

The Role of Mirror Neurons in Addiction and Recovery

Martin Nicolaus

In March this year, the HBO network in conjunction with major federal agencies and private foundations launched a 14-part series about addiction. A centerpiece of the Addiction series was brain imaging. We saw brightly colored images contrasting the normal brain with the brain on drugs, and we learned about the many ways in which prolonged alcohol and other drug use harms the brain's operations.

Images of addiction in the brain make a valuable contribution. They dramatize the physical impact of substance abuse. They give valuable clues to the complex interactions between different parts of the brain involved in drinking and using behaviors. They may lead to newer and more effective pharmacological interventions. But they ultimately beg the question of recovery. The more we learn about the negative impact of addiction on the brain, the less we understand how and why recoveries happen.

There are some diseases, like ALS, from which there is no recovery; the afflicted always die. Substance addiction is not one of those diseases. People caught in the trap of addiction don't all follow a predictable downward spiral through hospitals, jails, and institutions to an early grave. Many do go that way – too many by far -- but a great many others pull out of the spiral, stop drinking and drugging, and go on to lead sober, productive lives, sometimes as model citizens. There would be no recovery community, no recovery subculture, and no recovery support groups, otherwise. Because recoveries do happen – most of us in this room are living examples – there must be something else in the brain other than the addictive processes. There must be some brain structures that resist the impact of the addictive substances and apply themselves to the work of recovery.

I wish I could announce that the brilliant Dr. Nora Volkow, one of the leading brain imaging scientists, and director of NIDA, has produced a brain scan showing the areas that light up when an addicted person refuses a drink or a drug and makes a commitment to sobriety. Where are the resources in the brain on which a person in recovery draws for the strength to resist triggers and cravings, and to lead a sober, happy, and fulfilling life? We observe this behavior daily, but so far its neurological foundations remain obscure. Given the enduring fascination with the pathological – an urge that animates much of the public interest in addiction – it is doubtful whether the mainline American addiction research institutions will ever turn their mighty scanners toward the problem of understanding recovery.

Some tantalizing insights, however, have come from a laboratory in Parma, Italy. Neuroscientists there were studying a problem that on its face has nothing to do with addiction, namely the activity of monkeys' brains related to hand motions. By means of implanted electrodes, they found specific neurons that became activated with an electrical current when the monkey reached out for a peanut to eat. This was useful knowledge but hardly cutting-edge science. One day in 1996, a wired-up macaque was sitting on the sidelines doing nothing, just watching, when the experimenter reached out his human hand to take a peanut. To the experimenter's surprise, the neuron in the monkey's brain that fired when the monkey grasped the food also fired when the monkey saw the experimenter grasp the food. The same brain circuit as "monkey do" became engaged

when “monkey see.” The neuron’s energy mirrored the perceived action of another. This was totally unexpected and new.

Many experiments and much debate later, the Parma group – Vittorio Gallese and Giacomo Rizzolatti are its leading figures – stands at the center of the new theory of mirror neurons. Mirror neurons have been shown to exist not only in monkeys but also in humans. Many scientists, among them Prof. V.S. Ramachandran, director of the Center for Brain and Cognition of the University of California at San Diego, consider mirror neurons one of the most important findings in neuroscience of the decade. “Mirror neurons will do for psychology what DNA did for biology,” he has declared. Dozens of scientific groups are now doing mirror neuron research and investigating the relevance of mirror neurons for a great variety of separate issue areas, from language, to cognition and emotion to diseases such as autism. Virtually all areas of social psychology are due for reinterpretation through this new lens. This past year, mirror neurons have made the cover of *Scientific American* and *Time* magazine. Mirror neurons are possibly the hottest topic in neuroscience so far in this century.

In this talk, I want to explore the possible relevance of the mirror neuron discoveries to the field of addiction recovery, in particular to addiction recovery mediated by social interaction.

To begin with, the accidental experiment where the monkey’s hand-grasping neuron fired at the sight of another primate grasping a peanut seems painfully familiar. Substitute “glass of whiskey” or “line of white powder” in place of “peanut” and we seem to be back in well-mapped Pavlovian territory. The food or drug is a “reward” and the sight of it serves as a stimulus that activates a conditioned response, such as salivation or the release of certain neurochemicals that we experience subjectively as a craving. At first sight, the mirror neuron theory seems to be only a restatement or new explanation of basic stimulus-response or “trigger” mechanisms long known to cognitive behaviorist psychology, and familiar to just about every person who has ever listened to a modern addiction recovery treatment lecture.

But this resemblance disappears on closer examination. The mere sight of the peanut triggered no response in the monkey. These particular neurons fired only at the sight of a specific goal-oriented *action* involving the object, and only when that action was performed by a related living being (a fellow primate). This is quite different from the classic stimulus-response mechanism, where the response follows whenever the object is presented and regardless of who or what presents it. The paradigm of classical behaviorism is embodied by a single rat in a cage pressing a lever to get an automatic mechanism to release a pellet. Although the model can be and often is expanded to study social interactions, the core paradigm is asocial and mechanical. Another difference arises from the nature of the neurons and their function. These monkey neurons were not located in a part of the brain known to perform visual or cognitive functions; rather these were *motor* neurons, whose normal function is to control muscles. Furthermore, although an experiential basis has been shown necessary for mirror neuron activation, no special course of conditioning or habituation is required to produce the mirror neuron response, as is the case with cognitive behaviorist mechanisms. All that is necessary is to be a member of the same or related species. It is the absence of mirror neuron activity, not its presence, that forms the special case.

For these and other reasons, mirror neuron theory, as propounded by its discoverers, has evolved as a kind of challenge to cognitive behaviorist psychology. In the article by Gallese titled “Intentional Attunement. The Mirror Neuron system and its role in interpersonal relations,” [Handout], the author draws a contrast between a mental model that relies on the cognition and processing of representations, concepts, and propositions, on the one hand, and the model that emerges from the study of mirror neurons, on the other. He calls the former a “solipsistic, representational mind.” By solipsism, he presumably refers to a mind that believes itself to be completely self-contained and closed off, a universe of one, where awareness of external stimuli comes through more or less formal representations and chains of logical propositions handled mainly by cognitive processes. The model of this kind of mind is Mr. Spock of the Star Trek series, whose social mental skills are “confined to a declarative, conceptualized, and objective perspective.”

The mirror neuron model in humans, by contrast, according to Gallese, holds that our brains are hard-wired to be attuned to the intentional behaviors of others. When we perceive another person’s actions, the mirror neuron systems in our brain simulate the performance of those same actions, as if we were performing them ourselves. A key element of mirror neuron theory is that this simulation bypasses conscious cognitive processes. Although it requires sense perception to initiate it (sight, sound, smell and touch have all been shown to activate mirror neurons), this form of interpersonal communication, in Gallese’s words, allows us “to experientially penetrate the world of the other by means of a direct, automatic, and unconscious process.” It is a process that “does not entail the explicit use of any theory or declarative representation.” It constitutes, again in Gallese’s phrase, “direct experiential understanding.” Another researcher has called it “unmediated resonance.”

In humans, mirror neurons operate not only in the parts of the brain responsible for motor functions, but also in the systems that process emotions and sensations. When a mirror neuron is examined under the microscope, it appears the same as its non-mirroring neighbors. What distinguishes mirror neurons is that they have more connections, and more complex ones, with other parts of the brain, especially the meso-limbic system where emotions, sensations and social perceptions are shaped. From this connectedness comes the broad range of phenomena to which mirror neurons hold the promise of explanatory power. Gallese says that mirror neurons constitute a “general and basic endowment of our [human] brain.” When we wince inwardly at seeing pain inflicted on someone close to us, our mirror neurons are at work. When we see a smiling face, mirror neurons in our pleasure centers give us a sensation of happiness as if we were smiling ourselves. Almost any meaningful bodily action by another resonates with us, directly, automatically and unconsciously, as if we were engaged in that action ourselves.

Mirror neurons, in other words, are the organic underpinnings of empathy, and perhaps also of familiarity and intimacy. This is why Dr. Ramachandran refers to them as “empathy neurons” or also, with poetic license, “Dalai Lama neurons.” As Gallese points out in his paper, mirror neurons dissolve the airtight dichotomy between “self” and “other.” They allow us to experience the other within ourselves. They constitute a shared space within our minds, an interpersonal or “we-centric” neurological circuit.

Some researchers believe that the extensive mirror neuron system in humans is one of the key evolutionary acquisitions that marked the transition to homo sapiens. We have been from the beginning a social animal, and it would be surprising if this social character were not embodied in the wiring of our brains. The discovery of mirror neurons is anatomical evidence of our social nature.

As Gallese and others point out, the mirror neuron discovery opens “new and interesting perspectives for the study of the neural underpinnings of psychopathological states and psychotherapeutic relations.” One of the interesting pathologies is autism. The inability to empathize with others – a generalized social insight deficit – is diagnostic of a major type of autism. A study undertaken at UCLA in 2005 by Dapretto and colleagues showed that autistic children show depressed activity in a particular brain wave pattern believed to reflect mirror neuron activation. The hypothesis that a mirror neuron deficit may underly autism is one of the most exciting and stimulating research directions in this field.

Memo to Dr. Volkow: Is a mirror neuron deficit implicated in addiction? There are several tantalizing hints that point toward such a connection. A recent study by Dr. Christian Keysers and colleagues in the Netherlands found strong mirror neuron activity in the human insula, a brain organ that processes energies both from the visceral system (the gut) and from other brain regions. In an entirely separate study, Dr. Antoine Bechara at USC recently found that an injury to the insula dramatically extinguished the desire to smoke in persons addicted to nicotine – they simply “forgot” to smoke after the injury. (See <http://newrecovery.blogspot.com/search?q=insula>). To be sure, the mere presence of mirror neurons in an organ known to be involved in addiction is not proof of a connection, but it’s an issue that seems to warrant study. Another hint that addiction may be connected in some way with the mirror neuron system comes from behavioral observations of social isolation in many individuals with addictive disorder. Again, social isolation is far from a universal pattern, and isolation can be explained by other mechanisms – stigma, shame, rejection, etc. – but the mirror neuron hypothesis offers an interesting alternative perspective that bears investigating.

The most interesting new avenue that mirror theory opens up, in my opinion, is its significance for group therapy. The processes that promote healing in a group setting have been extensively studied from psychoanalytic and cognitive behavioral perspectives. (See, e.g. Yalom and Leszcz, *Theory and Practice of Group Psychotherapy*.) We know that properly conducted groups provide positive emotional reinforcement as well as educational and other values. What has probably not been illuminated sufficiently in the past is the sensation of *resonance* that group participants sometimes experience. In our LifeRing groups, where participants recount the highlights and heartaches of their current lives, we frequently hear people use the vocabulary of resonance – “this resonates with me” or “that rings a bell with me” or “I feel for you” are common expressions. This resonance has the quality of directly felt experience, a quality that goes deeper than cognitive similarity or abstract congruency. We can now hypothesize that this feeling of resonance occurring in the group process stems from the activation of our mirror neuron system. This resonance may lead to cognitive insights, and it may very well have an emotional component, but the core energy released is neither cognitive nor emotional, but experiential. Remember that the monkey’s neuron fired not at the sight of the peanut, but

at the sight of a person grasping the peanut – not at the object, but at the *action*. What we feel when we feel resonance is our simulated performance of the other person's action.

A well-known paradigm of psychological change, proposed by Prochaska, DiClemente, Norcross and others, points to the crucial line between contemplation and action. People in a transition typically spend considerable time in the contemplation stage before proceeding to action, if they proceed at all. It may be that activation of the mirror neuron system, because it is action-oriented, is a pivotal element in motivating the person to take that vital step forward from thinking to doing. Gallese's "embodied simulation" may form the hidden bridge between contemplation and action, and the inducement of this simulation via activation of the mirror neuron system may be one of the hitherto underappreciated functions of mutual support groups.

Mirror neuron theory can also shed light on one of the paradoxical phenomena frequently reported in support groups of the type where speakers dwell at length and in vivid detail on their histories of drinking and/or drugging. Some listeners to such "drunkalogues" report the awakening of powerful cravings to drink, and there are many reported instances when such individuals do leave the room immediately and go drink. The meeting process has activated the "wrong" mirror neuron system; that is, it has awakened the stored experiential action potentials related to the individual's own drinking history. These anecdotal reports caution us that the mirror neuron system is a two-edged sword, and that as conductors of the group process we need to be mindful of the keys that we play, lest, like the sorcerer's apprentice, we unwittingly unleash a deluge of harm.

Some of the early discussions surrounding mirror neuron theory, including some of Gallese's own remarks in the [Handout], have a dismissive and polemical tone in regard to classical cognitive behaviorist psychology. In my opinion, this attitude is a sign of the infantile state of the mirror neuron theory and will be outgrown as it matures. As research and discussion proceed, I believe it will become clear that mirror neuron theory and cognitive behaviorism have complementary explanatory powers, and that both are required to gain a fuller understanding.

Mirror neuron theory, together with classic behaviorist psychology, forms a secular framework for illuminating the addiction recovery process taking place in a group setting. In some eyes, the resonant thrill that participants in support groups sometimes experience is evidence of a divine presence, and the recovery process itself is believed to be the work of supernatural grace. Although it may be helpful for some individuals to cling to those beliefs, in my opinion the cause of recovery from addiction is ultimately not served by magical thinking. We honor sobriety best by approaching it with a sober mind. The knowledge that participation in support groups can help me by – among other effects -- activating the mirror neurons associated with sober living does not impair my sense of wonder at the beauty of the universe. On the contrary, every step of discovery that brings the images in my mind into closer congruence with scientific evidence is an incomparable thrill. Whether it confirms or rejects one's previous suppositions, scientific discovery is among the greatest adventures of the human heart.

The discovery of mirror neurons has stirred so much popular excitement because so many people in our time feel alienated, cut off, isolated and removed, and feel powerless to connect with others and gain a sense of community. Mirror neuron theory says that the

power to connect with others is a native evolutionary endowment of our brains, that the ability to feel and resonate with others is hardwired into us, and that the achievement of community is a biological talent with which we are born. That is not quite yet the same as actually reaching connectedness and community, but it gives us a sense of reassurance and empowerment to pick ourselves up and get moving to go there.

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