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Mirror Neurons: How Neuroscience Is Challenging the Way People Understand Each Other

Sally, who is six months pregnant, complains of back pain, nausea, and bloating. Soon, her husband Andrew experiences the same maladies. Sally and Andrew are confused: Sally's symptoms are consistent with pregnancy, but Andrew's symptoms do not appear to have a physiological cause. Puzzled, Sally mentions that Andrew's symptoms mirror her own at her next doctor's appointment. "Oh," her obstetrician says with a smile, "Andrew probably has sympathy pains. He understands what you're going through, and so he's experiencing the same things." Sympathy pains are a quirky example of empathy, a quality that is important in any social relationship. Empathy is a common discussion point among girlfriends and boyfriends, parents and children, and even employees and employers: it is the characteristic that allows a person to understand another person's actions and intentions. In the not-so-distant past, empathy was considered a logic puzzle for the brain to solve. According to scientists, the brain took in sensory information from a person's surroundings, processed it, and then spit out a conclusion that would allow the person to respond accordingly to the situation (Rizzolatti 54). However, a number of neuroscientists have recently begun championing a simpler theory of empathy that involves "mirror neurons," or brain cells that "fire when we perform an action and also when we watch someone else do the same thing" (Hotz, 1). Already, the societal implications of the mirror neuron theory are daunting: these neurons have crept into political analysis and autism debates, among other fields, even though the theory is primarily based on primate research and has yet to be conclusively proven in humans. In this paper, I will discuss the neurohype-laden language and

claims surrounding mirror neuron research in the political and autism arenas, and I will show why these claims are too broad given the current state of mirror neuron research.

Neuropolitics: Can brain scan results predict political attitudes?

Mirror neurons figure prominently in neuropolitics, an emerging area of social neuroscience that attributes political attitudes to emotion and cognition. Marco Iacoboni, a UCLA-based neuroscientist and author of the book *Mirroring People*, is one of the main proponents of linking neurologically-based social interaction to politics: "Given that a major component of politics is affiliation with others with whom we share values and ideas about how society should be organized, I think forms of mirroring are almost certainly involved in some aspects of political thinking" (Iacoboni, *Mirroring People*, 245). A particularly controversial 2007 study of Iacoboni's used functional magnetic resonance imaging (fMRI) to measure neural activity in a group of swing voters, ultimately claiming that activation in certain areas indicated how voters felt about the leading presidential candidates. For example, he and his fellow researchers said that Fred Thompson evoked more empathy than Rudy Giuliani because they "saw activity in the superior temporal sulcus and the inferior frontal cortex [when looking at Thompson pictures]" (Iacoboni, *This Is Your Brain on Politics*, 2). Among other sweeping claims of voter impressions, they also invoked mirror neurons in regard to empathy:

> The good news for Mr. Edwards is that the swing voters who did not give him low ratings, when looking at still photos of him, showed significant activation in areas of the brain containing mirror neurons – cells that are activated when people feel empathy. And that suggests these voters feel some connection to him. (ibid, 3)

Unsurprisingly, this analysis attracted quite a few criticisms from the neuroscience community. For starters, brain activation implies correlation, not causation; this distinction is magnified when considering a topic as sophisticated as political attitudes. It is possible that the subjects

empathized with or felt connected to Edwards when looking at his picture, but it is just as possible that the subjects experienced a different kind of thought or emotion. This is even more probable because the premotor cortex and inferior parietal cortex, two areas associated with mirror neurons, are also associated with other brain functions such as imprinting and encoding facial expressions (McPherson, 1).

A related problem arises from the study's methodology: one of the disadvantages of fMRI is its inability to distinguish activity in one neuron from its neighboring cell. Given that the foundation of the mirror neuron theory is that individual cells fire the same way in a person viewing an action as when the person is actually performing the action himself, fMRI is not a reliable enough measure to generate such overstated claims. In a review for *Nature*, neuroscientist Nikos Logothetis confirms this belief: "A more important shortcoming [of fMRI] is that this surrogate signal reflects neuronal mass activity. Although this fact is acknowledged by the vast majority of investigators, its implications for drawing judicious conclusions from fMRI data are most frequently ignored" (869). Though the brain activation induced by a particular stimulus may not lie, the interpretation of the activation may be dubious. This ties in with what Eric Racine et al. call "neurofallacies": the staggering leaps of faith that transform an innocent, potentially innovative scientific finding into the greatest discovery since sliced bread (4). As the discussion of autism will confirm, this is not a unique problem to mirror neurons within the realm of neuropolitics. In fact, it is indicative of the main critique of social neuroscience today: how quick scientists are to generalize a pattern of brain activation to an indiscriminate social commentary.

Autism: Can mirror neurons explain and ultimately solve a prominent social disorder?

Social neuroscientists such as Iacoboni and Rizzolatti also suggest that mirror neurons may explain autism, which is a hot-button issue for politicians, the media, researchers, and a growing number of families who have been affected by the developmental brain disorder. According to the National Institutes of Health, autism "typically affects a person's ability to communicate, engage in social interactions, and respond appropriately to the environment" (The Science of Mental Illness Glossary, 1). Vilayanur Ramachandran and Lindsay Oberman – the director of the University of California-San Diego Center for Brain and Cognition and a graduate student at the lab, respectively – elaborate on this topic in a *Scientific American* article:

> In the late 1990s our group at U.C.S.D. noted that mirror neurons appear to be performing precisely the same functions that seem to be disrupted in autism. If the mirror neuron system is indeed involved in the interpretation of complex intentions, then a breakdown of this neural circuitry could explain the most striking deficit in people with autism, their lack of social skills. The other cardinal signs of the disorder – absence of empathy, language deficits, poor imitation, and so on – are also the kinds of things you would expect to see if mirror neurons were dysfunctional. (65)

The observation of a dysfunctional mirror neuron system affecting the same functions that are disrupted in autism seems innocent enough; after all, the researchers suggest earlier in the paper that "mirror neurons appear to be involved in social interaction," and it is certainly true that autism involves social interaction deficits (ibid, 64). But Ramachandran and Oberman's theory hinges on a key point that requires a substantial leap in logic: "If the mirror neuron system is indeed involved in the interpretation of complex intentions…" It is important to discuss how the mirror neuron theory originated and why it is a neurofallacy to say that mirror neurons not only exist, but can explain the intentions underlying actions.

Mirror neurons were originally discovered when Rizzolatti and his team investigated premotor cortex neurons, which are involved in voluntary actions, in macaque monkeys via electrodes that measured individual cell output. Interestingly, they discovered that "a subset of the motor command neurons fired when the monkey watched another monkey or a researcher

perform the same action" as when the monkey performed the action itself (ibid, 64). After several more experiments with monkeys, Rizzolatti collaborated with Iacoboni to test whether humans had a "similar mechanism for reading intentions" via an fMRI experiment that measured participants' brain activation when looking at hand motor acts in context or not in context (Rizzolatti, 59). Another experiment of theirs tested brain activation when participants experienced and viewed pictures of disgust; an experiment of Tania Singer's used electric shocks to observe activation when participants experienced or watched others in pain. Both experiments showed similar activation in the "experiencing" context and "viewing" context, leading Rizzolatti to conclude, "Such data strongly suggest that humans may comprehend emotions, or at least powerful emotions, through a direct mapping mechanism involving parts of the brain that generate visceral responses" (ibid, 60).

Here, it is crucial to remember that these experiments relied on fMRI data to corroborate the theory that humans have mirror neurons, whereas researchers were able to "record the behavior of an individual neuron responding to the actions of others" in the macaque monkeys (Hotz, 2). As discussed in the neuropolitics section, it is not within the scope of fMRI to measure individual cells, and so there was no reliable indication that mirror neurons really existed in humans the same way as they did in monkeys. However, Hotz reported that an Iacoboni-led team at UCLA had found conclusive proof of mirror neurons in spring 2007: "[P]reliminary data from unpublished experiments this spring suggest that researchers at UCLA, probing the exposed brain tissue of patients undergoing neurosurgery, for the first time have isolated individual human brain cells that act as mirror neurons" (ibid, 2). The problem with this statement is the population that Iacoboni examined: healthy people do not undergo neurosurgery. It is entirely possible that some members of the population had blunted neuronal output as a result of the problem that led to neurosurgery, just as it is possible that other patients had increased neuronal

output because of hypersensitivity and plasticity within the brain. Simply put, it is not reliable to use a study population of people with a neurological disorder *unless* the focus of the study is that exact neurological disorder. Iacoboni may have discovered the existence of mirror neurons, but *only* within a population of neurosurgery patients. Generalizing the discovery to the rest of society does mirror neuron theory – and more broadly, social neuroscience – a disservice by affecting its credibility in the scientific world.

For the purpose of evaluating mirror neurons' ability to interpret intentions, consider the case in which science has accepted that mirror neurons exist in humans. The monkey and human studies both examined the way that mirror neurons are involved in learning and imitating gestures or facial expressions, but it is again a neurofallacy to say that because participants were able to imitate these voluntary movements, they therefore understood the intentions behind them. The appropriate conclusion would be that the neurons simply allow monkeys and humans to duplicate a voluntary movement, especially given their localization in the premotor cortex, an area previously described as being involved in voluntary movement. Regardless of the experimental setup, there is no conclusive evidence that says that neuronal output as measured by electrodes or fMRI mass signal determines intention. Given the time and money invested in autism research thus far and the desire to find some kind of neural basis for this disorder, this is a disappointing fact, but it is also a reality that cannot be ignored.

Sweeping claims and controversies: Issues and motivations behind current research and a glance at the future of social neuroscience

The above neuropolitics and autism discussions illustrate the sweeping claims that neuroscientists and journalists alike have made about the way mirror neurons will revolutionize our understanding of social interactions. Interestingly, this attitude was around in 2006, before

scientists had even tried to measure electrode output in individual human neurons. A New York Times article encapsulates this view: “The discovery is shaking up numerous scientific disciplines, shifting the understanding of culture, empathy, philosophy, language, imitation, autism, and psychotherapy” (Blakeslee, 1). Two years later, mirror neuron mania is at a critical juncture. In order for mirror neurons to “shake up” the scientific world, social neuroscientists must conclusively prove that mirror neurons really do exist in humans, potentially with multimodal imaging. Additionally, scientists must remember to reign in their inclinations to aggrandize brain activation or a flawed electrical output experiment into sweeping social commentaries.

Regardless of critical reception to social neuroscience, it is undeniable that the field has staying power in terms of funding and widespread curiosity. Thus, it is appropriate to examine the present and future influences of social neuroscience through the lens of mirror neuron research. The race to solve the autism puzzle is a classic example of social, political, and financial desires convening to influence social neuroscientists. Because of the emphasis on understanding the social deficits that underlie the disorder, it is not uncommon for neuroscientists to receive millions of dollars in funding from interest groups, the National Institutes of Health, families seeking a “cure”, etc. In an era when funding is growing increasingly competitive, particularly given the current economic climate, it is understandable that scientists would want to trumpet their findings to guarantee that funding continues to roll in. Perhaps this is a cynical view of scientific motivations, but it is also one grounded in reality. A slightly less cynical view is that autism is a disorder that affects more and more children every year, and it is devastating in terms of the money, time, and other resources required for both family and society (via health care systems) to care for an autistic child. Thus, it behooves politicians to spotlight the need for a cure by supporting the scientists conducting the research,

which in turn helps the politicians in terms of protecting budgets and boosting their own popularity.

Regarding politics, it would be extremely useful for pundits and politicians alike to have a failsafe mechanism to understand how voters make their choices. If, for instance, a social neuroscientist could image an Ohio swing voter's brain and somehow compartmentalize what the most important issues were to swing voters in Ohio, a candidate's campaign would be able to target that demographic much more easily. As fMRI becomes more and more trendy, it would not be surprising to see political action committees foot the bill for such research…or even for independent polling companies searching for an edge over other competitors by using multimodal methods of gathering voter impressions and inclinations. The reverse could be true, too: politicians are so eager to describe themselves as honest, hardworking, and empathetic that they might hop into the scanner to try to produce "conclusive" proof of their characteristics. The important point right now is that fMRI is not the tool for such sophisticated studies because it only measures correlation and not causation, and opinion polling seems to be a politically safer, cheaper option at the moment.

As an example of what could happen in the future, a central part of John McCain and Sarah Palin's 2008 presidential election campaign focused on how the candidates understood the issues facing middle-class America, particularly "Joe the Plumber." Given the prevalence of imaging these days, it is not a huge stretch to imagine that candidates may someday participate in fMRI scans in order to generate an article stating, "Brain scans indicate that Candidate X really understands the issues you're facing." After all, Barack Obama used text-messaging as a campaign tool; for better or for worse, fMRI cannot be that far off.

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