name “monkey see, monkey do neurons” but choose the term “mirror neuron” instead. A plethora of studies of the mirror neuron system ensued in monkeys and in humans. Later research showed that mirror neurons located in the monkey’s ventral premotor cortex is the homologue (comparative) of the human’s Broca’s region.



In 2003, Keysers[5], et al, described a population of neurons in the same premotor cortex area of different monkeys that “fired-up,” whether the animal performed the specific action and/or saw the action and/or heard the same action performed by another monkey. Keysers used the term “audiovisual mirror neurons” to indicate that this subset of neurons fire independently whether the actions are performed, seen, or heard.

Rosenblum[6] restated the importance of McGurk’s discovery, back in 1976. McGurk discovered that when a video tape of a person is dubbed with incongruent utterances at the single-syllable level, the optic information exerts a stronger influence on the perceived speech than does the auditory information.



Skipper[7] stated that both behavioral and neurophysiological evidence supports the idea that the human mirror neuron system plays a critical role in speech perception when mouth movements are observed. This perception of sound altered by the visual clues of mouth movements is called the McGurk Effect.

Neurophysiologically, observation of mouth movements have been used as an argument that the mirror neuron system and the motor system participate in Auditory + Visual (AV) speech perception. Using functional magnetic resonance imaging (fMRI), Skipper, et al, showed that it is primarily the visual aspects of observable mouth movements rather than the auditory content of speech that is responsible for this motor system activity. Auditory speech alone evoked far less activity in the motor system than Auditory + Visual speech.

Ramachandran[8] suspected that there was a mirror neuron dysfunction in children with autism, but they needed to find a way to measure the activity of those neurons without putting electrodes in their brains. They decided to use electroencephalogram (EEG) to measure the children’s brain waves. It is a well-known fact that an EEG component called the mu wave was blocked any time a person made a voluntary muscle movement and, strangely enough, this component was also blocked when a person observed someone else performing the same action. They proposed that observing mu-wave suppression would provide a simple, noninvasive way to measure mirror neuron activity.

I propose that by improving children's visual processing skills, their "auditory-visual mirror neurons," or those "monkey see, monkey do" neurons, are being fired up!

The first experiments focused on a high-functioning child with autism to confirm that any differences they found were not a result of problems in attention, comprehension, or the general effects of low cognitive abilities. The EEG showed that the child had a normal, observable mu wave suppression when he made a simple voluntary movement, but when he watched someone else perform the action, the suppression did not occur. Ramachandran concluded that "the child's motor command system was intact but that his mirror neuron system was deficient."

Ramachandran's lab replicated the experiment in 10 high-functioning individuals with autism and 10 age- and gender-matched controls. They observed expected suppression of mu waves when the controls moved their hands and watched videos of a moving hand, but the EEGs of the individuals with autism showed mu suppression only when they moved their own hands. Ramachandran, et al, concluded that individuals with autism have "a broken mirror neuron system."

In 2006, Iacoboni and Dapretto[9] compared 12 children with normal language skills and 12 high-functioning Autistic Spectrum Disordered (ASD) children. They were assessed by fMRI while they viewed and imitated several pictorially displayed emotions. Iacoboni and Dapretto found low mirror neuron activity in the right inferior frontal gyrus, specifically the Brodmann's 44 area for the children who had ASD. Brodmann's 44 is located in the Broca's region of the brain and is responsible for motor speech skills.

Dr. Dapretto was quoted saying, "The fact that we found this relationship says that the system is there; it is just not functioning to the full extent that it should." She further stated that researchers and clinicians should now focus on developing ways to boost the mirror neurons in individuals with developmental disorders.

Norrix[10], et al, did a study in 2007 in which she assessed the McGurk Effect on children with and without Specific Language Impairment (SLI). The experiment included 56 preschoolers, 23 had SLI, 23 had normal language (NL) skills. All participants passed a hearing screening. They were trained with pictures of a bee, a gi (a Judo outfit), and twins named Dee and Thee. Video clips were made using /bi/, /gi/, /di/ and /thi/. Each auditory signal was approximately 600 milliseconds in duration.

The children were then presented with a mismatched (visual) + /auditory/ message: (gi) + /bi/ = P =

- NL Adults had the McGurk Effect 90%
- NL children had the McGurk Effect 34%
- SLI children had the McGurk Effect 11%

The children who had the Specific Language Impairment had a reduced McGurk Effect. Why? A weak McGurk effect suggests reduced influence of visual information on speech perception. It seems as if the SLI children were not as influenced by the visual articulatory cues as their peers were.

DO CHILDREN WITH SLI PERCEIVE VISUAL INFORMATION DIFFERENTLY THAN THEIR PEERS?

Meltzoff[1] provides an excellent definition of imitation:

1. "The observer produces behavior similar to that of model."
2. "The perception of an act causes the observer's response."
3. "The equivalence between the acts of self and other plays a role in generating the response."

I propose that the broken mirror neuron system in children who have autism is broken due to poor "perception" of the acts[11]. I further propose that the perception of an act is dependent on the development of good visual processing skills. Good visual acuity and good visual processing skills are not the same. Visual acuity is having healthy eyes and basically passing an eye screening. Visual processing is the ability to analyze and interpret incoming visual information.[12]

I believe that there are three interconnected components[13] of visual processing:

1. Visual Gathering and Efficiency
2. Visual Motor Integration Skills
3. Visual Perceptual Skills

Every student in my practice, five years and older, starts the remediation process with an Auditory & Visual Processing Screening. In my 15 years of private practice, every student who has had a speech and/or language disorder also had a visual processing disorder. In particular, for those students who had autism, as we began the process of remediating the visual processing disorder, I noticed the child's ability to reflect more appropriate facial gestures, use more appropriate vocal intonation, improved empathy and show greater camaraderie with his peers.

I propose that by improving children's visual processing skills, their "auditory-visual mirror neurons," or those "monkey see, monkey do" neurons, are being **fired up!** Please consider this just an introduction to imitation, mirror neurons, and autism. If you are interested in learning more, I strongly suggest that you do some research on those topics and on visual processing disorders, auditory processing disorders, and motor processing disorders. **P**

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