

It's all done with mirrors: Neurological and sociological integration in the case of limb transplants

Clinical & Translational Neuroscience
January–June 2018: 1–5
© The Author(s) 2018
Reprints and permissions:
sagepub.co.uk/journalsPermissions.nav
DOI: 10.1177/2514183X18783390
journals.sagepub.com/home/ctn



Alexandra Catherine Hayes Nowakowski¹ and JE Sumerau²

Abstract

For most sighted people, looking into a mirror helps to consolidate a visual and spatial concept of the self. This concept connects both theoretically and substantively to other elements of identity. Similarly, observing the bodies of others plays a key role in social interaction between sighted individuals. These visual inputs offer cues to identity as perceived by other people as well as cues for responding to these attributes. Both the ability to observe bodies visually and the ability to respond psychosocially necessarily involve a variety of structures in the brain. Responses to these images were historically framed as lying outside the realm of neuroscientific inquiry. However, neurosociological inquiry has since evolved as a distinct field—one acknowledging that recognizing and acting upon visual cues is equally a sociological one and a neurological one. We apply a broader neurosociological model of embodiment to the specific context of limb transplantation. We do so using anecdotes and writings from practicing clinicians that illustrate ongoing debates about how people experience and adapt to life with transplanted hands. In the process, we call for more detailed exploration of the synergistic connections between sociological and neurological processes using concepts from dramaturgy.

Keywords

Interdisciplinary, neuroscience, bodies, identity, dramaturgy, perspective, surgery, mirror neurons

As far back as the work of George Herbert Mead,¹ sociologists have been interested in neurological manifestations, functions, and results in the society.² Especially in relation to symbolic interactionism and social constructionist traditions, sociologists have mapped a multitude of ways people think about, make sense of, communicate, and experience symbols, languages, cognition processes, emotions, and narratives. In so doing, sociological researchers have often demonstrated many outcomes of neurological functioning and the ways such functioning relates to concrete social outcomes, experiences, and inequalities in contemporary society.³ Building on these insights, the early 2000s witnessed ongoing debates within sociology concerning the potential utility of integrating aspects of sociological and neurological sciences in a more systematic fashion.^{4–6}

Neurosociology emerged from these explorations as a distinct field of integrative inquiry in the sociomedical sciences.⁷ In this essay, we utilize the case of limb transplants as a concrete example of neurosociology's unique potential to afford systematic understanding of social and biological experience over the life course. We attend to

both general trends in clinicians' and patients' perceptions of outcomes from hand transplantation and apparent discord between different accounts of same. In so doing, we both illustrate the overall value of neurosociological inquiry on embodiment and illuminate gaps in existing neurosociological models that may benefit from incorporation of dramaturgical principles.

A dramaturgical neurosociology

For the purposes of this essay, we utilize the intersection of neuroscience and sociology contained in the case of visual

¹ Florida State University College of Medicine, Tallahassee, FL, USA

² University of Tampa, Tampa, FL, USA

Corresponding author:

Alexandra Catherine Hayes Nowakowski, Florida State University College of Medicine, 250 E Colonial Dr, Ste 200, Tallahassee, FL 32301, USA.

Email: xnowakowski@fsu.edu



perception.⁸ For most sighted people (i.e. people capable of seeing images visually), looking into a mirror helps to consolidate visual and spatial concepts of the self.⁹ Dramaturgically speaking, the mirror represents an audience not unlike a crowd of people and looking into it provides the source materials for presenting and understanding the self in relation to an imagined other.¹⁰ One looks to the audience (i.e. a mirror or a stranger or a loved one) and based upon an assumption of audience reaction (i.e. how do I appear to this other set of eyes), one understands themselves biologically, socially, and as a member of a given group or identity category.¹¹ As such, understanding of the self relies upon both the initial performer who recognizes and audience (i.e. the mirror), and the way the performer in question interprets how they may appear to the said audience in relation to the existing social norms.¹²

Theoretically and substantively, this observation connects to many other elements of identity and widespread patterns of social interaction outlined by sociologists—within and beyond dramaturgical traditions—throughout the past century (see Schwalbe et al.,¹³ for a review). At the same time, observing images (our own or those of others) plays a key role in ongoing social relationships with known and unknown companions and provides a foundation for locating self within society and society related to the self.¹⁴ Both the ability to observe images (i.e. perceived objects or audiences for interpretation⁹) and the ability to respond to such images (i.e. perform social life¹⁰) necessarily involve a variety of structures in the brain.

Social action and cognition integrate with one another constantly throughout experiences of daily life, often becoming one and the same. At the same time, however, such processes are not uniform, but, rather, they often shift and change in relation to the interactional, interpretive, and embodied actions of people.¹⁵ As such, these processes, such as other elements of social life, offer fruitful arenas for the exploration of the ways people interpret the body, the self, and the performance and interpretation of these objects in relation to the self and social understandings, norms, and shared meanings.¹⁵ Despite the potential of this intersection, such social responses to issues of visual perception were historically left out of neuroscientific study, and the brain structures involved in the elaboration of such responses rarely gain mention in sociology.²

In the late 1990s and early 2000s, scientists proposed an alternate conceptual framework based upon the processes of both recognizing and acting upon visual cues biologically and sociologically.¹⁶ The field of neurosociology or sociological neuroscience focuses on the analyses of sociological and neurological intersections and processes.¹⁷ It engages a variety of different theoretical models from both neuroscience and sociology to achieve an integrated view of lived experience.¹⁸ Here, we add to these discussions by noting some ways dramaturgical insights concerning the ways people perform the self for audiences (i.e. self and other viewers) and make sense of the self in relation to

interpretation of audiences (i.e. self and other viewers)¹⁰ may be useful in further understanding neuro and social interconnections in daily life.

To this end, we operationalize a general neurosociological model of embodied cognition via the specific experience of limb transplantation and outline a specific case wherein such social–biological intersections play out in concrete experiences. We explore different accounts of hand transplantation from clinicians, reflecting both their own perceptions and those of the people they worked with. In so doing, we both highlight the general value of neurosociological inquiry on relationships between people, their bodies, and their loved ones and illuminate potential dramaturgical explanations for seemingly discordant evidence about the experience of transplantation from different clinicians.

A neurosociological case

The conceptual model in this essay emerged from the combination of our ongoing experience studying sociological and neurological scientific traditions, and the first author's experiences at a biomedical entrepreneurship conference in 2013. At this conference, the closing keynote speaker was Andrew Lee, a prominent surgeon who has successfully transplanted donor hands onto multiple recipients who previously experienced traumatic amputations.¹⁹ Lee's work both illustrates and challenges several important patterns in prior clinical experiences of hand transplantation.

As with other hand transplant populations, Lee's patients experienced a gradual return of motor and sensory function to their new limbs. In his conference keynote, Lee showed footage of several of his patients as they learned to manipulate their transplanted hands and adjusted to the general experience of having new body parts. Early videos showed one patient tentatively moving his hands without flexing the fingers, whereas the later ones found him picking up pencils and tossing a rubber ball around. Footage of another patient showed her examining her new hand in wonder at first, and then 2 years later using it to pilot a helicopter, her fingers gripping the controls with deft aplomb. As nerves grew longer and stronger in the transplanted hands, patients gained additional dexterity and strength as well as sensitivity and awareness of where their hands were in space.

Recalling the reactions of people seeing their new hands for the first time, Lee described an immediate sense of selfhood and propriety among most of his transplant recipients. Many patients felt no disconnect between their memories of their old hands and the visual stimulus of new hands. Some recipients even noted that the moment their new hand became part of their body it was theirs and theirs alone. The apparent ability of people to adapt to a new body part within moments of acquiring it offers a promising window into intersections between neurological and sociological experiences, concepts, and disciplinary concerns.

For example, Lee noted that in many cases the ease of adaptation extended not only to the recipients themselves but also to their family members, friends, and intimate partners. While it may seem logical in theory that seeing a new body part on a familiar person could initially foster cognitive dissonance or relational disruptions,⁹ this was not the case universally.

Pioneering hand transplant surgeon Jean-Michel Dubernard²⁰ has noted that integration of new body parts into people's concepts of their embodied selves often occurs gradually and incrementally. Indeed, Lee himself²¹ would later note that patients varied in their timing and trajectories of assimilating their new hands fully—but that eventual achievement of this outcome was practically universal. It thus appears likely that others were not necessarily responding to the visual input of new body parts per neurological mechanisms illustrated by Farnè et al.,²² Rather, many of Lee's patients appear to have been responding to social cues about how recipients perceived their new additions (see Goffman⁹ and Franks² as examples for the ability of interactional and relational backgrounds to smooth or ease dramatic changes to the self for others). In such cases, it would be reasonable for others' already established expectations of a recipient and/or recipients' visible reactions to the addition to ease the adjustment for friends, family, partners, and other people close to the recipient.

Of course, the idea that interactional cues can prevent and/or help manage dissonance and disruption over time is not new in and of itself.¹⁰ Rather, such understandings are a hallmark of dramaturgical work on self and social interaction.⁹ However, this finding also echoes prior findings in neuroscience concerning the experience of and reaction to limb loss. Ramachandran and Rogers-Ramachandran,²³ for example, revolutionized treatment for phantom pain with the mirror box, a simple portable structure that allows patients to achieve immediate relief from phantom pain as a result of visual stimulation. In so doing, mirror boxes capitalize on spatial representations of the body in the brain²⁴ as well as social representations as triggers for what one may accept as real and concrete.⁹ Put simply, the mirror box matches the information already stored in the brain (i.e. brain structures) while *also* capturing known and expected dimensions of space common to the person using it (i.e. a social representation one recognizes). The mirror box resolves the differences in social and biological cues a patient experiences within the brain, the same way a metaphor may be used in conversation to integrate different experiences into a shared meaning or narrative.¹¹ Specifically, the "virtual movements"—or symbolic stage of activity⁹—achieved with mirror boxes allow key neurological structures to operate as if the missing limb remains present and subject to control by the brain²⁵ and interaction with the recipient and the world.

The effectiveness of mirror boxes in relieving phantom limb pain²⁶ speaks volumes about how visual input translates to differences in emotions, cognition, and sense of

control (see also Ross and Mirowsky,²⁷ for discussion of these dynamics related to other social phenomena). Structures called "mirror neurons" are hypothesized to bridge the gap between visual information going into the brain and how this information affects a person's health after being processed.²⁸ They do so by activating in response to both a person's own action and a person's observation of another person performing that action. This is similar to the ways dramaturgical scholars outline the action of one person in relation to the information given explicitly or given off incidentally by another person or people within their line of sight or activity in a given setting.¹⁰ In terms of limb manipulation and recognition, these neurons would essentially allow people to integrate spatial bodily experience not only with the appearance of their own bodies inside their own brains but also with their perceptions of other people's bodies based on visual evidence of those individuals' behaviors, the same way social beings interpret the performances of others and meanings of other objects to integrate personal beliefs and perceptions with those of a given group or setting.

A couple of examples may be useful for further elucidating the similarities in interactional processes between people and such processes with body parts. For example, someone who is learning to use a newly transplanted hand that does not yet offer much sensory feedback in the fingertips can begin to achieve a sense of their new hand in physical space by allowing their fingers to touch another person's hand. A corollary experience outlined in dramaturgical research on interactions between people would involve someone who is learning a new language that does not yet have grasp of many words in the language who may then begin to achieve communication with others using the new language by reading their facial and bodily cues and emotional responses. In both cases, reading (of the touch of another or of the cues and signs given by another) provides visual input that helps the person understand the new piece (i.e. a hand or scripted language) of information they are still adjusting to in concrete practice, bodily recognition, and cognitive processing.

It is important to note that the difficulty of achieving these benefits may increase with parts of the body considered more central to identity formation, such as the face,²⁹ in much the same way we see difficulty vary in relation to the emotional significance of given new interactional or identity projects between groups of people.³⁰ Yet across body parts, experiences of mirroring—in neurological space as well as outside of the body and much like in cases of learning interactional norms in different populations—speak deeply to people's process of conceptualizing an embodied self and that self's location in relation to self and others. The idea that "it's all done with mirrors" from the title of this article references both this general truth⁹ and its specific manifestations in mirror neurons and mirror box therapy.

Returning to Lee's success in transplantation, we find that similar processes indeed take place in relation to others as well as the self, which suggests mirror neurons may respond to social cues as well as purely visual stimuli. The same way that amputees can achieve a visually conditioned sense of control over their limbs,³¹ they may establish a socially conditioned equivalent communicating such control or ownership to others.³² In such cases, changes in social cues may signal mirror neurons to establish a new understanding of the body—in space and in social context. These changes would hinge on both visual–spatial inputs and social behaviors and norms.²

In neuroscience, this phenomenon is referred to as “proprioception”,³³ and in dramaturgy, it is referred to as the “definition of the situation”.⁹ Both operationalizations of this central process involve the combination of sensory stimulation and learned behavior to establish biological and social understandings of a given event or self. The experiences of Lee's patients suggest that social cues can trigger such processes just as powerfully as purely biologically visual ones and that the two may work in concert with one another. Put simply, observing someone behaving as if a limb belongs within his/her self-concept may produce a shared understanding, which operates in tandem between neurological and sociological systems. At the same time, however, much like other dramaturgical events wherein one makes sense of and presents a self, such processes, as noted in other neurological case studies, may take a wide variety of forms, durations, and shapes as a result of differential interpretative, social, and other factors. Whereas one may have a smooth and almost automatic adjustment, one may also meet disruptions and disjunctures along the way that create a different trajectory or path to incorporation of the new information and body part. It is within these nuances, as Farnè et al.²² suggest, that a wealth of possibilities exist for both social and neuroscientific analyses to map and make sense of the multitude of pathways to successful and long-standing incorporation of limbs and perceptions of self.

The case of limb transplantation would thus suggest that as neurologically and sociologically complex creatures we may quite literally exist, interact, and adjust by mirroring others' perceptions of shared events (see e.g. Berlucchi and Aglioti,²⁸ Nystrom and Hagbarth,³³ in neuroscientific theorizing; and Goffman,⁹ Edgley,¹⁰ and Mead,¹ in sociological theorizing). Simply put, we accomplish such mirroring neurologically by adapting to evolving visual inputs. Similarly, we accomplish such mirroring dramaturgically by assimilating behavioral cues and responses to such cues in relation to these evolving visual inputs. These processes—as suggested by Franks²—are part and parcel of one another and unlikely to be empirically susceptible to separation in concrete practice. It would thus likely be much more beneficial to our ongoing understandings of the self and society, the brain and the environment, and the us and the others to integrate these developments in

neurological and sociological disciplines while mapping the dramaturgical practices and processes whereby people in varied clinical and other situations make sense of and accomplish such processes.

Concluding remarks

Within emerging findings, debates, and research programs in both neuroscience¹⁷ and sociology,² scholars continue to note intersections between a variety of different types of brain functions and patterned forms of social interaction.³ In so doing, scholars suggest—and often hypothesize or debate—many areas wherein sociological and neurological research could be improved and expanded through integrating disparate and shared insights about the “mind, self and society”.¹ Despite such discussions, efforts to integrate such concepts in specific cases, concrete experiences, and distinct biosocial contexts remain rare. In this essay, we have outlined some ways such integration could extend and expand existing knowledge and study concerning limb transplantation. Specifically, we note the ways that aspects of dramaturgical scholarship on processes whereby people incorporate self and social group expectations may also be taking place—and equally varied in duration and form—as people make sense of possession, use, and understanding of new aspects of their embodied existence.

To this end, we utilized emerging findings concerning the treatment and experience of lost limbs as a specific case at the intersection of neuroscience and sociology. Specifically, we outlined some ways that dramaturgical concepts may be used to shed light upon outcomes witnessed by medical practitioners working with people who receive limb transplantation and the significant others of these patients. As suggested by theoretical elaborations and debates on the developing field of neurosociology,¹⁷ such outcomes make a lot of sense when we pay attention to both the operations of the brain in response to social stimuli outlined in previous neuroscientific research and sociological research demonstrating the influence of social stimuli upon the ways self and others establish coherent, shared meanings and realities in specific contexts. We thus recommend the continued development of unified approaches merging sociological and neurological insights as a mechanism for expanding the theoretical and empirical basis for both of these fields and better understanding the complex interactions of biology, society, and the combination of the two in the individual and collective lives of people.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

References

1. Mead GH. *Mind, self, and society*. Chicago, IL: The University of Chicago Press, 1934.
2. Franks DD. Mutual interests, different lenses: current Neuroscience and Symbolic Interaction. *Symb Interact* 2003; 26(4): 613–630.
3. Choudhury S. Culturing the adolescent brain: what can neuroscience learn from anthropology? *Soc Cogn Affect Neurosci* 2009; 5(2–3): 159–167.
4. Beaulieu A. Images are not the (only) truth: brain mapping, visual knowledge and iconoclasm. *Sci Technol Human Value* 2002; 27(1): 53–86.
5. Littlefield MM. Matter for thought: the psychon in neurology, psychology and American culture, 1927–1943. In: Salisbury L and Shail A (eds) *Neurology and Modernity*. New York: Palgrave, 2010, pp. 267–286.
6. Rose S. *The future of the brain: the promise and perils of tomorrow's neuroscience*. New York: Oxford University Press, 2006.
7. Fitzgerald D and Callard F. Social science and neuroscience beyond interdisciplinarity: experimental entanglements. *Theory Cult Soc* 2015; 32(1): 3–32.
8. Waters T. Of looking glasses, mirror neurons, culture, and meaning. *Perspect Sci* 2014; 22(4): 616–649.
9. Goffman E. *The presentation of self in everyday life*. New York: Anchor Books, 1959.
10. Edgley C. *The drama of social life: a dramaturgical handbook*. New York: Ashgate, 2013.
11. Goffman E. *Interaction ritual*. New York: Basic Books, 1967.
12. Sumerau JE, Schrock DP and Reese TJ. Transsexuals' gendered presentations. In: Edgley C (ed) *Life as Theater: A Dramaturgical Handbook*. New York: Ashgate, 2013, pp. 245–260.
13. Schwalbe M, Holden D, Schrock D, et al. Generic processes in the reproduction of inequality: an interactionist analysis. *Soc Force* 2000; 79: 419–452.
14. Blumer H. *Symbolic interactionism: perspective and method*. Berkeley: University of California Press, 1969.
15. Franks DD. *Neurosociology: the nexus between neuroscience and social psychology*. New York: Springer, 2010.
16. Franks DD and Smith TS (eds). *Mind, Brain and Society. Toward a Neurosociology of Emotion*. JAI Press: Greenwich CT, 1999, pp. 85–103.
17. Choudhury S, Nagel SK and Slaby J. Critical neuroscience: linking neuroscience and society through critical practice. *Biosocieties* 2009; 4(1): 61–77.
18. Pickersgill M and van Keulen I (eds). Sociological Reflections on the Neurosciences. In: *Advances in Medical Sociology*, Vol. 13. Bingley: Emerald, 2011.
19. Lee WPA. *State of the science in hand transplantation*. In: *Keynote address delivered at the annual BioFlorida conference*, Tampa, Florida, 17 September 2013.
20. Dubernard JM. Hand and face allografts: myth, dream, and reality. *Proc Am Philos Soc* 2011; 155: 13–22.
21. Lee WPA. Hand transplantation: evolution of a personal outlook. *Journal of Hand Surgery* 2017; 42(4): 286–290.
22. Farnè A, Roy AC, Giraux P, et al. Face or hand, not both. Perceptual correlates of reafferentation in a former amputee. *Curr Biol* 2002; 12(15): 1342–1346.
23. Ramachandran VS and Rogers-Ramachandran D. Synaesthesia in phantom limbs induced with mirrors. *Proc R Soc London B Biol Sci* 1996; 263(1369): 377–386.
24. Gandevia SC, Refshauge KM and Collins DF. Proprioception: peripheral inputs and perceptual interactions. In: Gandevia SC, Proske U and Stuart DG (eds) *Sensorimotor Control of Movement and Posture*. New York: Springer, 2002, pp. 61–68.
25. Roux F. Virtual movements activate primary sensorimotor areas in amputees: report of three cases. *Neurosurgery* 2001; 49(3): 736–742.
26. Week SR, Anderson-Barnes VC and Tsao JW. Phantom limb pain: theories and therapies. *Neurologist* 2010; 16(5): 277–286.
27. Ross CE and Mirowsky J. The sense of personal control: social structural causes and emotional consequences. In: Aneshensel CS, Phelan JC and Bierman A (eds) *The Handbook of the Sociology of Mental Health*. Netherlands: Springer, 2013, pp. 379–402.
28. Berlucchi G and Aglioti S. The body in the brain: neural bases of corporeal awareness. *Trends Neurosci* 1997; 20(12): 560–564.
29. Soni CV, Barker JH, Pushpakumar SB, et al. Psychosocial considerations in facial transplantation. *Burns* 2010; 36(7): 959–964.
30. Goffman E. *Stigma: notes on the management of a spoiled identity*. New York: Basic Books, 1963.
31. Brodie EE, Whyte A and Waller B. Increased motor control of a phantom leg in human results from the visual feedback of a virtual leg. *Neurosci Lett* 2003; 341(2): 167–169.
32. Giummarra MJ, Gibson SJ, Georgiou-Karistianis N, et al. Mechanisms underlying embodiment, disembodiment and loss of embodiment. *Neurosci Biobehav Rev* 2008; 32(1): 143–160.
33. Nystrom B and Hagbarth K. Microelectrode recordings from transected nerves in amputees with phantom limb pain. *Neurosci Lett* 1981; 27(2): 211–216.