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David D. Franks
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Handbook of Neurosociology

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Handbook of Neurosociology

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ISSN 1389-6903
ISBN 978-94-007-4472-1 (hardcover)
ISBN 978-94-007-4473-8 (eBook)
ISBN 978-94-007-7409-4 (softcover)
DOI 10.1007/978-94-007-4473-8
Springer Dordrecht Heidelberg New York London

Library of Congress Control Number: 2012942914

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface

In the late 1990s, I was asked by the Editor of the *Annual Review of Sociology*, Karen Cook, to write a short essay for the millennial issue of that journal in which I would reflect on "what I don't know about my field but wish I did" (see Massey 2000). In the resulting article I wrote that "I have come to the reluctant conclusion that sociologists have gone too far in privileging the social over the biological," and went on to conclude that "we need to educate ourselves in the exciting work now being done on brain functioning, cognition, the regulation of emotion, and the biological bases of behavior." The hook line at the end of the essay was "I really wish I knew more about human beings as biological rather than social organisms and have begun reading to catch up."

Over the next several years I did a lot of reading on the subjects of behavioral ecology, evolutionary anthropology, genetics, neuroscience, and the emotional brain, all of which only reinforced my belief that sociologists needed to achieve a firmer understanding of human beings as biological and not just social beings. My goal then became to convince other sociologists of this need. I endeavored to accomplish this goal in my Presidential Address to the American Sociological Association, which was entitled "A Brief History of Human Society: The Origin and Role of Emotions in Social Life" (Massey 2002), which I later expanded into a book-length treatise on the evolution of urbanism (Massey 2005). The main point of my address was "to illustrate the creation and workings of the emotional brain and show how it operates independently of and strongly influences the rational brain." I argued that if sociology were to advance, "research and theory must grapple with both rational and emotional intelligence and focus particularly on the interplay between them."

I have been told by candid informants that in the wake of my ASA address, some colleagues were overheard muttering that I had "gone off the deep end" as they left the auditorium; and in the ensuing years, sociologists have charged me with being "reductionist," "eugenic," and even "racist." I have also discovered, however, that other colleagues in the field have come to the same conclusion as me and are pursuing parallel intellectual agendas. Many of these people came together in 2004 to form the ASA's Section on Evolution, Biology, and Society, with the stated goal of improving "dialogue between sociology and the biological sciences." The section is now well-established and offers a regular forum to consider the interface between the social and the biological.

The current volume is the fruition of efforts by many of those responsible for creating the new section. The *Handbook of Neurosociology* brings together work by leading social scientists who have been thinking about and studying the neurological bases of human sociality. The chapters offer a roll call of topics in which neurosociology has gained traction in understanding the dynamic interplay between the brain and the environment, covering such subjects as identity, rationality, interaction, sociality, prejudice, stereotyping, status, emotions, health, attachment, conformity, and the mind.

In my view, coming advancements in neuroscience to do to the social sciences what DNA did for the biological sciences: break down traditional boundaries between disciplines and promote work across sub-fields. It will do this by firmly establishing the neural bases for cognition, emotion, and behavior. Whereas models of sociality, rationality, and behavior in the past were grounded in convenient but unsubstantiated assumptions about the nature of human beings, in the future our theories increasingly will be based on actual knowledge not only of how human cognition works to shape behavior but also of how the environmental works to shape cognition. It is essential that sociologists be a part of the larger intellectual conversation now going on among neuroscientists because the critical environment forces shaping the expression of human proclivities is social and not physical.

The social environment is especially important in understanding human outcomes given the complexity of their genome and the importance of learning in shaping behavior. Human beings do not interact directly with the physical environment, but through the intervening filters of culture and society; and since cultural practices and social categories are transmitted through interaction with others, understanding the effects of the social settings that we inhabit on gene expression and human development becomes critical in comprehending the human condition. It is within specific social contexts that learning occurs and human proclivities play out, and to explain human outcomes one therefore must consider the series of social environments that people inhabit at different stages of the life cycle and at different historical stages of societal development.

The imperative for sociological and biological scientists to work together has assumed new urgency with the rise of epigenetics, the study of how the environment influences gene expression (Allis et al. 2007). For many years scientists had a rather static view of genetic inheritance in which specific genes were passed on by parents and duly inherited and expressed by progeny, irrespective of environmental conditions. Genes were thought invariably to be revealed biologically and the principal debate was over which was more important – genes or the environment – in accounting for observed traits and behaviors in the phenotypes of living organisms (Ceci and Williams 2000).

In recent years, however, this static view of gene expression has given way to a more dynamic model in which the environment itself determines whether and how specific genes are expressed (Ridley 2004). As a result, scientific debates now tend not to be over which is more important – genes or the environment – but about how genes and the environment interact to bring about the expression of certain inherited traits. The focus of current work in both the biological and behavioral sciences has thus shifted to gene–environment interactions (Rutter 2006). It is now understood that the environment – and for humans this means the social environment – not only shapes behavior through learning and conditioning, but also by determining which certain genes get turned on or off, and hence, expressed or not (Costa and Eaton 2006).

By exploring the dynamic interrelation between human brains, behavior, and the social environment, the *Handbook of Neurosociology* provides a welcome and very timely addition to the biosocial research literature. Its chapters offer a compelling introduction to basic precepts and pressing questions in the nascent field of neurosociology and lays the groundwork for future thinking and research. I am honored and pleased to commend it to all sociologists, for as I said in my essay for the *Annual Review*, "the beginning point in coming to terms with our situation must be the realization that we are indeed biological organisms…. We need to give up our historical resistance to the idea that social behavior has biological roots and accept the fact that we, as human beings, have inherited certain predispositions to thought and behavior that influence and constrain the social structures that we unconsciously evolve and rationally select." The publication of the *Handbook of Neurosociology* provides concrete evidence that the field of sociology is definitely moving in this direction.

Douglas S. Massey

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Chapter 1
Introduction: Summaries and Comments

David D. Franks and Jonathan H. Turner

David Franks: A Short History

In 2008, Howard Kaplan, sociology series editor for the Springer Press, requested that Professor Franks undertake this volume. At that time, the latter's response was that a handbook in neurosociology would be premature. Sociology was behind other disciplines in embracing neuroscience because anything biological was associated with the radical reductionism of E. O. Wilson's (1975) position that would have rendered sociology unnecessary. Things are obviously different now, but it has been an uphill battle, however rewarding for these editors. While early usage of the term neurosociology should be credited to Warren TenHouten (Bogen et al. 1972), the trek started in earnest with an issue of Franks' annual series with the JAI Press (1999) titled *Mind, Brain and Society* coedited with Thomas S. Smith. At that time, a reviewer wrote that all sociologists ought to read this volume, but that few would. According to our royalty checks, he could not have been more correct. A year later, Jonathan H. Turner came out with his *Origins of Human Emotions* (2000) that was heavily embellished with biological insights into the development of the Hominin brain processes underlying human emotion.

A great deal of the encouragement that existed then came from outside of sociology in the writings of neuroscientists like Gazzaniga who previously had written *The Social Brain* (1985) and others like Damasio in *Descartes' Error* (1994: 124–126). Both took an explicitly non-reductionist and pro-sociological approach in their work. Judging by the full house attracted by a didactic seminar on the social nature of the brain held at the annual meetings of the American Sociological Association in 2010, things were changing quickly even in sociology, and late in 2010 David Franks accepted Professor Kaplan's call for editing this handbook. It took only a week and a half to get enough sociological authors to start the next journey. Soon after that I was fortunate enough to recruit Jonathan Turner as my coeditor. Nonetheless, we have a few gaps in this volume that will be covered briefly here. One is of a methodological nature and the other is theoretical.

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D.D. Franks and J.H. Turner (eds.), *Handbook of Neurosociology*, Handbooks of Sociology and Social Research, DOI 10.1007/978-94-007-4473-8_1, © Springer Science+Business Media B.V. 2013

Brain Activity Measures and Limitations

The most sophisticated scanner is the fMRI. While the MRI (magnetic resonance imaging) takes static pictures of the *structure* of the brain, the fMRI literally gives us "movie pictures" of its functioning or *activity*. The images of both however are indirect: that is, they do not depict neuronal activity *per se*. What they measure is the *oxygen* level in different *areas* of the brain. Neuronal activity absorbs oxygen (energy from the body) and this is as far as fMRIs go in what they actually measure. Thus, what they actually tap into is distanced from neuronal activities in at least two important ways. First, they are removed from direct neuronal activity and second, they do not depict single, actual neurons, but statistical averages of brain *areas.* Part and parcel of doing this is a technique referred to as BOLD (Blood Oxygen Level Dependence). This measures the *ratio* of oxygenated to deoxygenated hemoglobin in the blood stream between nonactive brain circuits and active ones. BOLD therefore is the critical measure in all fMRIs but it has limitations. It is far from clear which kinds of neuronal activities can cause BOLD responses. Possibilities include excitatory neurons, mixed neuronal populations, astroglia and axonal tracts, or fibers of passage. Churchland (2011: 124), a leading philosopher of neuroscience, joins others in warning that the bright colors of the BOLD resolutions are highly deceiving. They suggest well-defined processing areas which support the modular theory of the brain. This assumes that the brain is organized like a Swiss army knife where each tool is autonomous. She points out in contrast that the brain's neural activity is probably distributed in "loosely defined networks." Everywhere in the prefrontal lobes, for example, she says there are looping pathways creating the convergence and divergence of information. This issue between the brain's modularity and a broader systems approach is not resolved as yet in neuroscience, but influences our interpretations. She warns that the differences in brain activities are really tiny, but coloring them red and subtracting everything else out, which is often done, results in an exaggerated impression that the colored area is all that is active when this may not be true. Not only that, but those unnoticed areas may be important to the modular-appearing activity shown in red. She also reminds us that any one brain circuits can be active in a certain behavior but that circuits can do numerous other things as well. Brain areas light up under many different states. We never know if the brain activity is unique to that behavior or state.

Another commonly recognized caution in interpreting fMRIs is that BOLD signals do not tap into actual single neurons but *averages* of deoxinations in tiny spaces called voxels. Because of the minute volume of these spaces, they cannot pick up the activity of axons that are very long in length. Churchland says this is like hearing a large noise in the rumpus room but not knowing what each child is up to. As we stated when first describing BOLD, we have little clue about the micro level of neurons and their networks (Churchland 2011: 125).

Her last warning goes beyond the limitations of BOLD and has to do with the vast difference between the language of humans and the language of the brain, that is, do we have an accurate vocabulary for what particular brain processes do? One can reasonably hypothesize that a neuron "can respond to a vertical stimuli" while this is less true of brain activities like "self-control," "delayed satisfaction," or "strength of will" (Churchland 2011: 126).

Next, a common dissatisfaction in brain research of any kind is that we are stuck with correlations instead of explanatory causes. This can be minimized by transcranial magnetic stimulation (TMS)—a highly intrusive procedure: a magnetic field is created under a copper coil placed in the head of the subject. This causes an electric pulse called a TMS pulse. A rapid series of these pulses disrupts the functioning of the brain area under the copper coil indicating whether the area is a necessary and sufficient cause of the activity being studied. Needless to say this has quite limited use.

Another consideration has to do with the relationship between fact and theory. If a fact is seen as an empirical statement about phenomena in terms of a conceptual scheme, its scientific worth is dependent on one's theory. According to Brothers (2001: 67), there is no unifying theory in neuroscience as there is in vastly more mature fields like the atomic theory of matter, the germ theory of disease, or the natural selection that drives evolution. Again, this does not negate the enormous strides neuroscience has made in the last three decades, but it behooves us from the very onset to be cautious. After all, according to Edleman (2004: 15–16), the cerebral cortex makes up approximately two thirds of the human brain. "If you counted its connections or synapses" (single neurons are just pieces of meat) and started right now, at a rate of one per second, you would finish counting them "32 million years from now". Caution, patience, and determination are obviously in order here.

Jonathan H. Turner: Coming on Board as an Editor

By the time that I became coeditor of *Neurosociology*, a good deal of the work in soliciting chapters had already been done. I added a few authors, but David Franks had done most of the heavy lifting, made even more necessary when I became seriously ill for several months. What strikes me most about the chapters assembled in this book is their diversity. Neurosociology is now just a label—but a good one—for thinking about the human brain and its relationship to human interaction and social organization. Curiously, in their efforts to escape anything biological, sociologists often make the case that the large human brain allowed for language and culture, and thus, the social universe is constructed by human agency rather than by bioprogrammers and mechanisms in the brain. But, if all of these social constructions that sociologists study are the consequence of a larger neocortex enveloping older subcortical areas of the brain, it would seem not only logical but also necessary to understand how this brain evolved and how it works. Human capacities for thought, language, and production of arbitrary symbols that build up culture do not obviate the study of the brain; rather, they demand that we understand its evolution and operation.

Still, as David Franks mentioned earlier, sociologists fear reductionism; and I can only paraphrase George Homans' comment about such fears: if sociology had a set of clear explanations for the operation of interaction and social organization, they would not fear that some of these might be deducible from the laws of behavior or biology. There are emergent properties of the social universe that are clearly emergent and not reducible, but any science recognizes that these emergent properties are built from more elementary properties and processes and that understanding of the latter can increase the robustness in explanation of the former. My own work on the brain followed this path. When I first began studying emotions some 15 years ago, I soon recognized that I needed to know something about the brain since emotions are generated in the subcortical areas of the brain, as these interact with the prefrontal cortex. Learning something about the brain and then comparing the size and, more importantly, the organization of the human with the brain of great apes led me, in turn, to try to explain the selection processes during the course of hominin evolution that could explain these differences. Not only are humans wired to produce culture and language, but we are wired to be highly emotional. And the evidence for this conclusion is in the rather jury-rigged manner in which subcortical areas of the human brain are organized and connected to the neocortical parts of the brain. Selection was clearly working rapidly to make humans more emotional; and this led to the question of why such should be the case. Perhaps some saw this as "reductionism" and were threatened by such research, but I saw it as giving sociological explanations of the social universe more power. We are strengthened by interdisciplinary work, not weakened. Only sociologists' collective insecurity makes at least some to believe that reductionism threatens sociology.

I go even further, however. A sociology that is willing to study the biological basis of human interaction and organization is not only stronger as a discipline but it also can inform other disciplines. Almost all of the selection pressures working on the hominin brain were sociological in nature; they were the direct result of selection pressures to increase the power and duration of social bonds of humans so that they could construct groups and eventually larger scale sociocultural formations. The so-called "modules" trumpeted by evolutionary psychology are a consequence of selection pressures that are social. The result is that not only can sociology learn something from neurology, we can provide needed information on why and how the human brain came to be wired the way that it is. I hesitate to quote August Comte, but to some extent, a neurosociology is one strategy for fulfilling Comte's prophecy that sociology as "the queen science" (o.k., a bit delusional, I admit) emerged from biology. It would then eventually begin "to inform" biology. We should not, therefore, be fearful of what seems like reductionism, but rather, we should see it as an opportunity to colonize other disciplines.

What Does Neurosociology Have to Offer?

The human brain became wired to increase social bonds among humans, first through enhancing interpersonal behaviors and then through using these enhanced interpersonal capacities to form more stable social groupings that, over the course of human history, were used to build up the macrostructures and cultures that we see today. Sociologists, in contrast to Homans' derisive comments, know a great deal about the dynamics of micro-level interaction as well as meso-and macro-level social organization. This knowledge of the outcomes of the great rewiring of the hominin and human brain compared to the brain of the great apes can inform researchers and theorists. If we see the subject matter of microsociology—or interaction dynamics—as a partial outcome of alterations of the hominin and human brain compared to the brains of the great apes, then we have a set of guidelines for studying the brain: find out how the brain affects the complex set of microdynamic forces driving interaction. Sociology can thus set up a research agenda for using the imaging methodologies discussed by David Franks to discover how the brain affects interaction, and vice versa. These last two words are critical because we know the brain to be plastic, and thus, individuals' experiences in interaction in group contexts have large effects on the brain, particularly in its formative stages of development. Thus, here is another research agenda: see how the sets of interpersonal processes that make human interaction, and group formation possible affect the development of the brain.

Many of the chapters in this book implicitly address some of these issues, but I would argue that they do not go far enough. We need to go beyond specific mechanisms driving interpersonal behavior—say, exchange, identity formation, emotional arousal, etc.—and explore *the full range of interpersonal mechanism*, which only sociology has done. Psychology has a limited view of these mechanisms, as does economics and even behaviorally oriented political scientists; their analysis is not so wrong as it is incomplete. And thus, a neurosociology offers real hope to understand more fully the relationships between brain systems—or "modules," if you insist—and the interpersonal behaviors that made human survival possible by allowing for more permanent group formations among weak-tie apes and hominins and that now make macrostructural, sociocultural formations possible. Both sociology and neuroscience will benefit from a mature neurosociology; and it is for this reason that I joined David Franks in editing this volume. It is a good starting point for further advancement, especially as the older generations of sociologists with all their reductionist fears give way to the younger generation of sociologists, more of whom seem willing to engage biology in general and neurology in particular.

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Part I
Large Issues

Chapter 2
Neural Social Science

George Lakoff

It is obvious: Reason is central to the social sciences. It is so obvious that it is not discussed. And it is not discussed because it is assumed that all social scientists, being human, are endowed with the capacity for reason. We can take reason for granted and go on.

Or can we? The past three decades in the brain and cognitive sciences have vastly changed our understanding of the nature of reason. What has emerged is the empirical study of "real reason"—how people really think, whether they are people studied by social scientists or social scientists themselves.

The social sciences, of course, study the material causes of social and political effects: poverty, hunger, illness, homelessness, lack of education, joblessness, disparity of wealth, and so on. But how people think also has social effects: How do people understand morality, markets, the proper role of government, the nature of institutions, and so on?

How social scientists understand reason will affect their theories, both their theories of material causes and cognitive causes of social effects. It is therefore vital that social scientists get reason right. The Brain and Cognitive Sciences have shown that Real Reason—the way we really reason—is a matter of neural circuitry and has effects that are far from obvious. The way the brain shapes real reason therefore makes all social science into neural social science.

Reason Is Neural

Because we think with our brains, all reason is neural in character. That's not a surprise. What is a surprise is the effect this simple truth has on how the social sciences are studied.

Neural systems work to structure ideas physically in such a way as to produce rich, largely unconscious thought, with elements like conceptual image-schemas, frames, metaphors and narratives, and categories defined by many kinds of prototypes, not necessary and sufficient conditions. What this means is that critical social thought must go beyond logic and Enlightenment Reason to look at Real Reason, as revealed by the Brain and Cognitive Sciences. Real critical thinking requires an understanding of Real Reason.

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D.D. Franks and J.H. Turner (eds.), *Handbook of Neurosociology*, Handbooks of Sociology and Social Research, DOI 10.1007/978-94-007-4473-8_2, © Springer Science+Business Media B.V. 2013

Back to the Future

There is a long history in Sociology of studying how the ideas of individuals shape social life, from Max Weber's *Ideal Types* to Erving Goffman's *Frames,* which are structural configurations of mind that shape everyday understanding.

Weber recognized that the Protestant ethic—a system of ideas—had everything to do with the social and material causes of capitalism and the shape that capitalism took in the Northern Europe of his day. Goffman recognized that social institutions—from asylums to casinos—have their causal roots in "frames" that structure the mind and determine how institutions are cognitively structured in many ways: in the roles that people in institutions play (e.g., nurse, croupier), and in their understanding of what does and does not happen in social institutions within the given frames.

What's in a frame? Look, Goffman told us, for where the conventional frame "breaks." In the Surgery Frame, surgeons operate on patients not patients on surgeons. The powerful oppress the powerless, not the reverse. Casinos, not customers, set house rules. Judges use gavels, not ping pong paddles. It is through structured frames that social life operates, exerting very real forms of power through systems of frames. As Goffman was fond of repeating, "Social life is no joke!"

We now know from neuroscience that ideas are physical, that they are neural circuits. Fixed ideas are fixed brain circuits, with synapses strong enough to make them permanent. The causal effects of ideas are neural effects.

But neurons are meaningless in themselves. How do hundreds of billions of neural connections forming trillions of circuits become meaningful—and meaningful in ways that have social effects?

How Brain Circuits Become Meaningful

Social scientists are usually trained on Weber's favorite metaphors:

- Time is Money (from Benjamin Franklin)
- Devotion to a Useful Craft is Devotion to God
- In Calvinism and related forms of Protestantism: Prosperity is a Sign of Righteousness and God's approval.

Metaphors, we now know, are conceptual and hence neural in nature. Just as frames are neural structures allowing us to understand the structure of the material world and social life—the roles we play, the norms of actions, the expectations we form—so, metaphors are neural circuits that map frames to frames, preserving social values, emotions, inferences, and hence normal expectations.

How does this work? Via the differentiation between associative circuitry and body circuitry—and the way they are connected. Body circuitry includes motor neurons, perceptual neurons, emotional neurons, temperature neurons, pain neurons, etc. Associative circuitry consists of complex "cascades" DeHaene (2009) made up of simple neural circuitry that "bottoms out" at the body circuitry, the circuitry that extends throughout the body. The cascades of associative circuitry link together a myriad of forms of inherently meaningful embodied experiences, like experiences of moving, seeing, grasping, etc.

As a result, phenomena that appear to be objective and material—matters of the external world in itself—are not. They could not be, because all out understanding comes via embodied neural circuitry for frames, metaphors, and narratives. We take common framing to be "objective." Because we do not notice our unconscious neural understanding, we take the material world-as-neurally-understood to be objectively material. Even the external, material sociology of how many racial hirings, sex education courses, college admissions, etc. are frame-dependent and often metaphor-dependent. These are studied because the social sciences are essentially moral in nature: they are the study of the right things to do. But morality itself is anything but objective and material. The ideas characterizing morality arise from framing and metaphor, that is, frame-circuits and metaphor-circuits, circuitry that determines what we consider the right thing to do. In short, embodied frame-circuits and metaphor-circuits determine the very goals of the social sciences. Social science can benefit from an understanding of how this works.

Reason and Social Science

By *Neural Social Science*, I mean the approach to social science research that is based on, and integrates, methods and results from the cognitive and brain sciences—including cognitive linguistics, embodied cognition, experimental social psychology, neural computation, social neuroscience, and neuroeconomics. The line between the social sciences and the cognitive and brain sciences is disappearing—fast. The most fundamental reshaping concerns the concept of reason itself.

Reason Itself: Enlightenment Fallacies

Frankly, I find it scandalous.

The social sciences are supposed to be committed to a rational understanding of social life. Rationality and science are seen as going hand-in-hand. If you believe in reason, you should believe in science—hence social *science!* Materialist social science takes on the trappings of physical science: objectivity of method, facts and figures, classical categories, logic, statistics—as well as the values of science: making the world a better place by eliminating superstition and fallacious, harmful myths. These are the Enlightenment values, and in the Enlightenment context of the seventeenth and eighteenth centuries, they led to marvelous advances.

We are taught in the social sciences that Enlightenment Reason is the hallmark of critical thinking and at the core of liberal democratic thought. If you accept the Enlightenment view of rationality, then the application of rationality and science *will* make the world a better place. And we certainly need to make the world a better place. Unfortunately, right now, America and much of the world are beset with a disastrous form of false "rationality." We do need to be rational to make the world a better place, but we need to replace Enlightenment rationality with real rationality—with the way that rationality really works.

Rationality is crucial to improving the world, but the cognitive and brain sciences show us that the *Enlightenment theory* of rationality is so flawed that it is helping to create the problems that threaten to destroy us! The brain and cognitive sciences do not just improve marginally on reason—the scientific results change our understanding of reason in a way that is absolutely crucial to saving what is most valuable in our world. Neural social science is absolutely necessary, not just nice.

Where are the fallacies of Enlightenment Reason most in use? In the social science departments of our universities (political science, sociology, classical economics, law, and public policy) and in our public policy institutions, both public and private, both governmental and corporate.

I am not kidding! Our best and most socially committed thinkers are being trained in a flawed system of thought.

The Enlightenment Fallacies

The First Fallacy: Reason Is Conscious

Consciousness is linear while conceptual thought uses brain circuitry that is massively parallel. For this reason, most conceptual thought could not be conscious—and it isn't. Andrea Rock, in *The Mind at Night* (New York: Basic Books 2005) quotes neuroscientist Michael Gazzaniga as estimating that reason is *98% unconscious*! That estimate seems about right to most brain and cognitive scientists. Consider a random chunk of consciously-focused-on text, for example. Imagine writing down everything *not* in that chunk of text that is needed to understand it—every concept and every piece of background information, including every rule of grammar and phonology. The ratio of 50-to-1 nontext-to-text is a reasonable approximation.

Consciousness is only the tiny tip of the iceberg of reason.

The Second Fallacy: One Can Reason Directly About the World

Because we think with our physical brains, which are connected to our bodies, we can only comprehend what our bodies and brains pick out, structure, conceptualize, and categorize. You can only reason about the understandings of the world that the embodied neural circuitry of your brain permits. The relationship between reason and the world is always mediated by the brain and body.

The Third Fallacy: Thought Is Disembodied

All thought is physical, a matter of the activation of neural circuitry that is grounded in the body. What makes thought meaningful is the body, and how we function in the world with our bodies. The content of concepts is determined by the way we interact in the world with our bodies. Conceptual thought always has a bodily component.

The Fourth Fallacy: Words Are Defined Directly in Terms of Features of the External World

All words in all natural languages are defined in terms of embodied conceptual frames, not the external world. There is no direct way in which words can fit the world independent of the framing provided by body and brain.

The Fifth Fallacy: Reason Is Unemotional

The opposite is true. If you have a stroke or brain injury that makes it impossible to feel emotions, then you don't know what to want because *like* and *not like* mean nothing, and you can't tell whether others will like or not like what you do. For this reason, you couldn't set rational goals. You can't act rationally without emotion. Rationality requires emotion.

The Sixth Fallacy: Reason Is Literal and Logical

Real reason makes use of frames, image-schemas, mental images, conceptual metaphors, prototype categorizations, mental spaces, blends, emotions, and narratives. These are embodied conceptual structures that have "logics" of their own, which, for the most part, do not fit traditional mathematical logics. This does not make reason "subjective," since the real world—both physical and social—places constraints on your experience. The very structure of reason is interactive. It requires both you and the world outside of you.

The Seventh Fallacy: Categories Are Defined by Necessary and Sufficient Conditions

Categories are structured by prototypes of many kinds: social stereotypes, which have major social effects; ideal, typical, and nightmare cases, which define social standards, norms, and social disasters; and salient exemplars—well-known cases that raise probability judgments significantly and change social behavior and social policy.

The Eighth Fallacy: Reason Exists Primarily to Serve Self-interest

That is partly true. But we know from mirror-neuron research that empathy is physical, that the capacity to put oneself in someone else's shoes is built into our bodies and brains. That capacity is at the center of social life. Social and interpersonal relationships are mainly served by our capacity for real reason.

The Ninth Fallacy: Conceptual Systems Are Monolithic

It is commonplace for human beings to have different inconsistent value systems in the same brain. For example, consider the Saturday night and Sunday morning value systems. Saturday night (party) and Sunday morning (church) moral systems are very different, yet most people shift readily between them with barely a notice.

The reason is that each value system is realized in neural circuitry, and two contradictory neural circuits inhibit each other, so that the activation of one inactivates the other. When one is turned on, the other is automatically turned off.

A great many Americans have conservative values on some issues and progressive values on others—shifting back and forth in different contexts without notice, unless a contradiction appears that is both very conscious and very troubling. That is called "cognitive dissonance." It does occur, but it is rare, and it rarely leads to significant change in itself. Pointing out logical contradictions to those with political positions rarely changes those positions.

The Tenth Fallacy: Words Have Fixed Meanings, and Concepts Have Fixed Logics

We now know that most important concepts can be essentially contested. Concepts may have limited agreed-on central cases that immediately come to mind, but are relatively unimportant. The important cases of contested concepts arise where there are major value differences across people (or even within the same brain). Then, what seems like a single concept named by a single word can vary widely in its meaning, depending on value systems. The effect of a single word, expressing a single simple idea in uncontroversial cases, can be deadly in the controversial cases when opposite meanings of the word are held by populations with different value systems.

The most detailed study of a single important contested concept is my book *Whose Freedom*?, which surveyed the vast differences of meaning in the word "freedom" under conservative and progressive value systems. It matters what freedom means, and the meaning of the concept has triggered a life-and-death struggle, not just in America, but in many parts of the world.

The Eleventh Fallacy: The Truth Will Set You Free; If Enough People Know the Truth About Social Issues, They Will Change Their Attitudes, to Society's Benefit

Actually, worldviews in the form of frames and metaphors are physically realized in the brain so strongly that, when the facts don't fit the frames, the frames stay and the facts are ignored or disputed or just plain not seen.

Those are among most basic properties of the Enlightenment theory of Reason. There are more, and we will discuss them before long.

The point is straightforward: the Enlightenment theory of Reason is inadequate for the social sciences. The social sciences need to incorporate what the cognitive and brain sciences have shown us about the nature of Reason. Reason itself, as it has been traditionally taught, is—or should be—a major issue in the social sciences. These results will require a rethinking of certain tools defined by old reason: the rational actor model, cost-benefit analysis, polling, and surveys based on old views of language and reason, and so on.

The inadequacies must be made conscious and replaced with an adequate theory of reason and rationality. That is part of the job of an adequate Neural Social Science.

Some Brain Basics

Color

There is no color in the world—no green in grass, no red in blood, no blue in the sky.

Color is determined by

1. Wavelength reflectances of objects; but wavelengths are not colors
2. Nearby lighting conditions
3. Color cones in the retina
4. Neural circuitry in the brain connecting to retinal color cones

(1) Wavelength reflectances of objects and (2) surrounding lighting conditions are in the external world. (3) The color cones and (4) the neural circuitry are in you—in your body! Without your body, there is no color—no experience of color no color concepts, and no words for color concepts. Colors and color concepts are embodied; they subsist in the relation between you and the external world, not in the external world alone.

Perception and Action

Perception and action are not different from the brain's perspective. Perception and action are determined by mirror-neuron systems. Complex actions (like taking a drink) are coordinated—choreographed—by the premotor cortex, which connects to the motor cortex, which in turn carries out the combinations of simple motor actions (grasping, lifting, opening the elbow, etc.) needed to carry out the “same” complex action like taking a drink: about 30% of these drink-taking premotor neurons also fire when you see someone else taking a drink. The other 70% perform interesting complex correlations between perception and action. The mirror-neuron system allows us to connect with others via empathy, by putting ourselves in the shoes of others. “Super-mirror neurons” in the forebrain do part of the job of distinguishing our actions from those of others (Iacoboni 2008).

That’s Why There Are Basic-Level Concepts

Basic-level concepts like *chair* and *car* come with motor programs (like driving a car), mental images (of what a chair looks like), and gestalt perception (the ability to perceive a chair or a car as a whole). The existence of basic-level concepts is a consequence of mirror-neuron circuitry, which is the same for perception and action.

That’s Why Verb Roots Are the Same for First- and Third-Person Experiences

Action is a first-person experience (I drink). Perception is a third-person experience (I see that he drinks). Yet in language after language, the expression of those experiences via verb roots is the same—because the neural basis of the experiences is the same. Sometimes affixes differ—*drinks* versus *drink*. Sometimes the vowel shifts (*run* versus *ran*) with the consonantal root preserved—as with triliteral roots in Semitic languages. And sometimes, there is a historical explanation for root differences (*be* versus *are*).

Imagining and Doing Use the Same Brain Circuitry

The brain circuitry used when you *actually see* something in the world overlaps considerably with the brain circuitry used when you *imagine* seeing the same thing. The same is true of actually moving your body and imagining moving your body, as when you kick your foot and imagine kicking your foot. The same is true of remembering and doing, dreaming and doing, and speaking and doing. There is a unique portion of brain circuitry for performing specific actions/imaging them/remembering tem/dreaming about them/and speaking about them.

That is why, there is an overlap between gestalt perception and mental imagery, both of which are carried out by brain circuitry.

Neural Computation and Simulation

In 2005, Vittorio Gallese, of the University of Parma Neuroscience Group, and I published “The Brain’s Concepts,” http://www.google.com/url?sa=t&source=web&cd=1&sqi=2&ved=0CBoQFjAA&url=http%3A%2F%2Finst.eecs.berkeley.edu%2F~cs182%2Fsp07%2Freadings%2FGallese_Lakoff.doc&rct=j&q=the%20brain’s%20concepts&ei=UkTsTZ7QKYy0sAO2suj4DQ&usg=AFQjC

NE1RZagC3j_yniSL-kJg8a1M-JqSQ&sig2=QDwFIvg4y99tqdNGlimNeQ, in which we reviewed the primary data on mirror neurons by Parma researchers. The data had been gathered via neuron-by-neuron probes of macaque monkeys' brains. The macaques were trained to perform discrete tasks—grasping and releasing, pushing buttons, peeling bananas, eating peanuts, etc. Each task made use of between several dozen and several hundred neurons—called a "cluster" or "node." Each neuron in the node has between 1,000 and 10,000 connections to other neurons along existing pathways. From the perspective of neural computation, each node can be seen as acting like a single, big, complex neural element, with many neural inputs and outputs. Though each neuron, at any instant, fires or does not fire, the node has many neurons firing or not, and hence appears to fire to some degree, as if the *probability* of the firing of individual neurons was the *degree* of firing of a node. Mathematically, in the theory of neural computation, the calculus of Bayesian probability is used to calculate what happens along a neural circuit made up of nodes. According to the Bayesian calculus, changes in activation in a neural circuit leads, via the Bayesian rules of computation, to other activations and inhibitions along the circuits. This permits Bayesian networks to model the "best fit" of certain changes to other changes, and so to model neural learning. Modeling is a theoretical enterprise, and so it is not known at present how well such modeling fits actual neural learning.

The Centrality of Metaphor in Social Life

The old Enlightenment Reason saw all meaning as literal, as abstract logical reason fitting the external world directly. Social policy studies have largely been based on this now-discredited view. The fact is that a huge area of reason—especially everyday thought about social concerns is—is metaphorical. Social policy is often made on the basis of metaphor, which by itself would not discredit the policy if the metaphor is apt, that is, if its entailments fit the social situation.

Always bear in mind that metaphor is a mode of thought. Linguistic expressions that are metaphorical are surface manifestations of metaphorical reasoning that shapes much of our social life. This is the basis of experimental work by Landau, Mark J.; Meier, Brian P.; Keefer, Lucas A.., "A metaphor-enriched social cognition." *Psychological Bulletin*, Vol 136(6), Nov 2010, 1045–1067. Landau and his colleagues have been producing experimental results that support the centrality of metaphor in social life, for example, "Evidence That Self-Relevant Motives and Metaphoric Framing Interact to Influence Political and Social Attitudes," Psychological Science 1, November 2009: 1421–1427.

Neural Metaphor

We now have a neural theory of how metaphorical thought arises and functions—and it is being confirmed experimentally, often by sociologists and social psychologists. Take the metaphor system of Moral Accounting, in which fairness and justice is defined in terms of the metaphor of Well-Being as Wealth. Receiving a favor is like receiving metaphorical money. You say *I owe you one, How can I repay you?, I'm in your debt*. Returning the favor is Restitution; it is balancing the moral books.

Consider harm—a decrease of well-being. Justice can either be a matter of Restitution, making up for the harm, or Retribution, harm balanced with harm. Revenge is based on the metaphor of Moral Arithmetic: Just as creating a debit is equivalent to removing a credit, so taking away something of value is a form of harm. These forms of moral accounting are central to our social life.

Just as eating pure food leads to satisfaction and eating rotten food leads to disgust, so, via the metaphor of Morality as Purity, immoral behavior is seen as disgusting. These metaphors characterize our emotional reactions to moral and immoral social behavior. And language follows: We speak of an immoral act as a disgusting, or rotten, thing to do. We speak of moral behavior as moral purity.

We metaphorically think of achieving a purpose as reaching a destination—a goal, and purposeful action as motion toward such a destination. Difficulties are conceptualized as things that get in the way of reaching a destination—encountering a roadblock, getting bogged down, being held back, being weighed down. In many cultures, including ours, people are expected to have life goals, with life seen as a journey toward such goals. In our culture, we even have special documents recording our progress on that journey—CVs, "curriculum vitae" (the "course of life"). To get certain jobs, one is expected to have an impressive CV, showing that one has made better than normal progress toward certain life goals. And married couples are expected to have compatible life goals.

These are just a handful of ways in which embodied conceptual metaphors define central aspects of our social lives.

The Narayanan-Johnson-Grady Neural Theory of Metaphor

One of the deepest results in theoretical neural cognition is the Neural Theory of Metaphor. It was arrived at via three interrelated dissertations at UC Berkeley in the mid-1990s by Srini Narayanan, Christopher Johnson, and Joseph Grady (Lakoff and Johnson 1999). Here is the basic idea.

Our conceptual systems are structured by hundreds of "primary" metaphors, conceptual mappings from one conceptual domain to another that are learned mostly in childhood just by functioning in the everyday world. We are usually not conscious of these metaphors, though we learn hundreds of them.

How Are Neural Circuits Learned?

By "recruitment."

At birth, our brains are structured to run our bodies, with existing neural pathways. We have 100 billion neurons and trillions of neural connections between them (between 1,000 and 10,000 connections per neuron). At birth, most of these connections are not yet organized into neural circuits that can perform particular functions. Functional circuits are formed when the right kinds of "strengthening" occur at synapses. Synaptic strengthening occurs when the neurons fire during experiences. As Donald Hebb noticed, "Neurons that fire together wire together." In Hebbian learning, two-way connections are formed slowly, as strengthening gradually occurs over time. Strengthening occurs as neurons fire and get used. Synapses that are unused die off. Between birth and the age of roughly 5, about half of the neural connections we are born with die off—the unused half. That is why, early childhood education is so important. If you do not hear music till the age of 5, you will not become a musician. A huge number of the ideas we use in later life are learned by recruitment due to early experience. Much of that experience is common—sometimes around the world, where More Is Up for everyone;—and sometimes in a society, where wealth may or may not be taken metaphorically as a sign of God's approval.

The Feldman Functional Circuitry Hypothesis

Jerome Feldman founded the International Computer Science Institute at UC Berkeley in 1986. I joined with him in setting up the Neural Theory of Language Project at the Institute. I brought with me fellow researchers and basic results of Cognitive Linguistics: the details of such embodied conceptual structures as image-schemas, frames, and conceptual metaphors, with language as the pairing of linguistic form (sounds, signs, gestures, writing, images) with such embodied structures. Feldman brought detailed computational theories of functional circuitry that gave promise of both describing how the cognitive structures got that way and providing a theoretical scientific account of how it all worked. Between us, we recruited a remarkable team of cross-disciplinary researchers: Charles Fillmore (and his whole FrameNet group), Eve Sweetser, Terry Regier, David Bailey, Lokendra Shastri, Srini Narayanan, Dan Jurafsky, Adele Goldberg, Benjamin Bergen, Vittorio Gallese, Lisa Aziz-Zadeh, Nancy Chang, Christopher Johnson, Joseph Grady, Carter Wendelken, Ellen Dodge, Steve Sinha, Joe Makin, Leon Barrett, Mett Gedigan, Behrang Mohit, John Bryant, Jenny Lederer, and others.

Over more than two decades, computational models of functional circuitry have drawn upon well-known computational techniques of PDP connectionism, localist connectionism, Petri nets, Bayes Nets, accounts of neural binding, models of neural modulation, models of basal ganglia, and so on. What has emerged is a sophisticated account of the theoretical–computational neuroscience of thought and language, based on the idea of functional circuitry unified with cognitive linguistics.

These ideas are surveyed in Feldman's MIT Press book *From Molecules to Metaphors.* The general point is that the brain functions according to simple computational structures defined over functional brain circuitry—and that is how all of thought and language works!

The details give rise to a theory of Neural Social Science—how meaningful social ideas arise in various cultures, providing a theory of significant cross-social similarities and differences.

Primary Metaphors

Primary metaphors are learned via synaptic strengthening of synapses in functional circuits. Consider the conceptual metaphor *More Is Up*.

Whenever a child sees a liquid poured into a container or things put in a pile, his or her brain "notices." Two areas of the brain are activated, one registering an increase in quantity and the other registering an increase in verticality.

Each time these areas are activated together, the neural synapses in both areas are strengthened. Because the neuronal groups are connected, neuron by neuron, each to thousands of other neurons, activation spreads along existing pathways, getting stronger each time the pairing of quantity and verticality occurs.

The spreading of increasingly stronger activation keeps on until a common pathway is found and the activations meet. The synapses along this pathway then get doubly strengthened from activation in both directions, until a permanent circuit is formed. That circuit is the physical realization of the *More Is Up* metaphor.

Narayanan on Spike-Time-Dependent Plasticity

The Hebbian learning account is a central part of the story, but not enough. Hebbian learning is bidirectional. But conceptual metaphors are unidirectional. We understand Affection as Warmth, not Warmth as Affection. Moreover, the subject matter of a metaphorical idea (e.g., Morality) can provide some activation of the range of metaphorical understandings of that concept: Morality can be Purity, Uprightness, Light, Obedience, Nurturance, Balancing Moral Books, and so on.

Moreover, primary metaphors—the irreducible ones—are all embodied: they link two brain areas with bodily connections. How can we make sense of this? Why *must* it be true? And why are the primary metaphors most likely to be the ones found all over the world, in culture after culture? Why should children know them early in life? And how can they be learned, in many cases, *even before language*!

Here is the intuitive idea.

Because the brain computes Verticality constantly, more than it computes Quantity, the synapses in the direction spreading from Verticality will be stronger than those spreading from Quantity. Since the neural circuit is formed by spreading in both directions, there will exist, at each point on the pathway, cases where the axon of neuron A forms synapses on neuron B, and conversely, where the axons of neuron B forms synapses on neuron A.

This situation gives rise to a phenomenon called "spike-time-dependent plasticity." Neurons "fire" in a series of "spikes." The neuron with the strongest input will spike first, and as a result, there will be synaptic strengthening in its direction and weakening in the opposite direction. This produces directionality in the metaphor. The stronger activation will define the source domain, the weaker will define the target domain. That is why metaphorical mappings are asymmetric. This correctly predicts the directionality of primary metaphors. For example, in More Is Up, Verticality is the source domain because the brain is always computing Verticality, even when we are asleep, but not always computing the concept of Quantity. In Affection is Warmth, Temperature is the source domain because the brain is always computing Temperature, but not always computing Affection. Thus, there is a neural explanation for the system of primary metaphors—the scaffolding on which our social concepts are built.

Neuromodulators and "Rewards"

Neuromodulators are chemicals, like dopamine, norepinephrine, acetylcholine, etc. that can powerfully change synaptic strengths, both positively and negatively, in a very short time. These constitute what is called the "reward system" of the brain. They play subtle roles in setting goals, changing attention, and producing emotional satisfaction and dissatisfaction. They are therefore central to decision-making. Decisions in the brain are made on the basis of vast numbers of neural circuits of the sort we have been discussing, for frames, metaphors, and so on.

Integrating Multiple Neural Systems

Contemporary research on real reason takes all of this, and much more, into account. Everything we understand uses frames, metaphors, and narratives that are characterized by neural circuitry, which in turn gets its meaning via embodiment. The circuits, as we currently understand them, have "gates"—points where they can be inhibited (turned off) or activated (turned on). The brain also has "binding circuitry" which, when turned on in context, can identify a concept in one circuit as being the "same" as that in another circuit. For example, a restaurant frame-circuit is composed of other frame-circuits: business, eating, and hosting. The customer in the business frame-circuit is neurally bound to the eater in the eating frame-circuit and to the guest in the hosting frame-circuit. When the binding circuitry is turned off, the frames for business, eating, and hosting can operate independently. Gating and binding allow for enormous compositionality of frame-circuits. And it allows for imagination and fictional entities, like flying pigs—where wing frame-circuits are neurally bound to the sides of the body of a pig in a pig frame-circuit.