CHAPTER 3

Social Cognitive Neuroscience

Historical Development, Core Principles, and Future Promise

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The supermarket checkout line provides interesting lessons about the human psyche. Beside the social norms that dictate that we stand in line and politely pay our bill, and before we encounter the disaffected teenage checker, there is the point-of-purchase magazine gambit. Strategically placed above the checkout conveyor belt are rows of magazines heralding the latest pop-culture happenings. Typically, two types of cover stories clamor for attention: those about the relationship hijinks of high-profile people and those about new businesses and technology that could "change the way we live and work." Since its emergence at the beginning of the 21st century, social cognitive neuroscience (SCN) has been purported to be both. At turns, SCN has been billed either as a hot new power coupling of social psychology and cognitive neuroscience or as a fast-growing research startup looking for investment capital.

The fact that we use relationship metaphors to describe SCN may not be that surprising. Indeed, the supermarket checkout line is a regular reminder that humans are fundamentally social beings (Fiske, 1991; Fiske, Kitayama, Markus, & Nisbett, 1998). Magazines capitalize on the facts that we care a great deal about our personal and our professional relationships and that stories and metaphors help us understand them (Lakoff, 1987, 1993). The beauty of metaphors is that when correctly applied they can help us intuitively grasp what something means. The danger of metaphors is that when incorrectly applied they can lead us to overlook important differences between the objects of comparison.

In this regard, using different relationship metaphors to describe SCN invites different types of questions about its nature. On one hand, a personal metaphor might lead to questions about how parent disciplines begat SCN, what they were thinking when they did so, and how SCN will develop and mature. On the other hand, a professional metaphor might lead to questions about SCN's business plan, principles for effective production, and growth potential.

The goal of this chapter is to address the nature of SCN. Toward that end, it uses the personal and professional relationship metaphors to organize discussion of questions about its practice, its principles, and its promise. The first section of the chapter takes the personal metaphor as a starting point for describing SCN's historical roots and developmental progression. The second section uses the professional metaphor to springboard consideration of core principles that govern its practice. The third and final section highlights promising directions for future work.

The goal of this chapter is not to describe basic psychological and neural principles that underlie a specific type of socioemotional ability. Rather, the goal is to describe the development and nature of basic principles that underlie SCN *as an approach* that can be applied to investigating any number of topics (Blakemore & Frith, 2004; Blakemore, Winston, & Frith, 2004; Ochsner & Lieberman, 2001). For principles related to specific types of ability, the reader is referred to other chapters in this volume, and to SCN work on social cognition and theory of mind (Gallagher & Frith, 2003; Keysers & Perrett, 2004; Lieberman, 2003; Puce & Perrett, 2003; Saxe, Carey, & Kanwisher, 2004), self-reflection and self-perception (Heatherton, Macrae, & Kelley, 2004; Lieberman & Pfeifer, 2005), perception of faces and other nonverbal cues (Allison, Puce, & McCarthy, 2000; Calder et al., 2002; Haxby, Hoffman, & Gobbini, 2002), and emotion and self-regulation (Beer, Shimamura, & Knight, 2004; Ochsner & Feldman Barrett, 2001; Ochsner & Gross, 2004, 2005; Ochsner & Schacter, 2000).

WHAT'S IN A NAME?: TRACING THE HISTORICAL DEVELOPMENT OF SOCIAL COGNITIVE NEUROSCIENCE

The German psychologist Hermann Ebbinghaus (1908) once wrote, "Psychology has a long past, but a short history," by which he meant that the roots of modern psychological inquiry run long and deep, but the field operates as if current psychological research is a recent development. The same might be said of SCN: Amid attention to its recent growth and development, lessons from its long past may be overlooked. In this section, we chronicle some of the past and present debates and disciplines that have contributed to SCN's gene pool and some developmental milestones that have marked its growth. The goal is to understand the interdisciplinary origins of SCN, its relationships to allied fields, and how and why SCN has a distinct identity.

The Genealogical Tree: From Animal Models to Phineas Gage

As illustrated in Figure 3.1, SCN is an interdisciplinary field that seeks to explain social phenomena at three levels of analysis: the social level of behavior and experience, the cognitive level of mental representations and processes, and the neuroscience level of brain systems. Although articles, laboratories, and conferences bearing the name "social cognitive neuroscience" have only appeared since the turn of the century, SCN has a long and important ancestry.

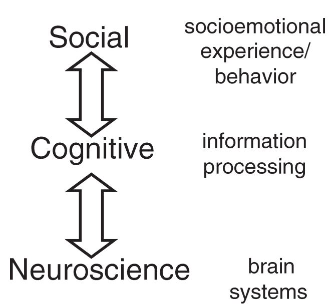

FIGURE 3.1. The three levels of analysis for social cognitive neuroscience.

SCN's Close Relatives

During the past century there have been a number of important findings in psychology and neuroscience that can be seen as precursors to SCN. The majority of this work has been done with animal models, with interest in human work growing during the past quarter century.

A LONG LINE OF ANIMAL MODELS

A great deal of work on the brain bases of social emotional behavior has employed animal models. In general, this work has followed two threads. The first concerns the study of prosocial behavior. Some of the earliest and best-known examples of this work came from Harry Harlow, whose studies of the effects of maternal deprivation on the development of social function in young primates is still cited an introductory textbooks today (Harlow, Dodsworth, & Harlow, 1965; Harlow & Harlow, 1962). In a similar vein, the classic studies of Kluver and Bucy purported to show that damage to the inferior temporal lobes resulted in a severe disruption of sexual, feeding, social, and maternal behavior (Kluver & Bucy, 1939). Modern work, however, has demonstrated that these effects are not wholly reliable. For example, Amaral and others have shown that the specific deficits observed in social function (e.g., showing either social disinhibition or fear of conspecifics) may depend on the specific location of cortical lesion in the temporal lobe, and in particular on the nature and extent of the damage to the amygdala (Amaral et al., 2003; Bauman, Lavenex, Mason, Capitanio, & Amaral, 2004a, 2004b). Consistent associations between impaired primate social behavior and damage to the amygdala and orbitofrontal cortex (among other regions) led Brothers (1990) to hypothesize that these systems together comprise a "social brain." Complementary work in rodents has less often concerned the amygdala, but more often other subcortical nuclei and neurohormonal factors important for mating, pair bonding, or maternal care. For example, Insel and colleagues have shown that oxytocin and vasopressin are important for promoting memory for and bonds with conspecifics (Insel & Fernald, 2004), and Meaney and colleagues have shown that early pup experiences of maternal licking and grooming set a threshold for subsequent responses to stress manifested at multiple levels of the neuroaxis (Meaney, 2001).

The second thread in animal research has emphasized the motivational and emotional, rather than the social, aspects of behavior. Some of the earliest work of this kind appeared during the first half of the century when numerous brain stimulation and lesion studies identified subcortical nuclei essential for the manifestation of various types of species-specific aggressive, fearful, and sexual behaviors (e.g., Davey, Kaada, & Fulton, 1949; Fangel & Kaada, 1960; Kaada, Andersen, & Jansen, 1954). This work was the impetus for some of the first "neural circuit" theories of emotion (e.g., Cannon, 1987; Papez, 1958). Building on this work, Paul MacLean later advanced the concept of the triune brain, alluded to above, in which impulses for both prosocial (e.g., play and maternal care) and defensive (e.g., aggression and flight) behavior depended on evolutionarily old brain systems humans share with other mammals (MacLean, 1969). Higher neocortical systems were thought to control the expression of these innate drives, motivations, and emotions. Following MacLean's lead, Panksepp (1998) later described multiple subcortical neural systems dedicated to distinct motivated and/or emotional behaviors, ranging from play to maternal care to aggression and love. Then, in the late 1980s, emotion came to the fore in neuroscience with LeDoux's (2000) seminal work on the role of the amygdala in conditioned fear.

RECENT REEMERGENCE OF HUMAN RESEARCH

Interestingly, in comparison to animal work that has seen decades of concerted effort, human research on the neural systems involved in social and emotional behavior has been slow to develop. This has not been due to a lack of early interest in these questions, however, either from social psychologists or from neuroscientists. As is recognized increasingly today (e.g., Heatherton, 2004), social psychologists early on recognized the importance of understanding the brain bases of social behavior. In one of the first social psychology textbooks, Floyd Allport (1924) wrote:

> The chief contributions of the cortex to social behavior may be summarized as follows: It underlies all solutions of human problems, which are also social problems, and makes possible their preservation in language, customs, institutions, and inventions. It enables each new generation to profit by the experience of others in learning this transmitted lore of civilization. It establishes habits of response in the individual for social as well as for individual ends, inhibiting and modifying primitive self-seeking reflexes into activities which adjust the individual to the social as well as to the non-social environment. Socialized behavior is thus the supreme achievement of the cortex. (p. 31)

Similar early emphasis can be found in one of the most famous neuropsychological cases of all time, which concerned disruptions of socioemotional behavior. In the late 1800s the "mysterious" case of Phineas Gage was well documented and generated great interest (Goldenberg, 2004; Macmillan, 2000). After damage to his orbitofrontal cortex in a freak railroad construction accident, Gage was described as being "no longer Gage." Gage had intact cognitive faculties but apparently diminished ability to conform to social norms (making lewd comments, inappropriate jokes, displaying inappropriate affect, etc.).

Despite this early interest, human research on the social or emotional brain was largely absent until the 1980s. The reasons for this dry spell are likely fourfold. First, it was during the first half of the 20th century that radical behaviorism was the dominant force in psychology. Because behaviorism was decidedly and antagonistically nonmentalistic, and social and emotional behaviors have a strong experiential component, the study of such behaviors was left out of the research mix.[1] Second, as described earlier, socioemotional behaviors often have been conceived as more primitive and animalistic than are our so-called higher cognitive faculties. In a sense, affect was noise in the cognitive signal, and the effects of affect were to be eliminated. Thus, when the yoke of behaviorism was cast aside and the cognitive revolution reintroduced mentalistic concepts to psychology, emotion again was left out of the cognitive science research mix (Gardner, 1985). Third, both in behaviorism and in cognitive science (as well as their descendants—behavioral neuroscience and cognitive neuroscience) there has been an emphasis on identifying species-general principles that govern behavior. This emphasis on the general leaves out social and emotional factors that vary by individuals and by contexts. Fourth, and last, psychologists and neuroscientists simply lacked the tools to easily and precisely study the brain bases of socioemotional phenomena in humans. Animal researchers could stimulate or ablate brain systems, but human researchers were left to the study the consequences of uncommon brain-damaging accidents of nature (such as stroke).

An early challenge to this status quo came from social psychology in the 1980s, when the use of peripheral psychophysiological measures to index autonomic nervous system (ANS) activity seemed to promise a means for studying the linkage between psychological and biological mechanisms governing social behavior. Unfortunately, such measures turned out to have only limited value for this purpose because (1) they do not directly measure the operation of the brain systems that implement psychological processes and (2) the measures themselves often show little differentiation across qualitatively different task contexts. As a consequence, correlations often are weak between ANS measures and either self-report or performance measures of behavior (Cacioppo, Berntson, Larsen, Poehlmann, & Ito, 2000), which renders these measures suitable for studying the *physiological consequences* of particular types of emotion or thought but less well-suited for drawing inferences about *information-processing mechanisms* (Blascovich, Mendes, Tomaka, Salomon, & Seery, 2003; Tomaka, Blascovich, Kibler, & Ernst, 1997; Wright & Kirby, 2003).

Be that as it may, interest in human neuropsychological research on the brain bases of socioemotional behavior was growing slowly, and appeared on multiple fronts in the 1980s. Examples include, but are not limited to, research on the involvement of the right hemisphere in nonliteral aspects of language, such as humor and metaphor (Brownell, Simpson, Bihrle, Potter, & Gardner, 1990; Kaplan, Brownell, Jacobs, & Gardner, 1990; Winner, Brownell, Happe, Blum, & Pincus, 1998); studies of the psychological mechanisms underlying face perception and their breakdown in prospagnosia (Ellis, 1992; Farah, 1990; Young & Ellis, 1989); descriptions of Capgras syndrome, which involves delusions that loved ones have been replaced by exact replicas (Ellis & Lewis, 2001); demonstrations that amnesics who lack explicit memory for melodies or encounters with people nonetheless can acquire preferences for them (Johnson, Kim,

& Risse, 1985); conceptually sophisticated psychophysiological work demonstrating distinct patterns for appraisals of threat versus challenge (Blascovich et al., 1992; Tomaka et al., 1997); scalp electrophysiological studies identifying cortical correlates of attitudes and evaluations (Cacioppo, Crites, Gardner, & Berntson, 1994; Crites, Cacioppo, Gardner, & Berntson, 1995); and a resurgence of interest in the effects on decision making and social behavior of orbitofrontal lesions like those suffered by Phineas Gage (Bechara, Damasio, & Damasio, 2000; Beer, Heerey, Keltner, Scabini, & Knight, 2003; Damasio, 1994).

This work set the stage for increased availability and common usage of functional imaging techniques such as positron emotion tomography in the mid-1980s, and functional MRI in the early 1990s, which enabled researchers to study the cortical and subcortical brain bases of phenomena in healthy normal individuals. The first topics to be studied using functional imaging were classic cognitive psychological phenomena involving language, attention, memory, and vision. This was due in large part to the fact that many of the best cognitive psychologists quickly became cognitive neuroscientists, and imaging work on their topics of interest has dominated cognitive neuroscience since its inception. But in the late 1990s, something changed and a new field emerged that was devoted specifically to the use of neuroscience methods to study the brain bases of socioemotional phenomena.

From Zeitgeist to Distinct Identity

What was it that changed? The preceding review points to the development of a Zeitgeist with three crucial elements. First, salient animal (e.g., work of LeDoux and Panksepp) and human (e.g., work of Damasio) studies of social and emotional behavior had achieved a great deal of notoriety, in part because they represented modern approaches to classic problems in both biological and social science that were discussed earlier. Second, functional imaging had become highly accessible in many research institutions, and high-profile imaging publications regularly received a great deal of attention. For researchers across many disciplines, these two factors made salient the questions and methodologies that when combined later would form the basis of social cognitive neuroscience.

Of course, as described previously, researchers have been using neuroscience methods to study questions about socioemotional phenomena for quite a long time. But researchers had not yet realized that the seemingly disparate strands of research listed earlier could be woven into a coherent whole. The third element of the Zeitgeist helped spark this realization. This element was a research climate very favorable to interdisciplinary research in which the past two decades had seen numerous new terms coined to describe distinct interdisciplinary fields. For example, the term "social cognition" came into common usage in the early 1980s to refer to the use of cognitive psychological theories and methods to study phenomena typically of interest to social psychologists. Then in the late 1980s, the term "cognitive neuroscience" was coined to refer to the use of neuroscience methods to study the brain bases of phenomena typically studied by cognitive psychologists. In the early 1990s, the term "social neuroscience" was coined to refer quite broadly to any research that linked the biological and social levels of analysis. This move broadened the use of an earlier term, "social psychophysiology," which had been used to describe the initially promising but ultimately limited movement in social psychology (described earlier) toward using peripheral autonomic measures as indices of underlying psychological processes. And finally, in the 1990s, the term "affective neuroscience" gave a name to the growing area of research (also described earlier) aimed at discovering the affective/emotional functions of specific brain systems.

In this context, social psychologists and cognitive neuroscientists in a number of locations began to use the term "social cognitive neuroscience" to refer to the use of cognitive neuroscience methods to study socioemotional phenomena. The first papers using the term described SCN as a marriage between social cognition on the one hand and cognitive neuroscience on the other (Lieberman, 2000; Ochsner & Lieberman, 2001; Ochsner & Schacter, 2000). Two motivations prompted the use of this term. First, it was thought to provide an accurate label for a new kind of interdisciplinary research that capitalized on what its parent disciplines have in common, at the same time making good use of their unique strengths. Both social cognition and cognitive neuroscience are concerned with information-processing mechanisms: whereas social cognition links the study of particular kinds of intra- and interpersonal experiences and behaviors to information-processing models of psychological mechanisms, cognitive neuroscience links these models to their neural substrates using neuropsychological, electrophysiological, and functional imaging methodologies. SCN puts it all together. The second motivation was pragmatic. It was hoped that the term "social cognitive neuroscience" might be intuitively appealing to both social cognition and cognitive neuroscience researchers who would see the name of their field in the new term and might therefore be encouraged to participate in it. Despite these principled hopes, however, in actual practice the nature of a field is defined by those who work within it. And as usage of the term "SCN" began to grow, important questions arose about the boundaries of the field.

Staking a Claim to a Research Domain

Questions about the domain and scope of a new research domain are common and important to address during its formative years. In the case of SCN, at least two important questions concerning its scope and boundaries need to be addressed.

The first question is simply whether it is useful to try to define a distinct new area of research. Or, in other words: With all those other interdisciplinary fields and subfields already out there, why coin a term for a new one? The answer, of course, depends on whether the new field is truly distinct, and whether the new term proves useful for guiding, promoting, and drawing new researchers into conducting a specific and potentially new kind of research. In this regard, it is useful to consider SCN's relationship to its closest neighbors: *social neuroscience* (SN), *affective neuroscience* (AN), and *cognitive neuroscience* (CN). Each of these terms and the fields they define have been around for a decade or more.

In the case of SN, although the term originally was intended to be quite broad, within psychology, "SN" initially was used to describe human studies that linked social variables to psychophysiological, endocrine, and immunological measures (Cacioppo, 1994). Animal researchers also began using the term "SN" to describe their research linking neuroendocrine and subcortical brain systems to affiliate and bonding behaviors (Insel & Fernald, 2004). In this context SCN was a newer term that appealed to social cognition and cognitive neuroscience researchers who did not identify themselves with the types of research SN had been used to describe previously. Similarly, the term "affective neuroscience" had been used most often by animal and clinical researchers studying the cortical and subcortical bases of so-called basic emotions and their role in affective disorders (Davidson, Jackson, & Kalin, 2000; Panksepp, 1998). Researchers interested in SCN also were interested in affect but construed more broadly the range of affect-related phenomena they wished to address. For SCN, this range included phenomena not typically of interest to affective neuroscientists such as attitudes, stereotyping, person perception, self-reflection, and decision making. An interest in such topics also differentiates SCN from CN, whose domain is typically conceived as the study of so-called basic mental abilities, such as memory and attention, that may be deployed in any number of social or nonsocial contexts. Thus, the term "SCN" appealed to researchers who (1) were interested in using cognitive neuroscience methods to study a wide array of socioemotional phenomena, (2) wanted to use this combined methodology to elucidate the information processing level of analysis, and (3) did not identify with the types of research questions and content areas previously associated with related fields, such as SN, AN, and CN.

That being said, the kinds of research to which a given term refers are somewhat fluid, and certainly evolve over time. For example, some researchers use the terms "SN" and "SCN" interchangeably, whereas others see them as distinct but interrelated. Perhaps the most useful way to think about this issue is in terms of a part–whole relationship. As originally intended, SN can be used broadly to describe many types of research that link social phenomena to their biological substrates described at any one of many levels of analysis, ranging from the cortical region to the neurotransmitter system. By contrast, SCN refers to an important subset of this larger domain, where researchers specifically integrate social cognitive and cognitive neuroscientific methods (see Figure 3.6, and the section "Mapping a Road Toward the Future").

This brings us to the second question facing an emerging field of research: What are its boundaries? Or in the case of SCN, what is *social* about SCN?[2] A partial answer to this question was provided by examining historical boundaries between disciplines that help define the relationship of SCN to its neighbors. For the rest of the answer one must understand that what is *social* about SCN is determined in large part by the proclivities of researchers who call themselves *social cognitive neuroscientists*.

Primarily two types of researchers have rallied around the SCN flag. Many are cognitive neuroscientists who bring with them numerous habits and assumptions about the way in which any type of phenomenon should be studied using neuroscience methodologies. As discussed later, this has led them to favor the use of memory, perception, and attention paradigms to study neural responses to visual perceptual stimuli that have social signal value (such as faces). For these researchers, what is *social* about SCN is that the purview of cognitive neuroscience has been broadened to include the processing of "basic" social stimuli.

The other main group drawn to SCN are social cognition researchers who also bring with them some important assumptions. In particular, they are interested in studying a much wider range of phenomena. Indeed, social psychology's purview includes the study of a wide variety of interpersonal phenomena, ranging from nonverbal perception to persuasion, as well as many intrapersonal phenomena, such as self-perception and self-regulation. For a social cognition researcher, what is *social* about SCN is that involves unpacking what is special about the way people—with all their motivations, goals, and contexts—process stimuli, and what happens when the stimuli are themselves social. As is discussed in the section, "Principles Governing the Practice of SCN," incorporates both of these perspectives in its core principles concerning the types of *contexts* and *content* with which the field is concerned.

Following the Parent's Lead: Taking One Step Down to Take Many Steps Forward

SCN is in the interesting position of viewing itself either as *social cognition* plus *neuroscience* methods or as *cognitive neuroscience* plus *social* content. However one views it, the new addition can be seen as broadening its scope, explanatory power, and conceptual breadth beyond that of its parent discipline. The addition of a new level of analysis to an existing area of research is old hat for social cognition and cognitive neuroscience, for similar transitions were responsible for the inception of each of these parent disciplines.

In the case of social psychology, a shift down one level of analysis from the social to the information-processing level marked the birth of social cognition. This shift has been credited as providing an answer to the, "crisis in social psychology" that happened in the late 1970s (Taylor, 1998). At that time social psychology lacked a unifying conceptual framework to describe the similarities and differences between different phenomena. Researchers working on seemingly similar topics came up with their own individualized lists of factors that predicted long lists of dependent variables. The information-processing language of cognitive psychology offered a way out: by appealing to concepts such as automatic and controlled processing, accessibility and spreading activation, selective attention, and schemas and scripts, social psychologists could start providing theoretical explanations that described the processes linking these lists together, which gave their theories greater coherence and staying power.

The case of cognitive neuroscience is quite parallel: Its birth was marked by a shift down one level of analysis from the information-processing level to the level of neural substrates. This move was prompted by a number of factors, not the least of which was a desire to use new methodologies to obtain new kinds of data that can help constrain information-processing models of cognitive phenomena (Ochsner & Kosslyn, 1999; Posner & DiGirolamo, 2000). As has been described in greater detail elsewhere, neuroscience has been used to provide converging evidence concerning the existence of multiple memory systems, the nature of mental representations underlying visual mental imagery, and the fractionation of attention into multiple interacting subsystems (e.g., Kosslyn, Ganis, & Thompson, 2001; Posner & Petersen, 1990; Schacter, 1997). For cognitive psychologists, the power of neuroscience methods is that patterns of brain activations or neuropsychological deficits can be used to draw inferences about the number and nature of underlying psychological mechanisms (Kosslyn, 1999; Ochsner & Lieberman, 2001).

By taking a step down, social psychology became social cognition,[3] and cognitive psychology became cognitive neuroscience. Thereafter, each field took many conceptual and empirical steps forward. SCN's emergence can be construed as either other a step down for social cognition or a step up for cognitive neuroscience. Either way, SCN is following in its parent's footsteps.

From Conception to Coherence: Milestones on the Road to Maturity

Once the term "SCN" began being used and gained currency in the research world, investigators scattered across numerous disciplines began to feel that they might share an identity. One of the key events in the crystallization of a singular identity for SCN was the first standalone meeting dedicated to the topic held in April 2001 at UCLA. This 2½-day meeting was organized not just by social psychologists and cognitive neuroscientists, but also by developmental psychologists, anthropologists, and political scientists. The meeting included attendees from all these disciplines and more, ranging from health psychology to behavioral neuroscience. The makeup of the organizers and attendees of this meeting is significant because it signaled that from the get-go, SCN offered a banner under which scientists interested in studying socioemotional phenomena at multiple levels of analysis could rally and find like-minded individuals whose work would be very relevant to their own.

In this regard, the role of developmental psychology in the growth of SCN is particularly important. Developmental psychologists had used the term "theory of mind" to describe the social and emotional deficits suffered by children with autism. Such children do not understand that other humans are agentic beings guided by internal mental states that describe goals, feelings, wants, and desires. Rather, they perceive other humans to be "sacks of flesh" that move unpredictably (Baron-Cohen, 1995). Psychologists studying autism had already been developing models of the disorder that cut across the social, information-processing, and neural levels of analysis. This multilevel approach was exemplified by the 1995 book *Mindblindness*, by Simon Baron-Cohen, which presented an empirical and theoretical account of autism that interpreted behavioral experiments in terms of hypothetical neural substrates. This book can be seen as one of the earliest examples of a social cognitive neuroscience analysis of a phenomenon, even though it predated the coalescence of the field. As described below, from the outset one of the strongest research programs within SCN concerned the neural bases of the social cognitive processes that support theory of mind and related abilities.

Since the UCLA conference, there have been numerous markers of growth in SCN research. Small private conferences dedicated solely to SCN work have been held at institutions such as Dartmouth, the University of Chicago, and Princeton. On the national level, starting in 2004 SCN preconferences were held prior to the annual meetings of the Society for Personality and Social Psychology and the Cognitive Neuroscience Society. The first jobs specifically advertising for positions with a focus on SCN were listed for Dartmouth in 2000 and Columbia in 2002. By 2006, postings for social psychology jobs with an SCN focus had become common. Undergraduate and graduate courses in SCN and related topics mushroomed, with growth in graduate programs offering training in SCN keeping pace. SCN's growth also has been apparent in the numerous special issues devoted to the topic that appeared in both psychology and neuroscience journals, including *Neuropsychologia*, *Journal of Personality and Social Psychology*, *Political Psychology*, *Journal of Cognitive Neuroscience*, *Neuroimage*, and *Cognitive Brain Research*.

But perhaps the most important developmental milestone for SCN has been the availability of funding from national agencies. In 1999 and 2000 the National Science Foundation (NSF) awarded Small Grants for Emerging Research (SGER, or "sugar" grants) to numerous researchers seeking to establish SCN research programs on numerous topics, ranging from stereotyping and person perception to self reflection and emotion regulation. These grants were awarded at the discretion of the director of behavioral science at NSF, Steven Breckler, who sought to provide seed money that would enable researchers to acquire pilot data for future grant applications. Then in 2001 the National Institute of Mental Health issued a Request for Applications (RFA) in social neuroscience, which provided the first opportunity for SCN researchers to apply for funding to a program specifically designed to meet the needs of interdisciplinary work linking social behavior to its neural bases. By 2005, other agencies, such as the National Institute on Drug Abuse and the National Institute on Aging, had issued similar RFAs.

The importance of funding for launching a new field cannot be underestimated. As an illustration of this point, consider the rapid growth of cognitive neuroscience in the early 1990s. Throughout the 1990s the private McDonnell-Pew Foundation provided substantial grants to researchers seeking to develop CN research programs, to train postdoctoral fellows, and to hold conferences. Other private foundations also provided money for small meetings that helped establish core groups of scientists whose work would exemplify the CN approach (M. S. Gazzaniga, personal communication). Although other factors played important roles, including a summer training institute at Dartmouth as well as an annual meeting and society, the availability of money, and the vote of confidence it implies, is essential for the development of any field. In this regard, SCN has been recognized as a distinct field by federal funding agencies. In the final section of this chapter, we revisit the topic of funding in the context of translational research that connects basic findings in SCN to clinical disorders characterized by socioemotional deficits.

PRINCIPLES GOVERNING THE PRACTICE OF SOCIAL COGNITIVE NEUROSCIENCE

In an American twist on the sentiments Ebbinghaus expressed earlier, Yale psychologist Neil Miller once quipped that "In most disciplines the scientists of today stand on the shoulders of the great scientists that have come before them. In Psychology, we step on their face" (S. Kosslyn, personal communication). The observation that psychologists don't just forget the past but actively may try to erase it may be an academic reflection of the market-driven mentality of Western culture. In the capitalist marketplace businesses compete for consumer dollars by marketing products as if no similar products ever had been offered before. Cars, cameras, and cookies are all the newest, most unique, and most satisfying. To the extent that product placements appeal to history, it is to emphasize that a particular product is the newest exemplar of a long line of products that always have been the most unique and most satisfying.

Miller is suggesting that psychologists are no different. Psychologists are essentially academic businesspeople hocking their theories and results in the marketplace of ideas. The consequence is that researchers often present their work in an historical vacuum that emphasizes their unique contributions at the expense of relating it to prior work.[4] Importantly, the tendency to ignore research peers is present not just at the level of the individual scientist but at the level of the scientific discipline as well. It is easy for researchers in either the traditionally "hard," biological and physical sciences or the traditionally "soft," social sciences, to believe that their cross-disciplinary colleagues can—and perhaps should—be ignored. Whether it is because their colleagues across the research fence are perceived to ask fundamentally different types of questions, to use fundamentally different kinds of methods, or to offer fundamentally uninteresting answers, it is clear that many biological and social scientists do not buy what their colleagues have to offer.

This all-too-human tendency to value one's kin, one's comrades, and one's research culture over those of others is as much a danger for SCN as it is for any discipline. The costs of such disciplinary myopia could be especially acute, however, for SCN. Because the field requires incorporation of the methods and theories of different disciplines, researchers who "go it alone" risk making conceptual and methodological mistakes both naive and serious. As illustrated in this section, whereas in *principle* SCN work prioritizes interdisciplinary collaboration, integrative methodology, and multilevel theory, in *practice* this does not always turn out to be the case. This section highlights core principles that govern the psychology–neuroscience partnership that lies at the heart of SCN by illustrating the partnership with examples of problems that may arise if it is not honored. These examples are then used to distill four core principles for SCN.

Specifying the Goals of SCN Research

There are two types of goals that motivate SCN research in particular, and more generally, any research seeking to link psychological and neural levels of analysis (Ochsner & Lieberman, 2001; Sarter, Berntson, & Cacioppo, 1996). The first goal is sometimes referred to as brain mapping, which means conducting experiments that link the involvement of specific brain regions to specific types of behavior and experience. The emphasis here is on drawing *functional inferences* about brain systems by carefully manipulating task demands and observing corresponded changes in the recruitment of brain regions. Research conducted in this mode is necessary to draw *functional inference* about the processes associated with specific brain systems. Drawing *functional inferences* has been the primary goal guiding CN and AN research, which has produced detailed models of the neural systems involved in both high- and low-level visual cognition, implicit and explicit memory, visual mental imagery, fear conditioning, and numerous other phenomena (see Gazzaniga, 1995, 2000, 2004, for reviews).

These models of brain function provide the foundation for work guided by the second goal of SCN research, which is to use information about brain function to draw inferences about the psychological processes underlying a particular phenomena. The emphasis here is on drawing *psychological inferences* about the processes underlying a given behavior or experience by using the activation of particular brain systems as markers for the occurrence of particular kinds of psychological processes. The strength of these *psychological inferences* depends on the reliability with which particular functions can be ascribed to particular brain systems. For example, in the case of some psychological processes that have received a great deal of empirical attention, such as the encoding and retrieval of explicit memories, the reliability of these inferences is fairly strong: One can be reasonably certain that, for example, activation of the hippocampus reflects recruitment of a process used to encode configurations of activated perceptual inputs and stored representations that together comprise an explicitly addressable memory for a life episode (Brewer, Zhao, Desmond, Glover, & Gabrieli, 1998; Davachi, Mitchell, & Wagner, 2003; Schacter, Alpert, Savage, Rauch, & Albert, 1996). By contrast, the neural bases of many emotional and social cognitive processes of particular interest to SCN have just begun to be investigated. This means that one must be careful when drawing psychological inferences based on patterns of brain activity whose association with specific brain regions has yet to be solidified.

The reciprocal interplay of these two goals in guiding research design and inference is illustrated in Figure 3.2. In a sense, every experiment is serving both of these goals by (1) providing additional information about psychological processes that elicit activation in particular regions of the brain and (2) requiring that we place these results in the context of previous research to draw inferences about the psychological processes that observed activations represent. Decades of neuropsychological and neurological study combined with 15–20 years of functional imaging research has provided a reasonable set of methodological tools and theoretical models for understanding the function of brain systems implicated in memory, attention, language, and other "classically cognitive" processes (Gazzaniga, 1995, 2000, 2004). Work on core self-referential, social cognitive, and emotional processes builds on this foundation.

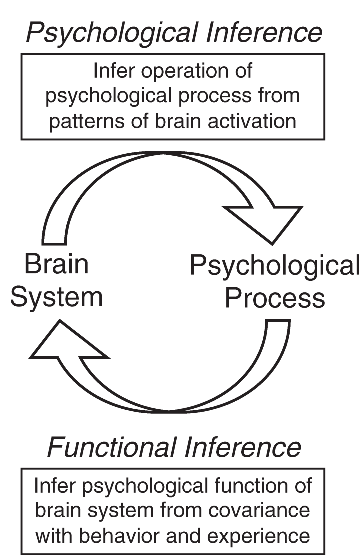

FIGURE 3.2. SCN seeks to draw two types of inferences concerning the relationship between psychological and brain processes. The first are functional inferences about patterns of experience and behavior to the operation of specific brain systems. The second are psychological inferences concerning the mental processes underlying a given experience behavior. In the case of functional imaging experiments, drawing these inferences depends on being able to reliably associate specific functions with specific brain systems based on prior research. For detail and explanation, see the section "Specifying the Goals of SCN Research."

In Practice, How Are These Goals Achieved?

Whichever goal guides a specific experiment, one must be careful that (1) the experiment is designed to maximize the potential for drawing the strongest inferences possible about either brain function, psychological processes, or both; (2) one appropriately interprets the meaning of one's results in the context of other studies. As is argued below, the probability that these two constraints are satisfied may vary as a function of whether one approaches SCN research as an extension of one's existing field (i.e., adding neuroscience data to social psychology or social phenomena to cognitive neuroscience) or whether one treats SCN as a true interdisciplinary partnership that draws on the theories and methods of both fields simultaneously.

Potential Pitfalls of Market Expansion

The former approach is analogous to market expansion in business: Just as a corporation might decide to expand from supplying automobile engines to making the entire automobile, social psychologists and cognitive neuroscientists might decide to expand their domain of inquiry to include the neural or social levels of analysis. As discussed in the first section of this chapter, the development of SCN can be described as involving exactly this type of market expansion on the part of SCN's parent disciplines. However, for this expansion to be successful, one must acquire the expertise necessary to succeed in the new market. An engine maker turned automobile manufacturer would surely fail if it did not incorporate principles of ergonomics when designing a car interior, principles of materials science when selecting the rubber for tires, and so on. In the context of SCN, a failure to acquire either the necessary neuroscience or social psychological expertise can result in experiments that either draw improper functional inferences, that lack an organizing meta-theory, or both.

THE FAULTS AND FOIBLES OF FUNCTIONAL INFERENCE

To illustrate one important danger of market expansion without acquiring proper expertise, consider the case of a social psychologist who wishes to use functional imaging to deepen her understanding of the way in which we make predictions about our emotional states. This kind of prediction is known as an *affective forecast*, and behavioral studies have suggested that there are numerous ways in which we overpredict the duration of our negative emotions and underestimate our ability to cope with adversity (Gilbert & Wilson, 2000). Let us imagine that this researcher would like to use functional magnetic resonance imaging (fMRI) to draw inferences about the psychological processes supporting affective forecasts about the near and far future. Her hypothesis is that judgments about the near future might evoke strong emotional responses whereas judgments about the far future might be made in a cold, abstract and propositional fashion (Eyal, Liberman, Trope, & Walther, 2004; Trope & Liberman, 2003). To test this hypothesis she records brain activity while participants make judgments about how they would feel about a hypothetical event (e.g., winning the lottery) if it took place in the near future (tomorrow) as compared to the far future (in a year). She knows that analysis of imaging data is similar to analysis of the behavioral data in that it involves contrasts of values on dependent measures in two conditions of interest. Thus, to identify brain regions more strongly associated with near forecasts, she subtracts activation on *far* trials from activation on *near* trials. To identify regions associated with far forecasts, she does the reverse, subtracting activation on *near* trials from activation on *far* trials. As illustrated in all four panels of Figure 3.3, the *near* > *far* contrast reveals greater activation in a region of medial prefrontal cortex (MPFC) identified by the crosshatched square.

What inference can she draw about the relationship of MPFC activation to her initial hypothesis? To address this question, she turns to the imaging literature on emotion and finds 48 different studies that show activation in MPFC when participants are perceiving, remembering, or experiencing emotion. As can be seen in Figure 3.3A–3.3D, the region identified in her *near* > *far* forecasts contrast lies in the middle of these emotion-related activations. She concludes that her initial hypothesis is supported—that near forecasts are more emotional than far forecasts—and proceeds to write up her results and sends them to a well-known cognitive neuroscience journal for publication.

What might her reviewers say about this paper? Imagine that the paper receives three reviews. Reviewer A is an affective neuroscience researcher whose work has suggested that emotion activates MPFC (see Figure 3.3A). Reviewer A therefore writes a positive review suggesting that this is an innovative application of imaging research to address social psychological questions. Reviewer B, however, does not write a positive review. Reviewer B is a cognitive neuroscience researcher who has found that self-referential judgments activate MPFC (see Figure 3.3B), and Reviewer B suggests that the experiment has failed to rule out an alternate hypothesis: when making *near* forecasts participants might be more likely to think about the personal implications of their choices (e.g., If I win the lottery, will I get greedy? Will it change me?). Reviewer B reasons that engagement of self-reflective judgments recruits MPFC and could be the reason the social psychologist observed MPFC activation in her experiment. Reviewer C also writes a negative review. Reviewer C is a cognitive neuroscience researcher who has found that theory-of-mind tasks activate MPFC (see Figure 3.3C), and C suggests that the experiment has failed to rule out another alternate hypothesis: When making *near* forecasts individuals are more likely to think about the thoughts, beliefs, and feelings of other people (e.g., If I

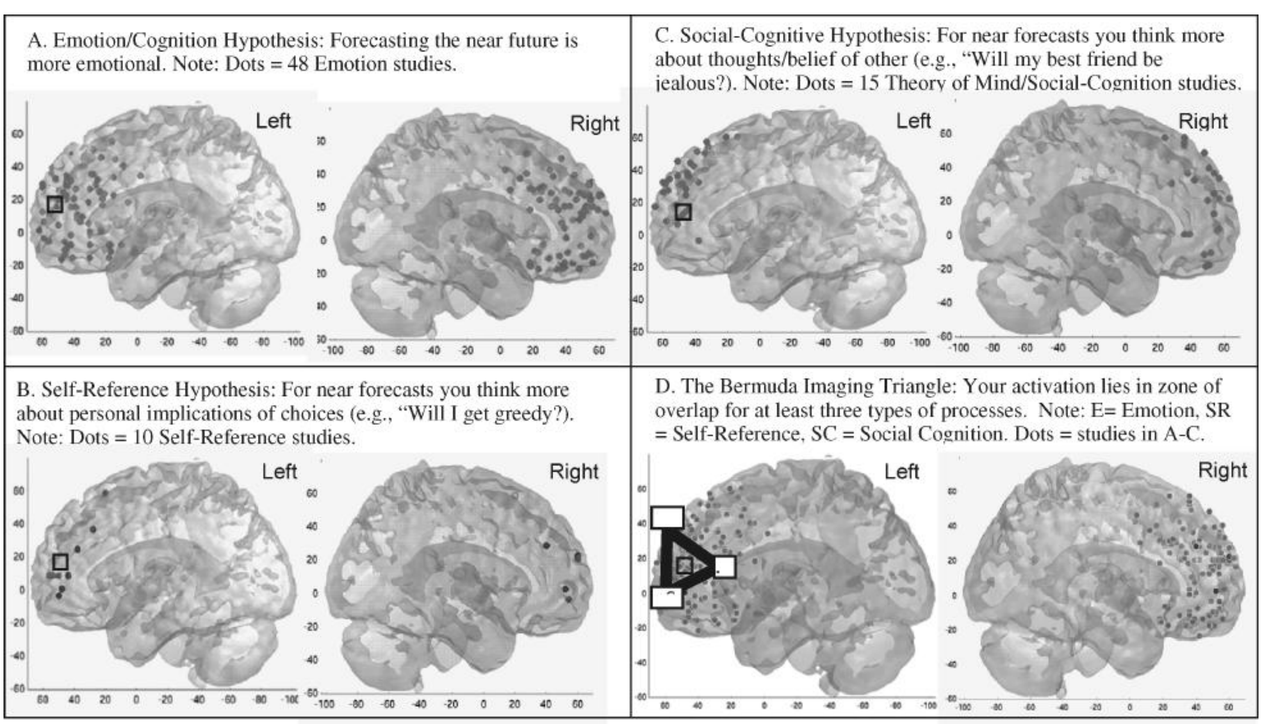

FIGURE 3.3. A diagrammatic illustration of the difficulty of inferring the operation of specific psychological processes given the one has observed activation in a specific brain region, such as medial prefrontal cortex (MPFC). Activation for a hypothetical affective forecasting task is illustrated by the crosshatched square superimposed over the left MPFC. Across panels A–C, MPFC activation is superimposed on images showing activation associated with emotion (A), self-referential judgments (B), and social cognitive attributions (C). For detail and explanation, see the section "The Faults and Foibles of Functional Inference" for details.

win the lottery, will my best friend be jealous? What will my wife think? Will my coworkers think I'm cool?). Reviewer C reasons that engagement of social-cognitive judgments recruit MPFC and could be the reason the social psychologist observed MPFC activation in her experiment.

At this point, the poor social psychologist might feel that she has been caught in what could be called the *Bermuda Imaging Triangle* (Figure 3.3D) from which her paper cannot escape. Because her focus of activation lies in a zone of overlap for studies that involve three (or more) putatively different types of psychological processes, it is difficult to draw post hoc inferences about what her pattern of activation means. As a consequence, the social psychologist could be perceived as naive by neuroscientists, her paper could be rejected, and she may feel confused and lose confidence that imaging can prove useful as a tool in her research program. An alternative, but in certain ways equally unfortunate, review outcome would be for her paper to receive only positive reviews from researchers that are favorable to her initial hypothesis (like Reviewer A). In this case, publication of her paper could be greeted by skepticism and disdain by neuroscience colleagues who study self-referential processing and social cognition who might perceive her as naive for thinking MPFC was only involved in emotion. Either way—in the review process or when the paper reaches the literature—evaluation of her work might suffer because she has not yet grasped the relevant neuroscience literature and thereby taken into account alternative explanations for the phenomenon question.

Given the multiple functions that could be associated with MPFC, what can the social psychologist infer about the meaning of MPFC activation in her study? And how can these inferences help her achieve a more positive publication result? At least three factors will determine the strength of her inferences. First and foremost, as is the case for all forms of psychological experiment, the design of her study is critical in determining what psychological inferences she can draw about the meaning of her observed brain activations. For example, she would be on firmer footing in making the claim that participants were more emotional for *near* than for *far* forecasts if her experiment had included a self-report or autonomic measure that indicated this was the case. In general, one must always include behavioral measures in experiments that index the psychological constructs in question. As described in the next section, many early imaging experiments on emotion failed to do this and as a consequence, are ambiguous with respect to why particular patterns of activation were observed.

Second, as highlighted by Figure 3.3, the extent to which converging evidence from other domains of research implicate clear functions for a given region will also constrain the inferences one might draw. In the case of MPFC, one might question whether the overlap of MPFC regions involved in emotion, self-reference, and theory of mind is more apparent than it is real. Cross-study comparisons of brain activation foci are clouded by various factors that could lead to apparently similar or dissimilar patterns of activation, including: individual differences in functional brain anatomy, differences in methodology and operationalization of psychological constructs, and the facts that different researchers spatially normalize and analyze their data in different ways. This makes it is difficult to say whether two studies with apparently similar locations of MPFC activation (or activation of any other brain region) truly are recruiting identical regions.

One way to address this question is by designing studies that include conditions that allow one to test alternative accounts of the processes underlying the phenomenon question. In the forecasting study, the social psychologist either could have included separate additional tasks that involve self-reference or theory of mind or could have included conditions in her forecasting task that vary the extent to which one is engaged in self-referential or theory-of-mind processing. If greater MPFC activation was found for judgments that elicit stronger emotion, are more self-referential, and involve judging others' mental states, then the social psychologist could infer that a computation common to all these judgments has been recruited. By contrast, if all three types of judgment recruited distinct regions of MPFC—and *near* forecasts are associated with just one of them—then the social psychologist could more clearly infer that one type of process was involved.

Third, leverage for drawing psychological inferences about patterns of brain activation can be gained by performing meta-analyses that identify patterns of association that are reliable across large numbers of studies. Meta-analyses for studies of emotion (Phan, Wager, Taylor, & Liberzon, 2002; Wager & Feldman Barrett, 2004; Wager, Phan, Liberzon, & Taylor, 2003) as well as various higher cognitive processes (e.g., working memory and attention switching (Wager, Jonides, & Reading, 2004; Wager & Smith, 2003) have begun to identify patterns of activation that can be associated reliably with specific types of stimuli (e.g., memories or images), emotional states (e.g., sadness vs. anger), and individual differences (e.g., gender). The promise of meta-analyses is that they may one day be able to provide probabilities that activations observed in any specific region reflect different types of psychological processes (T. Wager, personal communication, January 2005). MPFC, for example, may turn out to consist of multiple overlapping subregions and, depending on where one's observed activation falls, could be associated with self reflection with a high probability (0.7), emotion with a moderate probability (.4), and theory-of-mind attributions with a low probability (.1). Of course, meta-analyses are only as good as the studies they comprise, which should be designed to test specific hypotheses about the phenomenon in question. These hypotheses can be informed by prior results, by meta-analyses, or, as discussed in the following section, by metatheoretical perspectives that motivate experimental designs.

METATHEORETICAL MISSES, MISSTEPS, AND MISTAKES

The social psychologist of the preceding section was described as somewhat naive about neuroscience data and theory concerning MPFC function. More broadly, she could be described as being naive about the metatheoretical perspective that guides cognitive neuroscience research. A metatheory describes the relationship between dependent and independent variables at a level of abstraction removed from the particulars of a given phenomenon, and can be said to coherently describe core elements of theories within a field.

The metatheory guiding cognitive neuroscience research was first described by the late vision scientist David Marr (1982). Marr described three levels of analysis at which a given behavior or experience could be explained. At the highest *computational* level one provides a precise description of the phenomena to be explained. Marr termed this the "computational level" because it provides a description of the computational output to be produced by mechanisms described at lower levels of analysis. At the middle *algorithmic* level one provides a description of the information-processing mechanisms that give rise to the phenomena described at the computational level. At the lowest *implementation* level one provides a description of the neural hardware that instantiates information processing mechanisms described at the algorithmic level. Marr believed that these levels were independent, positing the functionalist view that any computation could be produced by numerous algorithms, each of which could be implemented in any type of hardware. Cognitive neuroscience, however, treats the levels as interdependent and interacting, because it recognizes that (1) not all algorithms can be implemented in all hardware (see example of mathematical operations permitted by Roman vs. Arabic numerals from Kosslyn & Maljkovic, 1990), and (2) although there may be numerous ways in which a given computational output could be produced by different algorithms, cognitive neuroscience is concerned with the ones that the human brain actually implements. The goal of cognitive neuroscience research is to construct a *theory of a functional architecture* that describes a phenomenon at these three levels of analysis (Ochsner & Kosslyn, 1999). This metatheoretical perspective finds expression in theories of memory, mental imagery, language, attention, motor control, and various other phenomena (for reviews, see Gazzaniga, 1995, 2000, 2004).

Our social psychologist's lesson in market expansion is that knowledge about the brain systems that could be involved in the processes under investigation is necessary at the outset. This would allow her to formulate a priori hypotheses about the brain regions that could be involved in affective forecasting, which would comprise the social psychologist's first-pass theory of the functional architecture underlying forecasts (Ochsner & Kosslyn, 1999). This theory should include a description of the specific kinds of forecasts under investigation, the psychological processes that are engaged for each type of forecast, and the hypothetical neural substrates for each type of psychological process. The psychological processes and neural systems could include those implicated in emotion as well as other types of processes, such as self-reflection or theory of mind. This theory then could be used to design appropriate control conditions for her experiment that could rule out alternative hypotheses about the mechanisms underlying forecasting. If these criteria are met, she will be in a much stronger position to infer that predicted patterns of brain activation (if observed) support her hypotheses about the processes underlying *near* as opposed to *far* affective forecasts.

Although our examples thus far have focused on what a social psychologist might not know about cognitive neuroscience research, it is no less important for cognitive neuroscientists interested in SCN to recognize their own potential for naiveté about the metatheory guiding social psychological experimentation. Indeed, because cognitive neuroscientists thus far comprise the largest number of scientists interested in SCN, it is perhaps more important that they become aware of the metatheoretical stance taken by many social psychologists. Although aspects of this metatheory have been described in many ways, a consensual account would include the interaction of two elements: (1) a person, with all of his or her dispositions, chronically accessible mental constructs, concerns, temperaments, moods, and so on; and (2) a situation, which may include other individuals and their thoughts and feelings, and various cues that set goals or are the triggers for specific behaviors, including prescriptions for socially normative behaviors, the desire to make a good impression, and so on. This *person × situation* interaction posits that a person's behavior at any given moment in time is a product of the interaction between who that person is and what behaviors are available, permissible, and possible in a given context (Ross & Nisbett, 1991). Critically, it implies that the meaning we ascribe to a stimulus is not inherent in the stimulus itself but, rather, is a flexible product of our interpretation or *construal* of its meaning according to our current goals, which in turn may be a function of the current context. Individuals often fail to realize that their judgments, impressions, emotions, memories, and experiences are the product of *construals*, which can explain the numerous self-serving and self-enhancing biases the people exhibit (Robins & Beer, 2001; Taylor, Kemeny, Reed, Bower, & Gruenewald, 2000). This view has been described as *naive realism*, a term that captures the implicit assumption that one's perceptions reflect a realistic picture of the world that accurately and directly conveys its true nature (Robinson, Keltner, Ward, & Ross, 1995; Ross & Ward, 1996). This metatheoretical perspective finds expression in theories of personality, attribution, self-awareness, stereotyping, impression formation, and various other phenomena (Higgins, 1997; Mendoza-Denton, Ayduk, Mischel, Shoda, & Testa, 2001; Mischel & Shoda, 1995; Mischel, Shoda, & Mendoza-Denton, 2002; Ross & Nisbett, 1991).

Lack of awareness of this metatheoretical perspective could lead a cognitive neuroscientist interested in SCN to miss the richness of socioemotional phenomena that is captured by the person × situation interaction. To illustrate this possibility, consider early cognitive neuroscience studies of emotion. Most of these studies examined either uninstructed perception, recognition/identification, or memory for stimuli with ostensible emotional value. The most commonly used stimuli were facial expressions of emotion, followed by photographs of real-world scenes that elicited different types of emotional responses, emotionally evocative film clips, emotion-laden autobiographical memories, and auditory (e.g., screams and music), tactile (e.g., feather or shock), olfactory (e.g., sour or sweet odors), or gustatory (e.g., chocolate) sensory stimuli that elicited pleasant or unpleasant feelings. Meta-analyses of these studies have revealed that emotion-related activations do not array themselves simply as a function of modality of input, type of task, or type of "basic" emotion involved (Feldman Barrett, Ochsner, & Gross, in press; Phan et al., 2002; Wager et al., 2003).

Why the inconsistent results? From the perspective of a social psychologist, these studies treated emotion as a stimulus property like shape, size, or color rather than a context-dependent *appraisal* process that interprets the emotional value the stimulus in the context of an individual's current goals, wants, and needs (Figure 3.4) (Ochsner & Feldman Barrett, 2001; Ochsner & Gross, 2004; Scherer, Schorr, & Johnstone, 2001). As a consequence, these studies fail to manipulate the way in which individuals construed, or *appraised*, the meaning of stimuli, which leaves participants free to appraise stimuli in numerous different ways. Classic studies in social psychology, including the seminal work of Schacter and Singer and Lazarus, have shown that how we cognitively appraise the meaning of an event may determine how we respond emotionally to it (Lazarus, 1991; Schachter & Singer, 1962), including the regulation of emotion via deliberate or spontaneous appraisal of emotional stimuli as neutral (Erber, 1996). In part, lack of control over appraisal seems to have been a holdover from animal models of emotion that were derived from studies employing stimuli with primary reinforcing properties, such as pleasant tastes or electric shocks. Some cognitive neuroscientists have suggested that human emotions are essentially responses to linked with differing degrees of complexity to reinforcers of this type (Rolls, 1999). While it is true that emotions are adaptive responses to situations of relevance to current goals, and that some may involve evolutionarily conserved responses to reinforcing stimuli, from a social psychological perspective human emotions may be elicited by both stimulus–response (S-R) and schematic mental representations; many involve experiential, behavioral, and autonomic components; and may involve various types of cognitive processing (for examples, see Scherer et al., 2001). The failure to appreciate this perspective also led to the failure of many studies to provide independent behavioral confirmation that emotional responses were, in fact, elicited. In the absence of independent behavioral verification that emotions were elicited—in the form of self-reports of experience, indices of autonomic arousal, or evidence of emotional behaviors such as facial expression—it is difficult to determine why or why not activation in a given brain structure has occurred.

The theory motivating most of these studies was that stimuli with emotional properties should activate classically "limbic," lower-order emotion-processing structures such as the amygdala but should not activate classically higher-order cognitive structures such as prefrontal cortex. Although some studies were consistent with this simple hypothesis (e.g., Buchel, Morris, Dolan, & Friston, 1998; Fredrikson et al., 1998; Irwin et al., 1996; LaBar, Gatenby, Gore, LeDoux, & Phelps, 1998; Lane et al., 1997; Morris, Ohman, & Dolan, 1999; Shin et al., 1997; Zald, Lee, Fluegel, & Pardo, 1998), numerous other studies were not. Some observed activation in prefrontal cortex but not the amygdala (e.g., Canli, Desmond, Zhao, Glover, & Gabrieli, 1998; Delgado, Nystrom, Fissell, Noll, & Fiez, 2000; Kesler-West et al., 2001; Mayberg et al., 1999; Phillips et al., 1998; Taylor et al., 1998), whereas others observed activation in both structures (e.g., Buchel, Dolan, Armony, & Friston, 1999; Crosson et al., 1999; Damasio et al., 2000; Phillips et al., 1997). From the emotion-as-stimulus-property perspective, these results were difficult to explain and seldom received specific commentary. By contrast, from the emotion-as-appraisal perspective, these results can be seen as the product of a relative reliance on top-down cognitive appraisal processes as compared to bottom-up stimulus-driven appraisal processes (see Figure 3.4 and Feldman Barrett

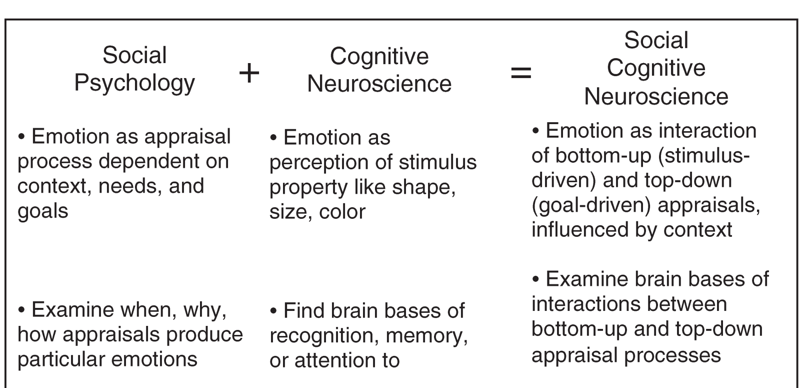

FIGURE 3.4. Diagram illustrating the differing approaches to explaining (middle row) and studying (bottom row) emotion for social psychology, cognitive neuroscience, and social cognitive science. For detail and explanation, see the section "Metatheoretical Misses, Missteps, and Mistakes."

et al., in press). The cognitive neuroscientist's lesson in market expansion is that the activations observed in different brain structures is not just a function of stimulus content but also a function of context and construal as well. As described earlier, current SCN experiments are investigating the conditions in which specific types of top-down or bottom-up appraisals lead to different types of emotional responses (see also Figure 3.4).

The Metatheory of SCN: Four Core Principles

The metatheory of SCN can be described as a combination of the metatheories guiding cognitive neuroscience and social psychology. SCN aims to describe behavior at three levels of analysis (see Figure 3.1 and Ochsner & Lieberman, 2001). The first is described as the *social* level, which includes a description of the phenomena of interest in terms of the experience and behavior of a person in a given context, as she perceives and interacts with a social target. Importantly, that target could be the someone else, or it could be the perceiver herself, as she reflects on her own traits, states, and goals and attempts to understand and make use of them. The second is the *cognitive* level, which includes a description—in information-processing terms—of the psychological processes that give rise to the experience or behavior of interest. The use of the term "cognitive" here is a holdover from the parent disciplines of social cognition and cognitive neuroscience and is not meant to imply a specific type of processing mechanism that is *cognitive* as opposed to something else. Instead, "cognitive" is a placeholder term for the notion that various types of processes and representations comprise the functional mechanisms that give rise to social level phenomena. Whether we call those mechanisms *cognitive* or *affective* or *motivational* may differ depending on the social level phenomena we are trying to explain, The third is the *neural* level, which includes a description of the neural systems implicated in the psychological processes hypothesized to underlie the social level phenomenon. SCN research uncovers relationships between variables described at these three levels of analysis by conducting studies that provide information about the psychological processes associated with specific brain systems, or uses information about brain systems to inform theories of the psychological processes engaged in social behavior (see Figure 3.2).

At its core, this metatheoretical perspective rests on four principles (see Figure 3.5).

- *Converging evidence:* Data from multiple levels of analysis provides constraints on theory
- *Content:* Processing of and by people is special
- *Construal:* All stimuli are multiply construable
- *Context:* Individual (internal) and situational (external) factors influence how specific types of content are construed

FIGURE 3.5. A list of four principles that form the core of social cognitive neuroscience's meta theory. For detail and explanation, see section "The Metatheory of SCN: Four Core Principles."

Constraints and Convergence

The first principle is that multileveled theories of behavior must be constrained by data collected using multiple methods with variables described at the three levels of interest. The combination of multiple streams of data allows researchers to converge on theoretical explanations that are robust and flexible and are not tied to a single specific experimental methodology. This principle is part of the bedrock of cognitive neuroscience research (Ochsner & Kosslyn, 1999), which employs multiple types of neuroscience methods, including not just functional neuroimaging (which is the emphasis in this chapter) but analysis of behavioral deficits in neuropsychological populations, electrophysiology, and many other related techniques (for reviews, see Kosslyn, 1999). In an analogous fashion, this principle also is part of the bedrock of social psychological research that employs multiple types of behavioral methods to study phenomena of interest. These methods range from self-report to various *measures* of behavior that indirectly indicate operation of a particular psychological process (response times, recall or other memory measures, etc.) to psychophysiological methods indexing sympathetic and parasympathetic arousal, and more (for reviews, see Cacioppo, Tassinary, & Berntson, 2000; Gilbert, Fiske, & Lindzey, 1998). SCN incorporates all these methods (Cacioppo, Berntson, Taylor, & Schacter, 2002).

Content

The second principle is that SCN is concerned with special kinds of content, at all levels of analysis. At the social level the field is concerned with social content, which includes stimulus cues involved in interactions with people. These cues include nonverbal perceptual inputs such as faces, facial expressions, eyes, bodies, and biological motion but also include higher-level inputs such as spoken language, nonverbal behaviors, and other forms of social communication including the beliefs and attitudes expressed by others. As noted earlier, the person with whom we interact is in some cases ourself, as our own behaviors, beliefs, and feelings become the focus of self-awareness, perception, and judgment. At the cognitive level the information-processing mechanisms engaged when processing social cues may be tailored to processing social information. The mental representations supporting perception of social cues, and the processes engaged when making judgments about them, may be different than those involved in processing nonsocial stimuli such as inanimate objects. Furthermore, the processes engaged typically are *hot*, which means that they involve processes that interpret the *emotional significance* of social cues, that *motivate* us to perceive or judge ourselves and others in particular ways, and that *affectively* color our experience while doing so. Most every judgment—social or otherwise—carries with it an evaluative core (Osgood, 1976), which places motivational processes at the core of SCN. At the neural level, there may be specific systems supporting the representations and processes engaged when processing socioemotional contents. A significant portion of current SCN work aims to understand whether the processes and neural systems engaged when processing social stimuli are similar to or different than those engaged when processing nonsocial stimuli (e.g., Mitchell, Heatherton, & Macrae, 2002; Mitchell, Macrae, & Banaji, 2004).

Construal

The third principle is that the meaning of any stimulus is a function of the way in which its meaning is construed. In other words, the impact of a stimulus is determined both by the bottom-up, stimulus-driven processing of its intrinsic perceptual properties (e.g., a pleasant or unpleasant smell or the depiction of a disgusting scene) as well as top-down, goal-driven processing that can control the way in which stimulus meaning is extracted (Feldman Barrett et al., in press). As described previously, the power of construal to determine the meaning of a stimulus is one of the bedrock elements of social psychology's metatheoretical perspective (Ross & Nisbett, 1991).

Context

The fourth principle derives from the fact that any given stimulus can be construed in many different ways, which has been termed "the multiple construal problem." Two kinds of context help determine the way in which perceivers solve the multiple construal problem by interpreting, for example, a stimulus person as a lawyer rather than a black man, or a comment as a joke rather than an insult. The first is an individual's *internal* context, which consists of his or her biological temperament, preexisting beliefs, attitudes, chronically accessible schemas, goals, memories, and biases (Kosslyn et al., 2002). The second is an individual's *external* context, which consists of various aspects of their current situational milieu. The external context can include situational cues that specify specific behavioral goals (e.g., to make a good impression or to determine if someone is deceiving you) and place constraints on normatively acceptable behavior (e.g., not cutting in line at the supermarket or not making lewd comments to a woman in a bar), by activating specific mental representations that comprise an individual's internal context (see Higgins, Chapter 19, this volume) for a detailed discussion of how person and situation factors influence activation of different types of knowledge, and in turn, construals).

A Metaperspective on SCN's Metatheory: Specificity versus Universality

If SCN's metatheory describes the kinds of theoretical accounts the field aims to develop, how specific should these theories be? Traditionally, a primary goal of much physical behavioral and biological science has been the derivation of species-general, universal laws that govern behavior irrespective of context, content, and construal. The search for such universal laws of behavior may represent an attempt to mimic the physical sciences, which aim to formulate "fundamental" laws of matter and energy that are widely applicable. The laws that govern behavioral and biological science may be fundamentally different, however (Kagan, 1998). Over the course of evolutionary time, natural selection exerts the greatest pressure for an organism to retain a heterogeneous set of mechanisms supporting behaviors appropriate for specific survival contexts that in turn depend on specific biological adaptations. The key is that behavioral and biological science fundamentally is about understanding the mechanisms that govern an interaction between an organism's biological endowment and its ecological environment (i.e., its *situation*). In keeping with this notion, SCN places relatively less emphasis on abstract universal principles and relatively greater emphasis on discovering contextually sensitive laws that govern human behavior. These laws specify underlying mechanisms at multiple levels of analysis. For example, following social cognitive models of dual processing, we might specify how and when automatic and controlled processes come into play as a function of situational factors such as motivational involvement and information-processing capacity, and following cognitive neuroscience models of control, we might specify the prefrontal dynamics underlying these processes.

THE FUTURE PROMISE OF SOCIAL COGNITIVE NEUROSCIENCE

This chapter began by drawing an analogy between personal and professional relationships on one hand and the nature of SCN on the other hand. From the personal perspective, social psychology and cognitive neuroscience can be seen as parent disciplines whose progeny has grown into an independent discipline. From the professional perspective, social psychology and cognitive neuroscience can be seen as business partners who need each other's expertise in order to expand their research market.

Which metaphor is correct? The answer is that metaphors are not mutually exclusive. Each one highlights different aspects of SCN that are important for understanding its development and its practice. Indeed, understanding the nature of any field presents its own multiple construal problem. In the case of SCN, the field can be construed as the offspring of successful parents with venerable research bloodlines, as an entrepreneurial startup with research potential, or a bit of both. The choice of construal may depend on the question one asks. If one wants to understand SCN's historical antecedents, the personal metaphor may be most useful. If one wants to understand what social psychologists and cognitive neuroscientists need to know about what the other discipline has to offer, the partnership perspective may be most useful.

Whichever metaphor guides one's construal of SCN, the question arises as to what the future may hold for the ongoing development of the field. Its rapid growth and the proliferation of conferences, publications, and funding opportunities suggests that SCN is not merely a flash in the pan. That being said, it is important to consider what questions currently are central to SCN research and how current research may translate into promising directions for future work.

Predicting the Future: Three Examples from Current Research

An old aphorism states that past behavior is the best predictor of future behavior. This suggests that a good way of predicting what the future may hold for SCN is to consider the state of its current understanding of a few key questions. In this section, we illustrate the SCN approach with examples of current research that highlight the difference between approaching topics from an integrative SCN perspective as opposed to approaching them from a social psychological or cognitive neuroscience perspective alone.

Person Perception

"Person perception" is an umbrella term referring to the various ways in which we first perceive social cues, judge social targets, and subsequently form impressions of social actors. SCN research on person perception has followed two major threads. The first has been heavily influenced by the cognitive neuroscience emphasis on bottom-up, stimulus-driven processing of perceptual cues. Research following this thread has examined the neural systems responsive to face as compared to nonface objects, facial expressions of various kinds, facial features such as the direction of eye gaze, bodies as compared to other objects, and biological as compared to nonbiological motion (Allison et al., 2000; Puce & Perrett, 2003). Much of this work is concerned with the question of whether or not social cues enjoy privileged status in the brain. For example, one hotly contested debate asks whether faces possess unique features and are processed by a dedicated cortical module (the fusiform face area, or FFA) or whether faces are one example of a stimulus for which we have gained great expertise and are processed by cortical regions tuned to support recognition of any stimulus for which we are recognition experts (Gauthier, Curran, Curby, & Collins, 2003; Gauthier & Tarr, 1997; Gauthier et al., 2000; Grill-Spector, Knouf, & Kanwisher, 2004; Kanwisher, McDermott, & Chun, 1997; Kanwisher, Stanley, & Harris, 1999; Yovel & Kanwisher, 2004). It is noteworthy that traditional social psychological approaches to person perception take it for granted that social cues are recognized accurately and concern themselves with subsequent stages of judgment and impression formation. By contrast, SCN models unpack this initial step into a suite of neural systems dedicated for processing different types of social cues. In so doing, SCN models deepen the understanding of person perception offered by social psychological models that are concerned less with the question of how nonverbal cues are recognized.

The second thread in SCN research on person perception concerns the way in which we infer or understand the intentions of other individuals. This research thread also has been heavily influenced by the cognitive neuroscience emphasis on stimulus-driven processing as exemplified by research on "mirror neurons" (Rizzolatti & Craighero, 2004), Mirror neurons were first described in primate studies of motor control. Some prefrontal cortical neurons would fire when a monkey would execute a hand motion and also would fire when a monkey would observe a different actor's hand executing the same action. Subsequent studies suggested that these neurons were sensitive to the goal of an action and not just its superficial gestural characteristics (Rizzolatti & Craighero, 2004). Human neuroimaging research picked up this thread by demonstrating common regions of primary motor, left inferior prefrontal, and parietal cortex that seem to be similarly responsive to the perception and execution of a motor action (Buccino, Lui, et al., 2004; Buccino, Vogt, et al., 2004; Decety, Chaminade, Grezes, & Meltzoff, 2002; Hari et al., 1998; Iacoboni et al., 1999; Ruby & Decety, 2001). Other studies have suggested that common neural systems may be involved when individuals perceive and pose facial expressions of emotion (Carr, Iacoboni, Dubeau, Mazziotta, & Lenzi, 2003) or both personally experience and watch others experiencing pain or disgust (Calder, Keane, Manes, Antoun, & Young, 2000; Jackson, Meltzoff, & Decety, 2005; Morrison, Lloyd, di Pellegrino, & Roberts, 2004; Singer et al., 2004; Wicker et al., 2003). These findings have led some to propose that "shared representations" underlying the perception and execution/experience of an action form the foundation of our ability to understand others' mental states (Gallese, Keysers, & Rizzolatti, 2004; Meltzoff & Decety, 2003). Thus, shared representations presumably provide an automatic internal simulation of what it would be like for the perceiver to perform an observed action and this simulation, or perception–action "resonance" enables the perceiver to understand what someone is doing and why.

There are three significant problems with this account. The first is that, to date, the activation of motor mirror neurons has never been shown to predict the ability to understand actions—whether social or nonsocial—of another individual in either a laboratory or a real-world context. Studies involving the experience and perception of pain have shown that common regions of activation covary with individual differences in empathic ability, but they have not yet demonstrated that the tendency to coactivate a given region in both perceptual and experiential contexts predicts the ability to accurately judge what another person is feeling or thinking. If the mirror neuron account was correct, such evidence should be found. The second problem is that the shared representations that have been identified to date are informationally sparse and are unlikely to support the inferences necessary to understand another person's intentions. Both developmental and social psychological models of intentional inference suggest that individuals draw on both semantic and episodic memories to help guide judgments about what a given individual is thinking or feeling in a given context, as well as higher-order capacities for reasoning and judgment. The shared motor and affect representations identified therefore are unlikely to contain this information. They might support vicarious learning about the causes and consequences of particular actions, but they likely do not support understanding that a person is trying to deceive us, that he or she might have incorrect beliefs about what we believe, and so on. The third, and perhaps most significant, problem is that mirror neurons/shared representations theories of person perception really are not theories at all. They are descriptions of data and provide neither precise social-level descriptions of the full range of phenomena to be explained nor information-processing descriptions of the steps necessary to achieve specific kinds of interpersonal understanding. By contrast, social psychological models of person perception provide both kinds of descriptions, which enables them to explain the situational and motivational factors that determine when and how we are likely to imitate others (Chartrand & Bargh, 1999; van Baaren, Horgan, Chartrand, & Dijkmans, 2004; van Baaren, Maddux, Chartrand, de Bouter, & van Knippenberg, 2003) and more generally what determines whether we are accurate or inaccurate empathizers (Hodges & Wegner, 1997; Ickes, 1997) or social judges (Gilbert, 1998; Krueger, 2003). Our errors of person perception are particularly revealing because they lay bare the egocentric biases, heuristics, and implicit theories that guide our judgments of others (Epley, Savitsky, & Gilovich, 2002; Saxe, 2005; Wilson & Brekke, 1994). Mirror neuron accounts of social cognition do not speak to these errors.

Current SCN work is moving beyond simple shared-representation models of person perception toward linking the systems used to encode perceptual cues to those important for the high-level processes and memory representations used to draw social inferences (Gallagher & Frith, 2003; Lieberman, Gaunt, Gilbert, & Trope, 2002; Mason, Banfield, & Macrae, 2004; Ochsner et al., 2005) and is just beginning to understand how these representations may bias the person perception process (Mitchell, Macrae, & Banaji, 2005). Two of the strengths of this work are its strong foundation in developmental psychological models of intentional inference and its breakdown in autism (Frith, 2001; Frith & Frith, 2003; Saxe et al., 2004) and its potential to help fractionate the person perception process into component parts by identifying different common and distinct patterns of brain activation associated with different types of judgment (Kosslyn, 1999; Ochsner & Lieberman, 2001). Thus, imaging experiments may be able to identify systems involved in the dynamic interplay of bottom-up and top-down processes during person perception, as well as systems involved in biased as compared to accurate judgments.

Self-Perception

Another major theme of current SCN research concerns the neural correlates of self-perception. As was the case for research on person perception, work on self-perception has transitioned from being strongly influenced by the CN emphasis on perception and recognition to a broader emphasis influenced by social psychological models of self-knowledge.

An initial attempt to organize neuroscience research on self-perception suggested that right-hemisphere advantages for various self-related tasks supports the theory that the right hemisphere plays a special role in self-recognition (Keenan, Nelson, O'Connor, & Pascual-Leone, 2001). These tasks included recognizing photographs of the self as compared to others (Keenan, Freund, Hamilton, Ganis, & Pascual-Leone, 2000; Keenan et al., 1999), retrieving autobiographical memories (Tulving, Kapur, Craik, Moscovitch, & Houle, 1994), and maintaining a coherent map of the body and its location in space, which is commonly disrupted by right parietal lesions that produce deficits of body and spatial awareness (Ramachandran, 1995). The major problem with this view is that it lacks a coherent theory or metatheory to explain what it is that links all these behaviors together. In what sense is viewing a photograph of one's self as compared to a stranger a core social cognitive process that is critical for social functioning? In what sense does this have anything to do with perceiving one's personality attributes and one's qualities? How does retrieving an autobiographical memory or being unaware that one has a neuropsychological deficit involve processes similar to or different than those involved in recognizing yourself in a photo? What criteria determine whether a task does or does not involve these processes? These questions have not been addressed by this account.

A second line of research on self-perception has used functional imaging to study the neural correlates of the self-reference effect in memory (Symons & Johnson, 1997), which refers to an advantage in memory for trait words (e.g., friendly) encoded by judging how well each trait describes oneself as compared to encoding them by judging some other semantic or nonsemantic attribute (e.g., number of syllables). Linking words to the complex organizational structure of self-knowledge is thought to enhance memory to levels difficult to match without some other sufficiently organized and elaborate method of study (Symons & Johnson, 1997). Initial neuroimaging studies of this effect suggested a special role for MPFC in judging the relevance of trait words to the self as compared to judging their relevance to famous but not personally known individuals, such as President George W. Bush (Craik et al., 1999; Fossati et al., 2003; Kelley et al., 2002; Macrae, Moran, Heatherton, Banfield, & Kelley, 2004). Subsequent studies have suggested that MPFC activation may be elicited by various other kinds of self-referential judgments as well, including assessing one's emotional state (Ochsner, Knierim, et al., 2004), preferences (Zysset, Huber, Ferstl, & von Cramon, 2002; Zysset, Huber, Samson, Ferstl, & von Cramon, 2003), abilities (Johnson et al., 2002), and attitudes (Cunningham & Johnson, 2007). Furthermore, some studies have suggested that similar regions of MPFC are involved in judging one's own feelings or attributes and the feelings and attributes of others (Ochsner et al., 2005; Ochsner, Knierim, et al., 2004; Schmitz, Kawahara-Baccus, & Johnson, 2004). These findings suggest that the process of reflecting on what others think about us is very similar to the process of thinking about ourselves directly, which bears on theories of the origin and nature of self-knowledge.

The fact that MPFC has been implicated in various types of self-perception, as well as mental state attribution more generally, is striking for least two reasons. The first is that it suggests that seemingly disparate social phenomena may share common underlying information processing and neural mechanisms. These data could not have been obtained using behavioral studies alone. This is important because social psychologists typically study some of these phenomena—such as attitudes and judgments of personality—independently from one another. The fact that they may share common neural mechanisms sheds light on their potential similarities in terms of common psychological processes that depend on those brain systems. The second reason was highlighted earlier, in the section "Principles Governing the Practice of SCN," which considered the difficulty of drawing specific inferences about the nature of these neural mechanisms given the fact that MPFC has been implicated in multiple different behaviors. An important direction for future research will be performing within-study comparisons contrasting different types of self-referential judgment as well as different types of judgments about the mental state of others. The goal is to determine the functional organization of MPFC, which could help clarify the similarities and dissimilarities on the different types of judgment associated with MPFC activation.

In this regard, it may be important to distinguish theoretically between different senses of self (cf. Gillihan & Farah, 2005), a topic that has been the focus of much social psychological research (Baumeister, 1998). One distinction that might be useful contrasts the first-person sense of ownership over one's actions and perceptions and the third-person sense of being the object of one's introspection. William James referred to these two senses of self as the *I* and the *Me* (James, 1890). The experience of the *I* is immediate and direct and accompanies both the stream of conscious sense of experiencing one's perceptions as well as the agentic sense of controlling one's behaviors. The experience of the *me* is metacognitive and indirect and accompanies the sense of reflecting on one's attributes, abilities, states, and body. It has been hypothesized that ventral portions of MPFC may be more strongly associated with the *I*, whereas dorsal portions of MPFC may be more strongly associated with the *me* (Ochsner & Gross, 2005). It remains for future work to test this hypothesis (for other potentially useful distinctions related to types of self-knowledge, see also (Higgins, 1996b; Lieberman, Jarcho, & Satpute, 2004).

Self-Control

The ability to control the content of one's thoughts, the nature of one's feelings, and the expression of one's actions is commonly referred to as self-regulation. In contrast to topics such as person perception and self-perception, this topic has seen perhaps the greatest amount of independent research from each of SCN's parent disciplines. Within CN, self-regulation first was studied under the rubric of executive function, which referred to a variety of abilities impaired by frontal lobe function, such as planning and problem solving, that were measured by neuropsychological task batteries. Global concepts of a central executive generated by this work have given way to focused models of specific forms of cognitive control, including working memory, selective attention, and response selection, all of which can be measured by sensitive speeded response-time tasks. Within self-perception, "self-regulation" has been an umbrella term referring to any number of different instances in which an individual needs to curb an impulse (e.g., to diet), alter an emotion or mood, or salve a blow to one's self-esteem or social relationships.

The key is that within both disciplines, the need to inhibit or transform prepotent responses has been a major focus of research. The long history of self-regulation research in both CN and self-perception has provided a firm foundation for interdisciplinary bridges to be built in the form of collaborative SCN research. This research has taken the form of using CN models of cognitive control and emotion to help elucidate the dynamics underlying various forms of control over person perception, affect, and emotion, traditionally of interest to social psychologists (Ochsner, in press; Ochsner & Gross, 2005).

For example, a number of studies have manipulated the level of attention paid to briefly presented faces that express emotion or are exemplars of racial ingroups or outgroups. These studies have tested the hypotheses that (1) emotionally relevant social stimuli should activate the amygdala, and (2) following the logic of behavioral experiments these responses could be considered automatic to the extent that they do not vary as a function of attention (Öhman, Flykt, & Lundqvist, 2000). In general, results have been mixed. Some studies have found results consistent with these hypotheses (Anderson, Christoff, Panitz, De Rosa, & Gabrieli, 2003; Öhman, 2002; Vuilleumier et al., 2002; Vuilleumier, Armony, Driver, & Dolan, 2001), whereas others have found that amygdala responses diminish as a function of attentional load (Pessoa, Kastner, & Ungerleider, 2002; Pessoa, McKenna, Gutierrez, & Ungerleider, 2002) or exposure (Hart et al., 2000).

Although there may be numerous reasons for these discrepant results, one possibility is salient in light of earlier discussion. Much CN research on emotion has treated it as a stimulus property, has lacked a metatheoretical perspective, and as a consequence has failed to measure or manipulate the way in which participants appraise the meaning of stimuli with affective relevance. Thus, it is possible that qualitatively different processes—including those involved in cognitive control—become engaged when participants devote their full attention to the encoding of emotionally evocative stimuli as compared to when few attentional resources are available.

This possibility is supported by research suggesting that when attentional resources are available and directed toward individuating (Wheeler & Fiske, 2005) or thinking verbally (Hariri, Bookheimer, & Mazziotta, 2000; Hariri, Mattay, Tessitore, Fera, & Weinberger, 2003; Lieberman, Hariri, Jarcho, Eisenberger, & Bookheimer, 2005) about socioemotional stimuli, that amygdala responses may be reduced. In part, this may be due to heightened awareness of ambivalent feelings about target stimuli possible, which participants regulate by engaging control processes. Thus, faces that can be perceived as expressing either surprise or fear activate the amygdala when judged to express fear and ventral MPFC when judged to express surprise (Kim, Somerville, Johnstone, Alexander, & Whalen, 2003). Similarly, attitude targets that elicit both positive and negative evaluations—such as abortion or a black face for a white participant who professes no explicit prejudice but exhibits prejudice one implicit tasks—tend to activate dorsal anterior cingulate and right lateral prefrontal regions implicated in cognitive control (Amodio, Harmon-Jones, & Devine, 2003; Cunningham, Raye, & Johnson, 2004). It remains for future research, however, to identify the specific patterns of social cognitive appraisal that lead stimuli to be perceived in neutral as compared to affectively arousing terms.

Studies examining the use of cognition to regulate the experience of emotion have identified at least two different types of *re*appraisal that engage prefrontal and cingulate control systems to downregulate emotional appraisal systems such as the amygdala. One strategy involves becoming psychologically distant and detached while observing an emotionally charged photo or film, which has been shown in behavioral experiments to be effective for downregulating negative emotion (Gross, 1998). Imaging studies have shown that this strategy engages prefrontal systems to regulate activation of appraisal systems related to sadness (Levesque et al., 2003, 2004), sexual arousal (Beauregard, Levesque, & Bourgouin, 2001), or negative emotion more generally (Ochsner, Ray, et al., 2004; Phan et al., 2005). A second strategy involves "looking on the bright side," or, "finding the silver lining," in an aversive event by reframing its meaning in terms that neutralize or even positivize its emotional punch (Lazarus & Alfert, 1964). For example, one could imagine that a sick man depicted in a photograph has a hearty constitution, feels little pain, and soon will be well. This strategy also activates prefrontal and cingulate control systems to downregulate amygdala responses to aversive images (Ochsner, Bunge, Gross, & Gabrieli, 2002; Ochsner, Ray, et al., 2004).

The specific locations of control and appraisal-related activations have varied considerably across studies, however, and it will be necessary for future research to provide within-study comparisons of strategy and stimulus type to determine how and why specific kinds of regulation are associated with specific neural dynamics. One study has directly compared the *self-focused* and *situation-focused* strategies described earlier, and found that they differentially depend on medial and lateral prefrontal cortex, respectively (Ochsner, Ray, et al., 2004).

It also will be essential that future work examine the numerous other forms of self-regulation typically studied by social psychologists, which range from the control of eating to the recovery of self-esteem after a failure or rejection (Ayduk, Mischel, & Downey, 2002; Heatherton, Polivy, Herman, & Baumeister, 1993; Steele, Spencer, & Lynch, 1993). Such work could help determine whether regulatory responses to social threat depend on psychological and neural processes similar to or different than those used to regulate responses to physical threats, such as pain (Eisenberger & Lieberman, 2004), or responses to any emotion-eliciting discrepancy between desired and actual outcomes (Higgins, 1996a, 1999). The goal here is to identify and understand the dynamics of core systems important for control on the one hand and emotional appraisal on the other. As discussed below, such models could have important implications for the development and dysfunction of social and emotional abilities (Ochsner & Gross, 2005).

Mapping the Road Toward the Future

All forms of research are journeys of discovery. With any luck, the journey follows a road that does not endlessly wind back on itself but moves forward toward its ultimate goal. In the case of SCN, that goal involves building multilevel models of socioemotional phenomena. Thus far, this chapter has been concerned with building normative models that describe the behavior of physically and psychologically healthy adults. But this is only a first step. Once a normative adult model has been established, it can and should be extended in numerous directions. As considered in this section, models can be applied toward understanding new domains of research and can be extended to additional levels of analysis.

When contemplating any journey it is often useful to have a map. To guide our discussion of new directions for future SCN research, Figure 3.6 maps the relationships between SCN and a number of allied disciplines, all of which are concerned with understanding the relationships between psychological processes, neural systems, and/or clinical outcomes. Construing the term "social neuroscience" broadly to refer to any research that links social-level variables to biological variables (Cacioppo, 2002; Cacioppo et al., 2002), this map charts the relationships among various disciplines within *social neuroscience*. The point of this map is to help visualize points of potential connection between SCN and other disciplines that could be the focus of collaborative work.

New Domains of Research

SCN is more of an interdisciplinary approach to asking and answering questions about (both intra- and interpersonal) social phenomena than it is a field with crisply defined topical boundaries. Understood this way, the SCN approach could be used to profitably address questions of interest to a number of closely related sister disciplines, some of which are depicted in the lower left of Figure 3.6.

For example, affective neuroscience, which as described earlier has been concerned with mapping the brain correlates of a basic set of emotional responses, potentially could benefit from SCN's emphasis on construal and context. For SCN, emotional experiences are many

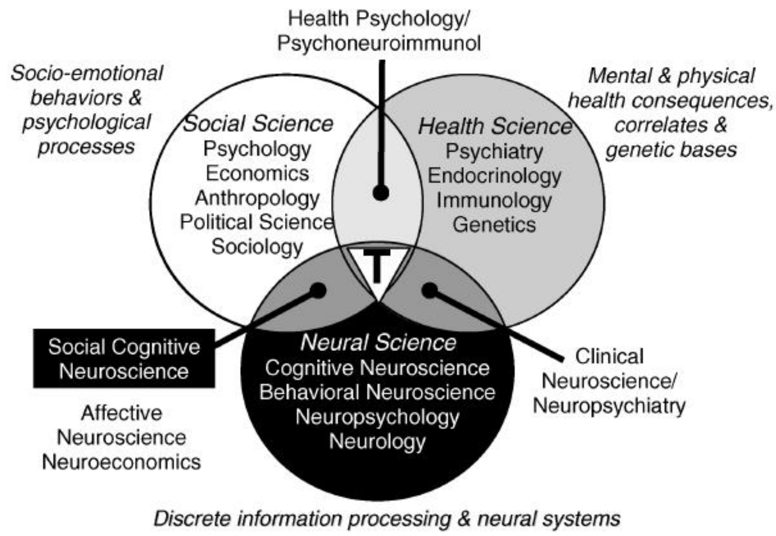

FIGURE 3.6. Diagrammatic map of the relationship between SCN and allied disciplines. The three large circles represent traditional disciplines in the social sciences, health sciences, and neural sciences. The concerns typically associated with each of these three major disciplinary categories are listed in the periphery. Interdisciplinary fields such as social cognitive neuroscience lie at the intersection of traditional disciplinary boundaries. Research that incorporates aspects of all three disciplinary categories would lie in the center of the figure, which is represented by the "translational triangle" designated with a capital *T*. Such *translational research* uses models of socioemotional behavior derived from basic science research with normative populations to address questions about the mechanisms underlying maladaptive mental and physical health outcomes. The map is intended to visualize the potential points of connection between SCN and other disciplines that could be the focus of collaborative work. For detail and explanation, see the section "Mapping the Road Toward the Future."

and varied and the product of cognitive construals or appraisals that may depend on a variety of neural systems. An important avenue for future research could be unpacking the ways in which different external situational and internal (states, goals, dispositions, etc.) contexts determine what type of emotional responses are generated (Feldman Barrett et al., in press; Ochsner & Feldman Barrett, 2001).

In like fashion, an SCN approach could benefit neuroscience research that recently has begun to emphasize the study of personality and individual differences (Hamann & Canli, 2004; Kosslyn et al., 2002). Although this research is explicitly focused on understanding the way in which internal contexts impact psychological and neural processes, it may benefit from SCN's additional emphasis on the way in which experience and learning impact the construal process as well. For example, apparent gender differences in neural responses to emotional stimuli could arise from ways in which cultural learning shapes the way men and women construe the meaning of emotional experiences (Wager & Ochsner, in press). These differences in construal may, of course, have neural correlates, but their origin may be attributable to the tuning of neural circuits via culture rather than innately specified genetic, endocrine, or other biological factors.

An SCN approach also could be used to help understand the development of and change in various social and emotional abilities across the lifespan. Cognitive neuroscience research has identified different developmental trajectories for systems related to cognition and emotion such that emotional appraisal systems such as the amygdala reach adult size earlier in life than do prefrontal control systems, which undergo a rapid growth spurt between the ages of 8 and 12 and continue to structurally develop into one's late 20s (Diamond, 2002; Giedd, 2004; Luna & Sweeney, 2001; Luna et al., 2001). This differential sensitivity to aging continues into older adulthood, as age-related degeneration of the amygdala (and other structures related to emotion, like orbitofrontal cortex) is slow compared to degeneration observed in lateral prefrontal and cingulate systems related to cognitive control (DeCarli et al., 1994; Raz, Gunning-Dixon, Head, Dupuis, & Acker, 1998; Salat, Kaye, & Janowsky, 2001). Behavioral data suggest that working memory and attentional capacities wax and wane with the growth and degeneration of prefrontal and cingulate control systems (Grady, 2002; Klingberg, Forssberg, & Westerberg, 2002; Milham et al., 2002; Reuter-Lorenz et al., 2000; Thomas et al., 1999), but it is not yet known if social and emotional functions wax and wane with structural changes in a similar fashion. The implications of developmental trends for person perception, self-perception, and emotional self-regulatory abilities could be an important topic for future SCN research—as would the potential impact of cultural learning history and life-stage transitions on the development of these abilities as well (Higgins & Eccles-Parsons, 1983).

The emerging field of neuroeconomics might similarly benefit from an SCN approach. Neuroeconomics is concerned with understanding the neural correlates of social exchanges, decisions, judgments, and predictions that have varying degrees of utility, or value, to a person. SCN could be instrumental in unpacking the concept of utility in terms of both the neural systems associated with subjective utility and systems associated with computing the objective value of a commodity. SCN models of self-perception and self-regulation could also inform the way in which decision makers regulate their affective responses to choice options and decision outcomes. For example, depending on whether one anticipates a positive or negative choice outcome (e.g., winning a bet), cognitive control processes could generate either anticipatory eagerness or regret. Depending on which outcome is actually experienced, control processes could help regulate disappointment, sadness, regret, or other negative emotions (Larsen, McGraw, Mellers, & Cacioppo, 2004). As described earlier, current SCN research is examining the neural systems implicated in emotion regulation, and the findings of these studies could be relevant here. Various studies of judgment and decision making activate prefrontal systems such as those used for emotion regulation (e.g., Bechara, Tranel, & Damasio, 2000; Rogers et al., 2004; Sanfey, Rilling, Aronson, Nystrom, & Cohen, 2003), but the relationship between the two is not yet clear. The key is that SCN incorporates social psychology's emphasis on context and construal and provides a direct link to a large body of social psychological research examining the way in which these factors influence judgment and choice.

Finally, an SCN approach also could inform other hybrid disciplines whose emergence may be on the horizon. For example, a recent special issue of the journal *Political Psychology* was devoted to describing the possibility that *political neuroscience* research could use neuroscience methods to study phenomena typically of interest to political scientists. An SCN approach to this endeavor could help specify the ways in which content, context, and construal are related to the neural systems underlying political attitudes, political decision making, and related phenomena (Lieberman, Schreiber, & Ochsner, 2003).

Translational Research

As normative SCN models of person perception, self-perception, self-regulation, and other abilities are solidified, they can be extended to help explain how their underlying mechanisms contribute to the maintenance of mental and physical well-being. Such *translational research* seeks to apply the methods and findings of basic science research to understanding the causes and consequences of both psychological and physical ailments. Translational SCN research would connect research located in the lower left of Figure 3.6 with traditionally biomedical and psychiatric research located in the upper right of Figure 3.6, thus occupying the intersection of the three primary domains of research depicted in this figure. This intersection zone is represented by the "translational triangle" in the center of the figure, designated with a capital *T*.

A prime candidate for translational SCN work might be unpacking the functional consequences of structural and functional abnormalities in emotional appraisal and cognitive control systems that have been identified in virtually every major mood, anxiety, and thought disorder, including depression, anxiety, posttraumatic stress disorder, obsessive–compulsive disorder, and schizophrenia (Bremner, Vythilingam, Vermetten, Vaccarino, & Charney, 2004; Davidson, Pizzagalli, Nitschke, & Putnam, 2002; Heckers et al., 2004; Mayberg, 2003; Quintana, Wong, Ortiz-Portillo, Marder, & Mazziotta, 2004; Rauch, Savage, Alpert, Fischman, & Jenike, 1997; Tillfors et al., 2001). Despite the fact that many of the distressing symptoms accompanying these disorders are often social or emotional in nature, the majority of extant functional studies have measured brain activity while participants are either "at rest," in the scanner or performing a cognitive task. A clear avenue for future SCN research will be to translate its basic models of normative functioning to clarifying why and how clinical populations are anhedonic, asocial, highly anxious, or depressed or experience other forms of affective and social dysregulation.

Equally important will be translating SCN models of self-perception and self-regulation into an understanding of how they relate to physical health outcomes. Health psychological research has identified relationships between social variables—such as the experience of shame or loneliness or the size of one's social support network—to the occurrence of common colds, cardiovascular disease, and level of immune functioning more generally (Bandura, 2004; Cacioppo et al., 1998; Dickerson & Kemeny, 2004; Kemeny, 2003; Kiecolt-Glaser, Cacioppo, Malarkey, & Glaser, 1992; Taylor et al., 2000; Uchino, Cacioppo, Malarkey, Glaser, & Kiecolt-Glaser, 1995). Current models of these effects either connect social level descriptions of interpersonal and regulatory behavior to other social-level descriptions of physical symptoms or bridge many levels of analysis between high-level descriptions of social variables and very low-level descriptions of molecular markers. These models do not yet make clear, however, how social, cognitive, and neural-level variables interrelate to produce adaptive or maladaptive health outcomes. SCN can play an invaluable role in filling in the missing levels of analysis, linking social variables to psychological processes, psychological processes to neural systems, and neural systems to transmitters, hormones, and endocrine systems.

Learning the Language

This chapter began with an everyday real-world scenario—waiting in the supermarket checkout line—that provides a glimpse into the metaphors by which we live. As the tabloid headlines reveal, human endeavors are easily described and understood in terms of personal or professional relationships. Much of this chapter used these two metaphors as the starting point for describing the historical development of SCN and the core principles that govern its experimental practice.

The supermarket checkout line reveals another important facet of human psychology, however, namely, the importance of communicating in a common language. Take a moment to think about the supermarket checkout line. In doing so, the reader may have spontaneously generated visual mental images of the scene. It is quite likely that the magazine headlines viewed in the mind's eye were printed in one's native tongue. Now imagine instead that the magazine covers are printed in an unknown foreign language. In this case, although one may be able to glean from the glossy cover photos that the stories inside are about people, the essential meaning of the stories is lost.

For an interdisciplinary field such as SCN, the importance of communicating in a common language cannot be underestimated. As described earlier in this chapter, there is always a danger that researchers in one domain will not be interested in the research products of their colleagues in another domain. This disinterest stems in no small part from an inability to understand cross-disciplinary jargon. Social psychologists may not understand the language of cortical and subcortical systems or fMRI scanners, and neuroscientists may not understand the language of attitudes, attribution, and person × situation interactions. Luckily for SCN, most newcomers to this field already have in common the cognitive, information-processing component of SCN's multilevel research language. Language pitched at this level provides descriptions of the psychological processes that link social phenomena and neural systems. This language, with some variation, includes terminology and concepts such as automatic and controlled processing, storage and retrieval, and selective attention that are part of social psychology and cognitive neuroscience as well as behavioral economics, psychiatry, and related disciplines.

A simple analogy can be used to illustrate the importance of the information-processing metaphor for understanding the mechanisms of socioemotional behaviors and unlocking the functions of neural systems. In the early 1800s, scholars in many nations were working to understand the meaning of Egyptian hieroglyphics. Their work focused on a stone slab discovered in the town of Rashid (*Rosetta*) in 1799 by Napoleon's invading army. Known as the *Rosetta Stone*, this slab contained a text written in three different languages. As depicted in the left panel of Figure 3.7, the top of the stone was written in hieroglyphics, a 3,000-year-old pictographic language. The middle and bottom portions were written in Demiotic and Greek, which were the languages of literate Egyptians (of the time) and the government, respectively. In 1822, French scholar Jean-Francois Champollion deduced that repeating combinations of characters in each of the three texts referred to the royal name Ptolemy, and from there, he was able to link Greek and Demiotic characters spelling the name to their hieroglyphics counterparts (Andrews, 1985).

The problem of translating hieroglyphics into Greek is not unlike the problem of translating the language of neuroscience into social psychological terminology—or vice versa. For the decoders of the Rosetta Stone, Demiotic, the everyday language of literate Egyptians, was the link between modern Greek and ancient Hieroglyphics. For social cognitive neuroscientists, the everyday language of information processing is the link between neuroscience and social psychology, as illustrated by the right panel of Figure 3.7.

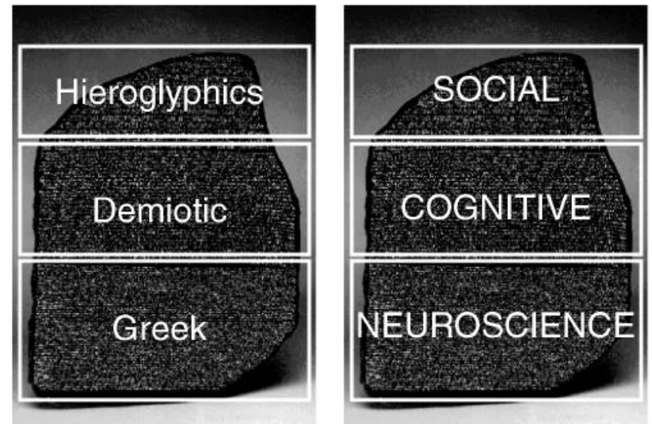

FIGURE 3.7. The ancient Egyptian *Rosetta Stone* provides an analogy for understanding how one can learn to translate between the differing languages used by social, cognitive, and neuroscience researchers. The original Stone contained the same text written in three different languages: hieroglyphics, Demiotic, and Greek. The relationship between Greek and Egyptian hieroglyphics was decided when it was realized that Demiotic characters spelling the name of a Pharaoh could be linked to their Greek and hieroglyphic counterparts. For social cognitive neuroscientists, the everyday language of information processing, originally derived from cognitive psychology, may provide a similar means for translating between neuroscience and social psychology.

Closing Comment: The Value of SCN

In the long run, SCN will succeed only if social psychologists and cognitive neuroscientists alike perceive the value of its approach. Toward that end, it will be important to recognize that SCN can be more than a simple addition of neuroscience data to social psychology or a new focus on social phenomena for cognitive neuroscience. SCN asks questions and aims to construct theories similar to, but importantly different than, those formulated by either of its parent disciplines. In comparison to social psychology, SCN offers the opportunity of constraining psychological theorizing through the use of neuroscience data that can use patterns of brain data to identify common and distinct processing systems underlying various behaviors. In comparison to cognitive neuroscience, SCN offers the opportunity to understand how contexts impact the way in which socioemotional contents are construed, thereby providing invaluable data about the functions associated with specific brain systems. For its practitioners, SCN can be an emergent discipline greater than the sum of its parental investment.

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NOTES

1. During this time period paradigms for studying various forms of learning were developed, and theories to describe the nature of the learning process were advanced, that did not make reference to mental states. Ironically, these paradigms are used today to study fear, reward, and their underlying mental processes.
2. It is notable that, historically, there also has been debate concerning what is "social" about social cognition. Some have defined the term as we define it here in the context of SCN, but importantly distinguish it from the social psychology of cognition, which is quite different. For discussion, see Higgins (2000).
3. It also could be argued that cognitive psychology to a "step up," to become social cognition (Higgins, 2000).
4. As has been noted in many circles, this may be attributable to an academic system that places emphasis on distinguishing the contribution of independent individuals, rather than teams or groups, in order for individuals to be granted tenure.

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