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# Neural Imaginaries and Clinical Epistemology: Rhetorically Mapping the Adolescent Brain in the Clinical Encounter

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## Abstract

The social work of brain images has taken center stage in recent theorizing of the intersections between neuroscience and society. However, neuroimaging is only one of the discursive modes through which public representations of neurobiology travel. This article adopts an expanded view toward the social implications of neuroscientific thinking to examine how neural imaginaries are constructed in the absence of visual evidence. Drawing on ethnographic fieldwork conducted over 18 months (2008–2009) in a United States multidisciplinary pediatric pain clinic, I examine the pragmatic clinical work undertaken to represent ambiguous symptoms in neurobiological form. Focusing on one physician, I illustrate how, by rhetorically mapping the brain as a therapeutic tool, she engaged in a distinctive form of representation that I call *neural imagining*. In shifting my focus away from the purely material dimensions of brain images, I juxtapose the cultural work of brain scanning technologies with clinical neural imaginaries in which the teenage brain becomes a space of possibility, not to map things as they are, but rather, things as we hope they might be. These neural imaginaries rely upon a distinctive clinical epistemology that privileges the creative work of the imagination over visualization technologies in revealing the truths of the body. By creating a therapeutic space for adolescents to exercise their imaginative faculties and a discursive template for doing so, neural imagining relocates adolescents' agency with respect to epistemologies of bodily knowledge and the role of visualization practices therein. In doing so, it provides a more hopeful alternative to the dominant popular and scientific representations of the teenage brain that view it primarily through the lens of pathology.

### Keywords

neuroimaging; chronic pain; bodily epistemologies; adolescence; clinical ethnography; United States

Recent work in science and technological studies has documented how neurobiological discourses have suffused sociological constructs like person, self, and identity, affording new ways of theorizing the relationships between the individual and the social world (cf.

Dumit, 2004; Rose, 2007; Rose & Abi-Rached, 2013; Vidal, 2009). The social work of brain images, as cultural symbols that provide a critical interface between the natural and social world, has taken center stage in this literature. As conduits of self-understanding, rhetorics of truth, and agents of moral legitimacy, brain images offer a key platform for inquiry into the sociocultural and ethical implications of contemporary biotechnologies (Roskies and Armstrong, 2011; Beaulieu, 2002; Buchman, Borgelt, Whitely, and Illes, 2013; Dumit, 2003). Yet as Pickersgill (2013) points out, neuroscientists make use of a much wider range of tools and techniques than imaging technologies. Neuroimaging is thus only one of the tools by which we inscribe social difference onto brain structures, and only one of the discursive modes through which public representations of neurobiology travel.

In keeping with this expanded view of the social implications of neuroscientific thinking, this article examines how neural imaginaries are constructed in the absence of visual evidence. By playing with the close affinities between “imaging” and “imagining,” I explore the rhetorical uses to which clinical imaginings of the brain might be put. Drawing on 18 months of ethnographic research in a United States multidisciplinary pediatric pain clinic, I examine the pragmatic clinical work undertaken to represent ambiguous symptoms in neurobiological form. Focusing on one physician, I illustrate how, by rhetorically mapping the brain as a therapeutic tool, she engaged in a distinctive form of representation that I call *neural imagining*.

As a conceptual technology, neural imagining represents brains through techniques of language by enrolling materiality as a rhetorical resource. The concept draws on the function of the imagination as an alternative mode of representation that resists the verisimilitude of diagnostic imaging technologies in favor of the creative forms of expression and pliability of meaning that bring depth to the life of the mind. Here, imagining offers a corrective to the fact that pain cannot be seen through traditional forms of imaging. In the cases that I will examine, the boundary between imaging and imagining is intentionally blurred, highlighting the playful dimensions of clinical (and particularly, pediatric) discourse. In developing this line of thought, I draw inspiration from Evelyn Fox Keller (2002), who has argued that scientific models often emerge from a process that she calls “theoretical imagining” rather than empirical observation. While these models may idealize and simplify scientific truths, Keller suggests, they also contribute to conceptual clarity and enable the development of new knowledge.

In shifting my focus away from the purely material dimensions of brain images, I juxtapose the cultural work of brain scanning technologies with clinical neural imaginaries in which the teenage brain becomes a space of possibility, not to map things as they are, but rather, things as we hope they might be. These neural imaginaries rely upon a distinctive clinical epistemology that privileges the creative work of the imagination over visualization technologies in revealing the truths of the body. By creating a therapeutic space for adolescents to exercise their imaginative faculties and a discursive template for doing so, neural imagining relocates adolescents’ agency with respect to epistemologies of bodily knowledge and the role of visualization practices therein. In doing so, it provides a more hopeful alternative to the dominant popular and scientific representations of the teenage

brain that view it primarily through the lens of pathology (Choudhury, McKinney, and Merten, 2012).

## Foundations of Bodily Knowledge

Anthropological studies have revealed a multitude of ways in which people use their bodies as a source of knowledge (Lock, 1993). For example, Kathryn Geurts (2003) beautifully illustrates how Anlo-Ewe-speaking people in southeastern Ghana rely on a kinesthetic sense to make sense of the world surrounding them. In biomedicine, however, vision is a privileged epistemological mode. From their earliest experiences in the cadaver lab, neophyte physicians are socialized into new ways of seeing the body, which shape, in turn, how they see the world (Good, 1994). As Foucault (1994[1973]) pointed out, biomedicine's reliance on this way of knowing is not a natural fact, but rather the product of a specific set of cultural and historical conditions that generated a crucial epistemological shift—from a view in which text-based learning generates medical knowledge to one in which knowledge emanates from the physician's ability to penetrate the body and see underlying, hidden truths.

Technology bolsters this professional vision (cf. Goodwin, 1994), expanding the perceptual range of the human eye while augmenting its objectivity (Kirmayer, 1992). Diagnostic imaging technologies materialize symptoms in visual form to confirm or deny the presence of disease. In this way, imaging technologies serve a critical role in mediating between bodily epistemologies and ontologies: in order to know that something is "real," we need to be able to see it. From this perspective, it is not difficult to see why chronic pain, which all too often evades visual representation through imaging technologies (Rhodes, McPhillips-Tangum, Markham, & Klenk, 1999) occupies such a precarious status in biomedicine. That is, it is pain's invisibility that casts its existence into question and renders it (potentially) "unreal" (Jackson, 1992; Trnka, 2007).

Yet vision, and especially the sort of vision that is facilitated by imaging technologies, is just one epistemological mode among many. Other examples of clinical epistemologies might include the ideology of inner reference so prevalent within American therapeutic settings (cf. Carr, 2006; Lester, 2009). The ideology of inner reference suggests that clinicians privilege what people say about their self-experiences as a window onto their inner states, and specifically, their mental health. This idea stands in striking contrast to cultural norms around the world which stipulate that sufferers ought to hide their inner states from others (cf. Throop, 2010), or that sick people (and women, particularly) are not reliable or appropriate narrators of their own suffering (cf. Chua, 2012; Wilce, 1995).

A *medicine of the imagination*, a term proposed by Laurence Kirmayer (2006), is suggestive of another such clinical epistemology. Where vision, as an epistemological mode, relies on images of the body "presumed to be more or less isomorphic to reality, directly encoding facts about the world," (Kirmayer, 1992, p. 327), a medicine of the imagination relies instead on the creative capacities of the mind to generate healing. A medicine of the imagination promotes a flexible view of bodily knowledge in which thoughts and expectations produce real physiological effects. Such effects are common in psychosomatics

such as hypnotherapy, but also appear in more mundane contexts. A key example is the placebo effect, or what Daniel Moerman (2002) has called the "meaning effect," underscoring the ways in which therapeutic response hinges on the meanings we assign to medications. Insofar as these transformative effects yield parallel changes in what we know about our bodies, bodily truths may, in a sense, be thought into existence.

Pediatric settings are particularly well suited for a medicine of the imagination, insofar as children are especially adept at responding to and enacting imaginative practices with respect to illness, medicine, and healing (Clark, 2004; Mattingly, 2008; Buchbinder, 2008). The opportunity for children and adolescents to take on an active, creative role in the therapeutic process through imaginative enterprises is particularly important in light of recent attempts to re-theorize children's agency with respect to illness and the body, and neurocentric models of the body, more specifically. In light of growing concerns about how brain images help to perpetuate logics of biological determinism (Beaulieu, 2000; Dumit, 2004; Martin, 2000; Vidal, 2009), social scientists have tracked the increasing tendency for scientists and parents alike to explain children's developmental variation in terms of brain differences (Rapp, 2011). At the same time, other scholars have demonstrated that children and adolescents evince complex, fragmented, and ambivalent identities despite increasing exposure to neurobiological explanations for identity and behavior (Choudhury, McKinney, and Merten 2012; Singh 2012, 2013). "At the level of discourse," Singh (2013, p. 823) writes, "children do not tend to subjugate the 'I' or behavior to brain-based explanatory models. Rather, children tend to narrate 'I' – brain relations that emphasize their capacity and desire for personal agency." In line with such views, the account developed here suggests that neural imaginaries need not be reductive technologies of self. Instead, I focus on the generative potential of neural imaginaries to facilitate children's agentive healing.

## Background and Methods

This article is based on 18 months of ethnographic fieldwork (2008–2009) that I conducted in a multidisciplinary pediatric pain clinic located in a metropolitan region of the western United States. While the clinic served pediatric patients with all types of pain, it specialized in intractable cases that evaded clear diagnoses. Most clinic patients had pain symptoms that could not readily be linked to an identifiable organic disorder. The most common pain conditions treated in the clinic included recurrent abdominal pain, chronic daily headaches, and chronic regional pain syndrome (CRPS).[1] The majority of the clinic's patients were adolescents, although patients as young as age five and as old as 25 were seen.

The clinic combined traditional biomedical therapies such as pharmaceuticals, injections, and psychotherapy (though not, most notably, surgery) with complementary and alternative medical treatments such as acupuncture, hypnotherapy, and yoga. In addition to two pediatric pain physicians, the clinical team included one psychiatrist, four psychologists, two physical therapists, and four complementary and alternative medical (CAM) practitioners. Aside from the two physicians, whose outpatient clinic met in the pediatric wing of a

[1]Chronic regional pain syndrome is an extremely painful neuropathic pain condition characterized by burning pain, restricted range of motion, swelling, and skin sensitivity. It often manifests at the site of an injury that fails to heal properly.

university hospital, the team members saw patients in their private practices located throughout the community. Because many of their services were not covered by medical insurance, the clinic served a primarily middle to upper-class population.

The data for this study included observations of clinical consultations and weekly meetings of the multidisciplinary pain team; open-ended interviews with 71 adolescent patients, parents, and clinicians; and video-recordings of four focal families in their homes and social worlds. In my fieldwork, I did not align myself with patient or clinician experiences per se, but rather sought to examine the social and cultural logics undergirding clinical practices (Mol, 2003). The study received approval from the Institutional Review Board at the University of California, Los Angeles. This article focuses on extensive fieldnotes recorded during clinical observations of Dr. Novak,[2] the senior pain physician and driving force behind the clinic's integrative biopsychosocial model of care (Engel, 1977). Fieldnotes were analyzed through an inductive, iterative review process to identify and refine key themes.

An accomplished yet unassuming woman in her 60s, Dr. Novak had longstanding interests in adolescents with chronic disease. Having received training in mind-body medicine, with a particular focus on the medical use of hypnosis, she assembled a team of interdisciplinary clinicians to care for children and adolescents with complicated pain conditions. Beyond her commitment to integrative care and mind-body medicine, Dr. Novak was also heavily invested in the creative use of clinical rhetoric, as we will see shortly. To mitigate the stigma that most patients had already encountered in medical settings (cf. Jackson, 2000), Dr. Novak relied on a neurobiological model of pain in clinical conversations with families. For clinic patients, neurobiological explanatory tropes served to legitimize pain as a "real" illness (as opposed to "all in your head"), rendering them worthy of clinical attention (Dumit, 2000). Consequently, Dr. Novak devoted a great deal of her clinical rhetoric to establishing pain as neurobiological, a problem of brains and not minds.

## An Explanatory Model of Pain

Dr. Novak's neural imagining rested on an elaborate explanatory model that identified the links between neurobiological activity, pain, and therapeutic relief. A key assumption of this explanatory model was that the pain clinic's patients were exceptionally smart. A large proportion of the patients were academically gifted and talented in athletics or the arts, leading Dr. Novak to refer to her clinic as "the smart clinic." Dr. Novak's clinical explanatory model positioned this smartness as a cornerstone of pain etiology and treatment: adolescents developed chronic pain problems because they had "smart neurons," yet because they were smart, patients would easily learn to "rewire" their faulty neural networks through techniques such as hypnotherapy, thereby reducing their pain. Elsewhere, I discuss how this explanatory model builds on certain class-based presumptions about achievement and exceptionality, as well as how my understanding of the therapeutic possibilities of this clinical discourse builds on—and complicates—a long history of linking psychosomatic illnesses to specific character types (Buchbinder, 2011). For the present purposes, it is important to note that this was very much a local explanatory model; none of the 12

[2]All names in this article are pseudonyms.

pediatric pain clinicians that I interviewed from outside my primary field site offered a similar explanation of pain.

The following excerpt from eleven-year-old Brittany Rogers' first clinic visit illustrates how this explanatory model unfolded in clinical practice. Brittany, a petite ballet dancer and straight-A student, fit the "smart clinic" prototype perfectly. She indicated on her intake questionnaire, "Middle school stresses me out," and identified her heavy course load in the honors gate program at her public middle school as a primary source of stress.

> Dr. Novak explained to Brittany that the nervous systems of young people who exert a lot of pressure on themselves are wound just a little more tightly. She emphasized that this was a neurological and not a psychiatric problem. Although the headaches sound like migraines and the family history lends support to this explanation, there is also a myofascial component. The system can get set up for certain muscles to go into spasm, which leads to a vicious cycle. The nervous system had gotten turned on and had become more sensitive as the brain made pain connections. If an electrical engineer were to look at the wiring, he would see the pain signals getting turned on. The treatment would work to quiet down the signaling by rebalancing the central nervous system. Because Brittany is smart, creative, and talented, her brain will make connections to undo all of this pathological circuitry and get her back to normal. [Field notes, March 16, 2009]

According to Dr. Novak, Brittany's neurobiology—that of a bright, motivated, and capable, if somewhat overwhelmed, adolescent—had put her at risk for developing chronic pain problems, but it would also enable her to learn strategies to cope with the pain. Therefore, in addition to prescribing two medications, Dr. Novak recommended Iyengar yoga and hypnotherapy. The hypnotherapy, Dr. Novak explained, would help Brittany to learn strategies to "change the circuitry in her brain."

Brittany's case illustrates three main premises that compose Dr. Novak's explanatory model of pain: 1) smart children have "*smart neurons*"—that is, sensitive nervous systems that make pain connections quickly and learn to be in pain; 2) an *electrical engineer* could see the pain by looking at the neurobiological wiring; and 3) being smart, creative, and talented will enable the patient to "*rewire*" *the circuitry* in the brain through mind-body therapies. Patients would learn to "rewire" their neural circuitry through imaginative techniques of their own. Ultimately, then, there are two forms of "imagining" at play in this article: those enacted by Dr. Novak as she explained pain to patients and families, and those which patients were expected to perform on themselves as a therapeutic practice.

In what follows, I illustrate how Dr. Novak, in conversation with patients and families, used a rich set of imaginative practices to elaborate each of these three premises. Within any particular clinical interaction, these elements often overlapped and were organized differently, yet the basic components remained the same. As I will show, these rhetorical practices were steeped in metaphorical language and neural imaginaries that characterized chronic pain as a legitimate neurobiological problem and highlighted neuroplasticity as the lynchpin to a life free from pain.

## Smart Neurons

In Dr. Novak's explanatory framework, the adolescent brain offered a critical link between being smart (or, as it was sometimes formulated, creative, talented, and motivated) and developing chronic pain. That the clinic's patients were overwhelmingly smart was relevant, from the perspective of this explanatory model, because smart children have "smart neurons": sensitive nervous systems that make pain connections quickly and "learn" to be in pain. In the words of 16-year-old Jason Katz, a long-term clinic patient: "She said that because I was, like, really smart, that my brain, like, *remembered pain*. More than somebody else's" (my emphasis).

Jason had been a patient in the clinic since the age of 10, when he developed chronic pain in his foot following reconstructive surgery to correct his flat arches. Later, he also developed chronic stomachaches and headaches. In a separate interview, Jason's mother, Debbie, who described Jason as "brilliant," also related Jason's widespread pain to his intelligence:

> His brain remembered it. He cannot get rid of it. He's nauseous everyday. He's got stomachaches every day…His mind learned it. We were in Italy last year. Never had a headache in his life. Got a sinus infection. We didn't catch it soon enough, came home, he's had severe headaches everyday since that day. Because his mind remembers the headache. Jason remembers. He remembers every fact. Play Jeopardy with him—he's amazing.

In this account, which reproduces Dr. Novak's explanatory model with remarkable acuity, an analogical relation is drawn between remembering facts and remembering pain. Jason's brain (or his mind, in one of Debbie's utterances), *remembered* pain because "that's how his brain is wired," as Debbie later put it. Moreover, in their depictions of memory, both Jason and Debbie personified the brain by imputing it with tremendous agency (Vidal, 2009, p. 21). If chronic pain developed because Jason's brain acted with an independent, even renegade, agency, the therapeutic intervention would be premised on Jason's wresting control back from his brain and regaining bodily agency.

Jason and Debbie's explanations reflect powerful cultural models of the brain and its relationship to intelligence, memory, and pain. These models can be traced to the clinic, with the images that Dr. Novak used to depict "smart" brains. Consider the following:

> Dr. Novak explained that pain that becomes persistent happens to really bright kids who are sensitive and caring—"everybody's dream kid." There is something about the neurobiology of being smart, she said, where you learn quickly, nerves carry pain information, and connections are made to the part of the brain that holds the pain perception system. In bright people with chronic pain, the circuitry is ongoing and active, like an automatic pilot loop. "It's like, okay already, we got the message!" she said. As that circuit goes on autopilot, the pain signaling system becomes hyper-excitable. The problem was not with the patient's muscles; it was in her brain. There were also corresponding changes in the brain-chemical environment, like a car working less efficiently. As Dr. Novak revealed this account, the patient's father sat at the edge of his seat with a slight grin on his face.

> I thought this might have reflected a perverse (though perhaps understandable) sense of pride in his daughter being labeled with a "smart" illness. [Fieldnotes, July 20, 2009]

As this excerpt suggests, a metaphor of rote learning underlay Dr. Novak's explanations of pain: "smart" neurons were those that quickly "learned" to be in pain. Such metaphors were particularly well suited to the explanatory context at hand because the patients themselves, in virtue of their appearance in the "smart clinic," had already been characterized as good learners. Dr. Novak's folk neuroscience thus posed a metonymical relationship between a smart adolescent patient and her "smart" neurobiology, in which "smart neurons" came to stand in for the person herself.

This metonymy broke down, however, when the "smart neurons" overtook the patient's agency. Although the *person's* agentive capacity as a quick learner was a necessary prerequisite for this explanatory framework, Dr. Novak specified that at the neurobiological level, smart neurons could learn with minimal active input from the person. In the fieldnote excerpt quoted above, for example, Dr. Novak notes that the pain circuitry eventually goes on "autopilot," transmitting pain signals repeatedly. Dr. Novak described this function to a 17-year-old girl and her parents: "The neuromatrix goes on 'autopilot' because Sabrina learns so well. It's like learning the alphabet. Once you learn something, it's hard to unlearn it." Likewise, in a similar discussion with a twelve-year-old boy, Dr. Novak suggested that learning to be in pain was just like riding a bike: "You don't even think about riding a bike. You already know how to ride. Well, your brain already knows how to have stomach pain and it's going to whether you want it or not."

In these examples, learning to recognize letters and learning to ride a bicycle serve as metaphors for the habituation associated with chronic pain. Depicting the learning associated with chronic pain as a habituated process alleviated some of the burden of responsibility on adolescents for learning to be in pain. By framing pain as something that develops outside of personal agency, "whether you want it or not," Dr. Novak created a subtle distinction between actions of the person and actions of the brain. Insofar as such splitting between person and brain mitigates personal responsibility for illness (Luhrmann, 2000; Martin, 2009), it served an important rhetorical function: it diminished the possibility that adolescents might be blamed for their pain. Therapy would target "rewiring" the brain to contain its renegade agency.

The metaphorical language surrounding smart neurons also offered a concrete set of images that visualized chronic pain and located it in the brain. Metaphors for modes of transit, such as cars, bikes, and pilot loops, represent in visual form how pain circulates the body, while circuit and signal metaphors materialize the communicative pathways enacted by smart neurons to perceive and process pain. The inventive realities created by Dr. Novak's neural imagining were thus worlds in which otherwise invisible bodily processes could readily be "seen." More specifically, these imaginative realities posed worlds in which "smart neurons" could overtake the body and cause pain signals to go haywire, in spite of the person's agency. As we will see, such metaphors entailed specific possibilities for therapeutic action,

conceptualizing treatment as a recalibration of habituated signals through “rewiring” the neural circuitry.

## Electrical Engineers

The imaginative reality that Dr. Novak created was inhabited by a key imaginary figure: the electrical engineer. The second element in Dr. Novak’s explanatory model suggested that, hypothetically, an electrical engineer could verify the presence of pain by examining the patient’s neurobiological wiring. (Wiring, in this context, is also a metaphor; I discuss this further below.) I observed this logic unfold in Dr. Novak’s conversation with Marissa Turkle, a 16-year-old patient with severe abdominal pain. Marissa had been hospitalized several times and had undergone a full gastrointestinal workup, but the tests had all come back negative. After hearing Marissa’s history during her first clinic appointment, Dr. Novak assured her, “It’s real, not psychological. In fact, you’re the most psychologically healthy patient I’ve seen in a long time.” Dr. Novak explained that the diagnostic testing Marissa underwent had not been helpful because pain is transmitted in the nerve signals, which cannot be seen on x-rays. “That’s why they look and look and look and look and don’t find anything,” she said. “But if you had an electrical engineer look at the wiring, he’d see where the problem is.”

As an imaginary figure, the electrical engineer performed two important rhetorical functions. First, Dr. Novak’s reference to Marissa’s mental health indexes a central concern for patients and families: the possibility that medical providers might diagnose chronic pain as “psychological.” The figure of the electrical engineer enabled Dr. Novak to navigate around pain’s fragile ontology and reassure her patients that she believed that their pain was real. Second, and perhaps more crucially, the electrical engineer helped to explain a persistent mystery: why did diagnostic testing repeatedly fail to find evidence of pain if the pain indeed was real? As Dr. Novak told Kyle Liu, a 17-year-old boy with irritable bowel syndrome, “The signaling system got out of balance a long time ago, and it’s the sort of problem that only an electrical engineer would be set up to identify. That’s why no one has found ‘the cause’—it’s not structural, metabolic, or immunologic. The reason the tests did not turn up anything was that there was no disease there.” From this perspective, the electrical engineer served as an imaginative substitute for a test that could identify pain. In this way, the electrical engineer helped Dr. Novak to creatively navigate the ontological politics of pain’s invisibility.

Of course, Dr. Novak did not literally believe that an electrical engineer could visualize Marissa’s pain. In an interview that I conducted as my study was drawing to a close, Dr. Novak confided, “I have no idea what an electrical engineer would think.” Yet as an imaginative representation, the electrical engineer performed crucial rhetorical work: it suggested that even if contemporary medicine could render pain visible, there was someone out there who can. If, as Dumit (2000, p. 219) has argued, “brain imaging offers the promise of *showing* that the disorder is really in their brain and not in their head” (emphasis in original), then this form of neural imagining and the metaphors that comprise it presented an alternative means of visualizing brains and establishing patients’ legitimacy.

Mattingly (2011) draws on the work of Beardsley (1962) and Ricoeur (1984) to suggest that metaphors are "logical absurdities" that point us to imaginative spaces beyond the world we live in. In a similar way, Dr. Novak's metaphor of the electrical engineer, while itself absurd as an index of neurobiology, nonetheless pointed to a possible world in which Marissa and Kyle's pain might be verified through neuroimaging, capturing what was currently invisible to contemporary technologies. That such a world is not so difficult to envision today points to the dynamic tension entailed by juxtaposing "logical" with "absurd." Thus, as part of a larger rhetoric of persuasion, the figure of the electrical engineer located pain in the body (and brain) and asserted that it was real.

## Rewiring the Circuitry

The last element in Dr. Novak's explanatory model worked to close the hermeneutic loop between causality and cure by articulating how being smart would enhance therapeutic efficacy. Dr. Novak explained this connection to George Broderick, a 14-year-old patient who had broken his arm playing football and developed CRPS after his cast was removed. Since his injury, George had had difficulties concentrating and struggled to maintain his standing in the 9$^{th}$ grade gate program, but his teachers allowed him to remain in his honors classes despite his failing grades because, according to his parents, "they knew he was smart." Dr. Novak told George and his parents that kids who develop complex pain are really smart, and that the neurobiology of being really smart made them more susceptible to pain. "This is the downside of being really smart," Dr. Novak acknowledged. "But once you learn what to do, you'll be able to use your smarts to help you climb out of it." Therefore, although George's intelligence had played a role in pain etiology, it would also prove a therapeutic asset.

More specifically, Dr. Novak indicated that patients' smartness and creativity could be mobilized toward pain management by enabling them to "rewire the circuitry" in the brain. Spatial metaphors for the body, such as circuits and wires, locate pain within a diffuse network of nerve-signaling difficulties, rather than a specific bodily organ. They also help to explain why other specialists typically fail to grasp the problem: they tend to locate pain in the stomach or head, instead of in the nervous system, where circuitry problems properly arise. In laying out this alternative conceptualization of pain, then, Dr. Novak offered a persuasive rationale for a novel mode of treatment based on "rewiring" the neural circuitry rather than repairing "broken" parts.

Dr. Novak typically employed the circuitry metaphor to frame her discussion of hypnotherapy. Although hypnotherapy enjoyed some of the clinic's highest rates of therapeutic success, it was often met with skepticism or suspicion. Charlotte LeFevre, the clinic's hypnotherapist, distinguished her work as a hypnotherapist from that of a hypnotist —a common source of confusion for families. Hypnosis is an induced mental state of heightened suggestibility, while in Charlotte's version of hypnotherapy, the mind serves as a tool to gain control over pain using techniques such as guided imagery, color visualization, breathing exercises, and progressive relaxation of the body. For the patient, then, hypnosis is a passive practice, whereas hypnotherapy relies on an active therapeutic stance.

The language of "rewiring" circuitry served to reframe a potentially dubious therapeutic practice as a legitimate biomedical treatment by appealing to folk neuroscientific constructions of the body. For example, in Marissa Turkle's first clinic appointment, Dr. Novak described hypnotherapy as a means to "reprogram" pain circuits through guided imagery: "With hypnotherapy, you can learn how to use the imaginative parts of the brain that can think in pictures to reprogram the pain map. Then you can turn off the pain system from the brain." Here, metaphors such as "rewiring circuitry" and "reprogramming" pain "maps" and "systems" hint at specific possibilities for therapeutic action. In one respect, this mechanized language suggests the existence of a technical solution for chronic pain in which one only has to follow a systematic procedure to attain a desired therapeutic outcome. It also enhances Dr. Novak's neural imaginary by spatializing pain and tracing it to a firmly grounded pathophysiology.

In quite another sense, however, "rewiring the circuitry" signals far more creative therapeutic possibilities. In Dr. Novak's rendering, representations of the brain were repurposed from diagnostic tools to therapeutic agents. Her account thus illustrates one way of conceptualizing a medicine of the imagination: the imaginative act itself facilitates healing (Kirmayer, 2006). By thinking in images, Dr. Novak suggested, Marissa could rebuild her internal pain signals, working to actively control, and eventually eliminate, her pain. With this second form of neural imagining, Dr. Novak charted a way for adolescents to be active in therapy.

Such a neural imaginary paints a picture of a plastic brain, one that is flexible and predisposed toward self-healing. Yet what model of adolescent agency is offered through this depiction of "rewiring the circuitry"? On the one hand, Dr. Novak's request that her patients "rewire" their neural circuitry merges a folk neuroscientific model of the body with imaginative practices that position adolescents as active agents of their own recovery who wrest bodily control back from their brains through hypnotherapeutic practices. On the other hand, however, the patients were not the primary authors of much of their therapeutic imagery. Instead, ample scaffolding from clinicians like Dr. Novak and Charlotte rendered theirs a carefully orchestrated form of therapeutic agency. (This is to say nothing of the strong possibilities within contemporary social theory for viewing the plastic brain as a liability as much as a platform for new forms of agency.[3])

To be sure, such neural imaginaries could mislead or pressure adolescents and result in disappointment. As many have observed, expectations for an active response to chronic illness may augment the suffering of those who, often because of the illness itself, are not able to act with agency (cf. Hay, 2010). In the pain clinic, this was particularly likely when patients were told that, although they were smart, their pain resisted treatment because their

[3]Some recent social scientific accounts have argued that new understandings of neuroplasticity tether "neuronal subjects" to projects of bodily improvement that are inflected with neoliberal ethics of self-care and personal responsibility (cf. Pitts-Taylor 2010). In this sense, plasticity is far from liberating. However, other theorists have highlighted the creative sociopolitical and ethical potential of viewing the nervous system as an "emergent form" (Rees 2011:157; see also Malabou 2008; Papadopoulos 2011; Wilson 2004). Critical perspectives on plasticity may be particularly limiting for thinking about children's agency because self-care and responsibility are developmental goals in themselves and not just a means to an end. As Singh (2013:814) has noted, "To disregard children's capacity for agency, even as part of a justified critique of the structural constraints imposed on children, misses an important opportunity to discover resilience as well as vulnerability in children's experiences."

brains were “sticky.” Here, I am referring to a sizable minority of clinic patients whom were believed to show signs of pervasive developmental disorders. Clinicians used terms such as “sticky brains” and “sticky neurons” to describe the perseverative thoughts and hyper-attentiveness that characterized these patients, and consequently, made their pain more resistant to treatment. In this case, “sticky brains” posed a striking counterpoint to clinical configurations of neuroplasticity: patients got “stuck” on their pain due to supposed neurobiological abnormalities that prevented them from “rewiring the circuitry” (see Buchbinder, 2012).

The possibility of stickiness points to a central tension within Dr. Novak’s explanatory model of pain, which imaginatively cast patients as agentive actors capable of rewiring their neural circuitry even as it endowed their brains with an independent agency that could conflict with the patient’s actions and desires. We see this, for example, in Debbie Katz’s slipping between “Jason remembers” and “his brain remembered” when explaining his headaches. These slippery statements index the competing forms of agency underlying the explanatory model’s vulnerability. Moreover, there was also a certain therapeutic privilege at stake that dictated who got to have “smart neurons” and plastic brains, and shaped the possibilities for using them.

Nevertheless, by giving patients a distinctive, creative way of understanding their pain, neural imagining provided adolescents with the sense of an enduring core of capability and strength that could be brought to bear on unknown future adversities. In this respect, the explanatory link that was forged between personhood and brain offered a way of envisioning a different kind of future in which a “smart brain” *could* facilitate emancipation. Furthermore, by providing patients a strategy for materializing the previously invisible and explaining the previously inexplicable, Dr. Novak’s neural imagining offered adolescents a compelling alternative to the scientific epistemologies of the body that had so persistently let them down.

## Discussion

In this article, I have shown how Dr. Novak relied on an imaginary toolkit consisting of vivid neurobiological language, images, and metaphors to help adolescent patients and their families make sense of and manage a phenomenon that resists traditional forms of diagnostic imaging. This conceptual alternative to imaging, which I have called *neural imagining*, plays on the close kinship between *imaging*, as a graphic form of visual representation, and *imagining*, as a conjectural act in which mental pictures are formed. Neural imagining was employed for several purposes: to mitigate stigma and legitimize symptoms; to reaffirm aspects of adolescent identities that often floundered in the face of chronic illness; and to offer a glimpse of a possible world in which intractable pain could be visualized and cured. In this final respect, Dr. Novak’s imaginative techniques worked to overcome the epistemological limits of the biomedical body, in which “to be ‘real’ is to ‘show up’ visually” (Rhodes et al., 1999, p. 1196). That is, neural imagining afforded a metaphorical means of spatially locating pain when diagnostic technologies fell short. Through imaginative representations, pain that could not be seen in the body could still be configured as real.

Exploring the clinical epistemology of imagination has revealed how imaginative practices may work to subtly disrupt the special status of vision within contemporary biomedicine as a diagnostic mode. Yet the role of imagination is not limited to its diagnostic function. As I have shown, mental images can also be agents of therapeutic efficacy (see also Kirmayer 2006). This article thus offers key implications for social and cultural studies of biomedicine, insofar as it can help to reframe popular conceptualizations of biomedical ideologies that pose an ontological separation between the imagination and the material world. In other words, mental life can leave a durable impression on ontologies of the body. The brain poses particularly fertile ground for this imaginative work in light of its interpretive flexibility, in that it may be used to advance a wide range of rhetorical projects while enveloping them in a veil of objectivity.

Although the clinical dynamics I have explored here are admittedly quite particular, this detailed analysis of clinical rhetorical processes contributes more broadly to the burgeoning literature on neural subjectivities. Dr. Novak's explanatory model of pain stipulated that a key component of recovery entailed adolescents reclaiming control over renegade brains through hypnotherapy techniques. The understanding of agency embedded in this model was also a source of tension, however, because it reified an implicit separation between person and brain that could surface again problematically, as in the case of sticky brains. Even so, this vulnerability provides an important opening to speak back to critical perspectives on the "neurologisation of the person" (Singh, 2013, p. 813). Specifically, the configuration of brain-person relations traced here suggests that the neurobiological does not cleanly eclipse the person in clinical discourse on individual agency. Instead, Dr. Novak narrated a shaky ontology of brain-person relations that highlights the incomplete penetrance of neuro-centric thinking and enlists patients and families to take on the generative work of neuroscience in action (Pickersgill, 2013). This is particularly significant because, while it has been well established that lay populations resist totalizing neurobiological narratives (cf. Broer and Heerings, 2012; Buchman et al., 2013; Pickersgill, Cunningham-Burley, and Martin, 2011), the creative uptake and transformation of neurobiological discourses on the part of clinicians has not yet been fully explored. Moreover, by shifting my focus from a concern with neuroimaging per se to other discursive forms in which neurobiological representations travel, I have highlighted less-explored ways in which neurobiological thinking leaks into clinical life. In doing so, I have pointed to a wider range of ways in which social scientists might engage with the sociality of neuroscience and move beyond logics of determinism and constraint.

By surfacing the body interior (Taylor, 2005) through alternative representational techniques, Dr. Novak cultivated an alternative epistemology of bodily knowledge that drew on the imaginative capacities of pediatric patients to render previously inscrutable symptoms logical and coherent. This intimate form of self-knowledge offers an important corrective to prevailing cultural discourses that picture the adolescent brain as a site of pathology. In Dr. Novak's rendering, chronic pain became not only a consequence of flawed neurobiology but also an occasion to exercise agency. For adolescents with chronic pain, this novel view of the brain represented a vital opportunity to understand the bodies that had failed them in new, rejuvenating ways. Within a biomedical regime that privileges neuroplasticity, "smart neurons" held the promise of possible futures in which new neural connections could erase

the work of intractable pain. Thus, instead of the mystification that ensues when pain fails to appear in diagnostic imaging, neural imaginaries depicted adolescents as legitimate patients whose personal strengths held the key to therapeutic success.

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## Highlights

- Social studies of neuroscience have focused on brain images.
- "Neural imagining" represents brains through language rather than images.
- Privileging the imagination opens new possibilities for knowledge of the body.
- These possibilities affirm adolescent agency vis-à-vis neurobiology.
- This, in turn, challenges dominant views of the teenage brain as pathological site.