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Theory and method at the intersection of anthropology and cultural neuroscience

Rebecca Seligman,[1] and Ryan A. Brown[2]

[1]Department of Anthropology and [2]School of Education and Social Policy and Institute for Policy Research, Northwestern University, 1810 Hinman Avenue, Evanston, IL 60208, USA

Anthropologists have become increasingly interested in embodiment—that is, the ways that socio-cultural factors influence the form, behavior and subjective experience of human bodies. At the same time, social cognitive neuroscience has begun to reveal the mechanisms of embodiment by investigating the neural underpinnings and consequences of social experience. Despite this overlap, the two fields have barely engaged one another. We suggest three interconnected domains of inquiry in which the intersection of neuroscience and anthropology can productively inform our understanding of the relationship between human brains and their socio-cultural contexts. These are: the social construction of emotion, cultural psychiatry, and the embodiment of ritual. We build on both current research findings in cultural neuroscience and ethnographic data on cultural differences in thought and behavior, to generate novel, ecologically informed hypotheses for future study. In addition, we lay out a specific suggestion for operationalizing insights from anthropology in the context of cultural neuroscience research. Specifically, we advocate the development of field studies that use portable measurement technologies to connect individual patterns of biological response with socio-cultural processes. We illustrate the potential of such an approach with data from a study of psychophysiology and religious devotion in Northeastern Brazil.

Keywords: brain; ethnography; emotion; ritual; cultural psychiatry

INTRODUCTION

The field of cultural neuroscience, though in its infancy, represents a major step forward in neurobiological research for a number of reasons. Like the field of social cognitive neuroscience from which it has emerged, it represents a step beyond reductionist and universalizing trends in neurobiology, which often seeks to identify the neural substrates of cognitive processes in a kind of ecological vacuum (Henningsen and Kirmayer, 2000). By taking seriously the 'motivationally charged stream of everyday life', social cognitive neuroscience challenges the tendency to investigate cognition in a way that excludes the very social contextual factors which cognition was likely evolved to manage (Ochsner and Lieberman, 2001). A natural outgrowth of the imperative to study the social ecology of cognition, cultural neuroscience represents a challenge to the assumption that cognitive processes, because they are pan-human capacities, necessarily look the same in every context, and employ the same neurophysiological mechanisms (Chiao and Ambady, 2007; Han and Northoff, 2008). Rather, this field has the potential to explore the way that sociocultural systems structure not only the developmental experiences of individuals, but also the content and process of experience, thought, and behavior in everyday life in ways that have a recognizable trace at the neural level.

This volume is a testament to the fact that a number of scholars working in the field of neuroscience have taken seriously the role of culture in shaping cognitive and neural differences. As the field historically most centrally concerned with the study of culture, anthropology is positioned to make important contributions to the project of investigating culture in the brain, and the brain in culture. In particular, anthropology can contribute a nuanced, dynamic understanding of how culture shapes social environments, and how it contributes to the structure and function of individual minds.

In this article, we discuss in depth the mutual contributions that anthropology and cultural neuroscience can make to one another. We begin by describing common interests and complementary tools. We then suggest three interconnected domains of inquiry in which the intersection of neuroscience and anthropology can inform our understanding of the relationship between human brains and their socio-cultural contexts. These are: the social construction of emotion, cultural psychiatry and ritual and embodiment. In each of these domains, we describe current research findings from cultural neuroscience and anthropology, and use these as the basis for the generation of novel, ecologically

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Correspondence should be addressed to Rebecca Seligman, Department of Anthropology, Northwestern University, 1810 Hinman Avenue, Evanston, IL 60208, USA. E-mail: r-seligman@northwestern.edu

informed hypotheses and studies. We close with an additional suggestion for operationalizing insights from these domains of anthropological inquiry in the context of cultural neuroscience research. Specifically, we suggest that the methodological repertoire of cultural neuroscience be expanded to include field studies that use portable measurement technologies to connect individual patterns of biological response with socio-cultural processes. We illustrate the potential of such an approach with data from a study of psychophysiology and religious devotion in Northeastern Brazil.

ANTHROPOLOGY AND CULTURAL NEUROSCIENCE: COMMON GROUND AND COMPLEMENTARY TOOLS

In recent years, cultural anthropologists have become increasingly interested in embodiment, or the ways in which socio-cultural factors influence the form, behavior and subjective experience of human bodies. For example, a number of cultural anthropologists have theorized about the profound impact of meaning on bodily experience, from the influence of metaphor on the experience and expression of illness (Kirmayer, 1992; Jenkins and Valiente, 1994; Low, 1994) to the impact of socialization on everything from posture to taste (Bourdieu, 1977, 1990; Strathern, 1996; Kontos, 2006). However, for a variety of reasons, discussions of embodiment in the field of cultural anthropology mostly lack an adequate account of the biological or cognitive (i.e. memory, attention) mechanisms through which symbolic and social processes shape bodily functioning and experience (R. Seligman, submitted for publication).

Biological anthropologists, on the other hand, have used increasingly sophisticated tools, including methods from endocrinology (Worthman and Stallings, 1997; Flinn and England 1998), psychoneuroimmunology (McDade *et al.*, 2000, 2007) and psychophysiology (Dressler, 2000; Gravlee and Dressler, 2005; Decaro and Worthman, 2008) to study the effects of environments on human physiology. However, physiological measures are often used as static outcomes of social forces, rather than as indicators of how physiological systems function dynamically within the flow of social experience. In addition, biological anthropologists have generally not studied cultural embodiment at the level of central nervous system functioning or closely related parameters (Electroencephalography (EEG), Event-related brain potentials (ERP), etc.), despite the fact that a number of anthropologists have advocated, and even engaged in speculative work, along these lines (Lex, 1979; Turner, 1983).

Cultural neuroscience may well help fill the gap between these two lines of research. Developments in neuroscience offer important new tools for thinking about the mechanisms of embodiment. Over the last several decades, neurobiological research has demonstrated that the environment—including the socio-cultural environment—contributes fundamentally to the structure and function of the nervous system through experience-dependent effects both before and after maturation (Changeux, 1985; Ochsner and Lieberman, 2001; LeDoux, 2002; Blakemore and Choudhury 2006; Lieberman, 2007). Such research has demonstrated that the social/cultural construction of the brain includes effects at both high- and low-levels of cognitive function (Han and Northoff, 2008). For instance, a recent study of attention demonstrated that fewer neural resources were recruited in the service of attention to a culturally salient task, compared with a task that did not resonate with cultural emphases (Kitayama *et al.*, 2003). In another recent study, Chiao *et al.* found that even highly automatic responses, such as activation of the amygdala in response to facial expressions of fear, seem to be modulated by embodied representations of one's 'in-group' (Chiao and Ambady, 2007). Other studies seem to indicate that high- and low-level cognitive processes may be shaped by the same socio-cultural influences. For instance, self-style, or whether the self is understood as more independent or interdependent, can affect perception, according to a recent study. More specifically, cognitive priming for independent self-construal was associated with perception of specific visual targets apart from their context and a larger ERP component in response to a local perception task, while interdependent self-construal was associated with the tendency toward more global visual perception and a larger ERP component in response to global targets (Lin *et al.*, 2007). Hence, key culturally determined aspects of social orientation may penetrate basic cognitive processes, like visual perception. Anthropologists can contribute to such research using ethnographic data derived from intensive study in field settings, through which they learn about a culture from an insider perspective. Such data can be used in the development of new hypotheses and study designs that push beyond identification of the neural substrates associated with isolated cognitive tasks, and better capture the contingent and socially embedded nature of human cognition.

Anthropologists also have access to cross-cultural knowledge and a relativist epistemology that can help expose subtle cultural biases that may exist in current experimental designs. For example, current research in cultural neuroscience highlights the importance of taking a comparative approach to investigating the neural substrates of cognition. As important as this comparative perspective is, however, it also has certain pitfalls. For instance, the prevailing experimental paradigm, which involves having members of two different cultural groups perform the same cognitive task, needs a more explicit recognition of the fact that the same task may have different meaning for different groups, and may therefore tap very different cognitive processes. The possibility that activation of different neural mechanisms might actually represent entirely different, and even unrelated responses to the same task, has not been adequately

considered. In other words, as with most experimental designs, the task is assumed to be neutral, while outcomes are expected to vary.

But anthropological research suggests that just as items on standardized psychological inventories have to be evaluated to assure that they mean the same thing to members of different cultural groups (have 'conceptual validity') and that their effect is the same among people in different social contexts (have 'technical validity'), experimental manipulations should also be subject to checks for conceptual and technical validity (Canino *et al.*, 1997). For example, in a study on stress and emotional reactivity among Mexican immigrants in the United States, we have found that 'social stress' or 'trauma' in direct translation seem to mean less to Mexican origin individuals than assessing such factors in the context of experientially rich event–symptom clusters (Coronado *et al.*, 2004), such as *susto* (single traumatic event linked with fright) or *coraje* (prolonged aggravating stressors linked with rage). Thus, the typical laboratory stressor known as the Trier Social Stress Test, which contains a math task and public speaking task that likely have much higher salience among more highly educated adults, is unlikely to have conceptual or technical validity among this Mexican immigrant population (MacArthur Network, 2000). In response to these issues, the authors are currently designing a protocol in which narratives concerning *susto* and *coraje* experiences are elicited, and then these personally salient situations are re-experienced by participants through script-guided imagery (Duncan *et al.*, 2007; Baker *et al.*, 1984) during psychophsyiological measurement.

Cultural neuroscientists might also consider using different stimuli or tasks for different groups, based on ethnographically derived expectations about group differences in cultural content. Such an approach would allow researchers to map the range of stimuli that have certain kinds of effects for individuals from different social contexts. Many group comparisons using the typical experimental design would also benefit from the incorporation of data about subjective experience, gathered through the use of culturally validated self-report inventories and/or open-ended self-report prompts (Hurlburt and Heavey, 2001; Lutz *et al.*, 2002).

Cultural neuroscience has thus far been primarily concerned with the project of documenting culture-based differences in the functional neural mapping of cognitive and emotional processes. However, as Ochsner and Lieberman (2001) have argued, the ultimate goal of socio-culturally informed neuroscience research should be to move beyond mapping, to the investigation of complex human behaviors and experiences. Knowledge about the functional neural map should be applied to research investigating elements of human experience that exemplify the complex interactions among mind, brain and environment. Research into the neural substrates of culturally unique patterns of experience, behavior or forms of knowledge—like trance and meditation, for example, can help us to better understand the cognitive affective processes they employ (i.e. narrowed attention, perceptual distortion, self-deception, memory suppression, etc.) as well as the cognitive and affective transformations they facilitate [cf. Lutz *et al.*'s recent (2008) study of compassion meditation]. Such research can also shed light on the nature of more widely shared elements of lived human experience and the cognitive-affective and neural correlates of those phenomena as well. For instance, application of neuroscience methods to the study of religiosity or spirituality can help us to better understand the powerful embodied effects of religious belief (Bernston *et al.*, 2008; Kapogiannis *et al.* 2009).

In the following section, we describe in-depth three interconnected domains of inquiry in which the intersection of neuroscience and anthropology can productively inform our understanding of the relationship between human brains and their socio-cultural contexts.

SOCIOCULTURAL CONSTRUCTION OF EMOTION

Culture helps to entrain and regulate emotion at the same time that emotion provides the mechanisms by which socio-cultural systems constitute and reproduce themselves. We provide several examples of how culture and emotion are intimately interwoven, focusing on ways in which these points of intersection could generate new research projects or directions in cultural neuroscience.

Perhaps the most heavily cited evidence for cultural variation in emotion is the existence of emotion terms that appear to be culturally specific. For example, in Japan, *amae* refers to the desire to be socially dependent on others (Markus and Kitayama, 1991), and among the Ifaluk in Micronesia, the emotion word *fago* refers to a loving, wistful, empathetic form of compassion (Lutz, 1982; Nuckolls, 1998). Neither emotion word appears to have a direct English analog.

Cultural neuroscience has the opportunity to capitalize on existing ethnographic work on emotion, by employing a complementary experimental approach. In its simplest form, such an approach would work with local participants (in Japan, Micronesia or elsewhere) to develop a set of stimuli that most reliably trigger the subjective state of *amae*, *fago* or other apparently culturally specific emotion terms. Functional neuroimaging could help determine if such stimuli have a unique neural signature (i.e. distinct or overlapping with basic emotions, attachment, etc.), and cross-group comparison could determine whether this neural signature was somehow either accentuated or showed unique attributes for individuals from cultural environments in which *amae* (or *fago*, etc.) was a recognized category of emotion.

Ideally, such a research project would work with anthropologists and local participants to build a set of stimuli that properly represents the emotional referent at hand.

Anthropologists have developed tools to ascertain both agreement (Weller, 2007) and diversity (Hruschka *et al.*, 2008) in cultural models. Such tools could be applied to assess the degree to which certain emotion terms are indeed broadly representative (or not) of subjective experiences in the local population.

Emotions, of course, are not just automatic responses to certain types of stimuli, but are subject to meta-awareness and appraisal (Ochsner and Gross 2005), which lead to processes of regulation (e.g. accentuation or suppression of associated facial expressions, behaviors and subjective states). These appraisal and regulatory processes seem to rely especially on the prefrontal, orbitofrontal and anterior cingulate cortices (Ochsner and Gross 2005), and have recognizable effects on peripheral nervous system activity (Ohira *et al.*, 2006).

In addition to these sites of neural control, appraisal and emotion regulation also have sites of social control. The drive to engage in such regulatory processes hinges on both direct social sanctions and the individual embodiment of social messages about how 'bad' or 'good' it is to experience or express certain emotions. For example, Harkness and Super (2006) show how cross-cultural variation in parenting strategies inculcates different patterns of emotional regulation in children (e.g. the emphasis on quietness and self-regulation in Dutch society). Similarly, Tsai (2007) shows how East Asian cultural environments instill the sense that feeling calm is an ideal emotional state, while the cultural environment of child rearing in the United States valorizes states of high arousal.

The pressure to inhibit or display affective states and associated behaviors is structured by common social forces such as gender and social status (Keltner *et al.*, 2003). Anthropological research is particularly useful for identifying the cultural scripts, social sanctions and socialization practices that inculcate an embodied sense of certain emotional states as 'proper' or 'ideal'. Detailed ethnographic observations also suggest causal mediators in the relationship between culture and affect. For example, Fry (1992) documented how differential child socialization and community differences in social reinforcement for aggressive displays were associated with strikingly different levels of violence in two neighboring Zapotec communities. Cultural neuroscience could make use of these putative causal mediators, moving beyond inter-group comparisons to examine the relationship between socialization experiences and patterns of neural response to stimuli.

Thus, due to intensive data collection and local knowledge, anthropological research often identifies sub-national—i.e. differing aggression patterns in neighboring Zapotec communities—or sub-regional—i.e. different parenting theories regarding the socialization of emotion in neighboring European countries—variation in emotion and related outcomes. Such local comparisons could be of use to cultural neuroscience, especially as two neighboring communities are likely to share historical, ecological, genetic and other factors that would otherwise confound comparisons across groups vastly separated in geographic space. Such local comparisons could well help to lay bare how culture and socialization work to affect important outcomes, since 'non-cultural' (particularly exogenous ecological) confounders are more likely to be held constant in such cases.

CULTURAL PSYCHIATRY

Evidence from anthropology and cross-cultural psychiatry tells us that diagnostic categories and symptoms of psychiatric disorders are culturally variable, underscoring the importance of environment in shaping the experience and expression of emotions and emotional distress (Kleinman, 1988; Shweder, 1991; Kirmayer and Sartorious 2007). Differences in preferences and social sanctions around affective states contribute to such variations (Kirmayer, 1989). Hence, although mental pathology may be instantiated in the brain, understanding the determinants and consequences of such pathology requires knowledge of the interpersonal interactions, social meanings and individual motivations associated with disordered thought and behavior (Henningsen and Kirmayer 2000).

The case of dissociation illustrates this point. The term dissociation has been used to describe 'both a set of behaviors and experiences involving functional alterations of memory, perception and identity as well as the neurophysiological processes presumed to underlie these phenomena' (Seligman and Kirmayer, 2008). In Euro—American cultures, dissociative disorders are part of the psychiatric nosology of the Diagnostic and Statistical Manual (DSM-IV). More specifically, the current psychiatric paradigm treats dissociation as a pseudo-adaptive, functional neurological response to the experience of acute stress and trauma. Thus, in Euro—American contexts, dissociation is most often associated with the feeling of being distanced from self, being in a fog or witnessing one's experiences from a distance, partial or complete suppression of conscious awareness by the core self, and suppression of particular memories, in response to severely traumatic experiences. In contrast, in many other cultural contexts dissociative experiences are valued and even voluntarily induced, rather than pathologized and perceived/experienced as distressing (Bourguignon, 1989; Boddy, 1994; Seligman and Kirmayer 2008). In fact, anthropological investigations of dissociation indicate that dissociative experience in other cultures most frequently takes place in the context of socially sanctioned religious rituals and healing practices, and commonly takes the form of possession by a spirit or deity. In such contexts, dissociative experiences are voluntarily induced through ritual behaviors including drumming, dancing and singing/chanting and involve the replacement of an individual's self or consciousness by that of a powerful other who uses the

individual's body to enact behaviors that he/she typically does not remember after his/her consciousness returns.

Meaning and attribution play a vital role in shaping the etiology and phenomenology of both pathological and non-pathological forms of dissociation. Pathological dissociation is frequently a response to traumatic experiences in which the autonomous self is violated, and a dissociated self represents a response to such violation that is at once protective and distressing. In the context of religious ritual and healing practice, on the other hand, dissociative experiences represent expansive forms of consciousness that allow individuals to enact alternative selves and to disavow responsibility for certain thoughts and behaviors—that may or may not be related to traumatic experiences (Obeyesekere, 1981).

How then, can we reconcile the pathological and non-pathological forms of dissociation? And what role might cultural neuroscience play in our understanding of these disparate forms of dissociation? Neuroimaging studies of various forms of pathological dissociation seem to support a cortico-limbic model in which inhibitory activity in the prefrontal cortex disrupts the 'emotional tagging' of perceptual and cognitive material by the amygdala and related structures (Sierra and Berrios, 1998; Simeon *et al.*, 2000; Lamius *et al.*, 2002; Medford *et al.*, 2005; Sierra *et al.*, 2005). Interestingly, several recent studies of hysterical conversion have found similar patterns of brain activation. Evidence from these studies suggests that somatosensory information continues to be processed at lower levels in such cases, but that inhibition by parietal and prefrontal structures disrupts the link between mechanisms that generate the intent for movement, and those responsible for its execution (Athwal *et al.*, 2000).

Thus, neurobiological studies of both trauma-related dissociation and hysterical conversion suggest mechanisms involving disruption or inhibition of the connections between higher order cognitive mechanisms responsible for volition and awareness, and affective, information processing and motor systems. These patterns of inhibition can be understood as part of a larger process of self-regulation that involves complex interactions among emotion, cognition and attention in relation to the social environment (Damasio, 1995; Seligman and Kirmayer, 2008). Proximate causes, like trauma, and more complex socio-cultural and cognitive processes, like religious beliefs and socially motivated role enactments, shape the situations in which reduced self-awareness, dampened emotion and other hallmarks of dissociation are efficacious and appropriate (Seligman and Kirmayer, 2008). These causes interact in complex ways with neural inhibitory mechanisms to produce particular states of consciousness, which are in turn labeled and experienced in diverse ways depending on the socio-cultural context in which they take place.

Cultural neuroscience research can advance our understanding of dissociative phenomena and their mechanisms through carefully designed neuroimaging studies that address the question of whether pathological and non-pathological dissociation indeed share a common pattern of neural activation. This would mean attempting to capture phenomena like spirit possession in a laboratory setting—a difficult project, to be sure, but one that appears more realistic in light of the recent success of neuroimaging studies of meditation (Brefczynski-Lewis *et al.*, 2007; Lutz *et al.*, 2008). Because experienced mediums know techniques for the voluntary induction of trance states, it is possible that they could enter such states in a laboratory setting, especially if the setting were manipulated to resemble a typical ritual context, or if relevant stimuli were reproduced in the lab through the use of video footage or script-guided imagery. In addition, as will be discussed in a later section, portable technologies can be used to measure EEG and autonomic nervous system activity taking place *in situ*, in ritual contexts. In addition, collaboration between cultural neuroscientists and anthropologists can result in the design of sophisticated experimental studies that further investigate the effects of attributions and meanings on neural mechanisms—especially cortical inhibitory mechanisms.

RITUAL AND EMBODIMENT

Ritual typically involves physical, sensory and emotional stimulation, all of which have been argued to contribute to its role as a central mechanism of socialization (Turner, 1969; Kertzer, 1988; Durkheim, 1995 (1915); Seligman, 2005). The unique features of ritual appear to lend themselves to associative learning, and through such learning the social ideologies and cultural models they present are imbued with particular significance. This in turn creates particularly strong memories for this information, and links it to powerful emotions that help make it motivationally salient (Turner, 1983; Whitehouse, 2000).

Neuroscientists have demonstrated that certain kinds of sensory stimuli are especially likely to reinforce learning and produce mnemonic effects (LeDoux, 1998; Rolls, 1999), and rituals appear to employ these kinds of stimuli. For instance, initiation rituals often induce strong emotions through the use of physical pain and discomfort (i.e. circumcision, scarification, sleeping on the floor, etc.), exposure to loud noises, drumming, etc. (Barsalou *et al.*, 2005; R. Seligman, submitted for publication). In addition, studies of emotional memory provide evidence that emotionally arousing experiences and events are encoded and consolidated in special ways that make them particularly powerful and durable. Given the emotionally arousing nature of ritual, memories for material presented in its context are likely to be enhanced in these same ways.

Evidence from neuroscience indicates that the enhancement of emotional memories takes place through a combination of attention-mediated short-term effects on encoding, and facilitation of longer term memory consolidation by the amygdala (McGaugh, 2004; LaBar and Cabeza, 2006). For instance, a number of studies have found that amygdala

activation while viewing emotionally arousing films, slides or scenes is correlated positively with subjects' recall of the material several weeks later (Hamann *et al.*, 1999; Canli *et al.*, 2000). Moreover, it appears that the greater the emotional intensity of the material, whether positive or negative, the more closely amygdala activity is correlated with encoding and consolidation (Anderson *et al.*, 2003; McGaugh, 2004). Studies also indicate that the amygdala is activated during retrieval of emotionally arousing material (Dolan, 2000; McGaugh, 2004).

Using creative protocols that allow amygdala activation to be measured during the encoding and retrieval of ritually salient symbolic material, cultural neuroscience can study the connections between ritual practices, associative learning and emotional memory. For example, neuroimaging can take place while subjects are asked to recall a salient ritual in which they have participated several weeks earlier. Anthropologists can also contribute in-depth knowledge of ritual practices and access to ritual experts to help with the design of creative protocols that simulate ritual contexts and introduce new, salient ritual knowledge to religious participants, for use in neuroimaging studies of encoding and memory consolidation by the amygdala.

OPERATIONALIZING INSIGHTS FROM ANTHROPOLOGY AND CULTURAL NEUROSCIENCE

In the previous sections, we illustrated the potential for the design of ethnographically driven laboratory studies and the development of ecologically valid experimental protocols, to better capture the complexity of peoples' lived socio-cultural worlds in a laboratory setting.

In this section, we propose that another way of approaching the neuroscience of lived human experience is through the incorporation of proxy measures of central nervous system activity into ethnographically driven field-based research. For example, the kinds of variations in memory encoding and consolidation discussed above are also modulated by neurohormonal activity. Specifically, evidence suggests that beta-adrenergic enhancement of long-term emotional memory consolidation is mediated by the amygdala, and is also functionally connected to arousal-related memory effects in the hippocampus (Roozendaal *et al.*, 1999; LaBar and Cabeza, 2006). Thus, measurement of adrenocortical activity can provide one source of information about the factors affecting memory consolidation at the central level (Lupien and McEwen, 1997). Innovative techniques for the measurement of hormone activity in field settings make them a particularly 'field-friendly' proxy measure (Worthman and Stallings, 1997; McDade *et al.*, 2007). Other factors affecting memory consolidation, such as sleep, immune inflammatory markers (e.g. interleukin-6) and circulating catecholamines can also be assessed with field-friendly protocols, and could be measured *in situ* during field studies of ritual process (e.g. before, after and even during breaks in ritual events).

The emotionally arousing properties of rituals discussed above can also be measured *in situ* using ambulatory psychophysiological measurement techniques to investigate the effects of ritual participation on things like heart rate, blood pressure, skin conductance and the differential contributions or 'balance' of the sympathetic and parasympathetic nervous systems in relation to cardiovascular activity in the context of ritual (Berntson *et al.*, 1991, 1996). A study employing such a research strategy in the context of religious practice and spirit possession mediumship in Northeastern Brazil, was conducted by one of the authors (R. Seligman, submitted for publication). This study of the Afro-Brazilian religion, Candomblé, examined the relationship between mediumship, or the tendency to regularly enter trance or dissociative states and become possessed by the religion's spirits and deities, and autonomic regulation. Impedance cardiography, a method that sends low-voltage, high-frequency electrical signals through the thoracic cavity to measure changes in electrical impedance associated with cardiac stroke volume (Berntson *et al.*, 2007), was used to generate data on individual and group differences in cardiac reactivity. Ten mediums were compared with 10 non-medium initiates, another group of deeply devoted religious participants who unlike mediums cannot enter trance states or become possessed, on measures of parasympathetic (high-frequency (HF) heart rate variability) and sympathetic (pre-ejection period, PEP) cardiac control. It was hypothesized that as a group, mediums would show different patterns of autonomic control, associated with their ability to deeply embody their religious beliefs through possession trance.

Following Berntson *et al.* (2008) who recently found that individuals who scored high on a religiosity index had higher levels of overall cardiac autonomic regulation, the scores of mediums and non-mediums were compared on a derived index of total autonomic control (HF + PEP = CAR). Differences between the two groups did not reach significance, probably due to limited power, but on average, mediums had CAR scores half a standard deviation higher than those of their non-medium counterparts. While limited in sample size ($N = 20$), these findings suggest that these religious experts, who embody their belief in a way that involves not only physical participation in ritual, but also psychobodily enactment through trance and possession, have different patterns of autonomic regulation, which may form the basis of, or be caused by, their exceptional level of religious embodiment.

CONCLUSION

Both anthropology and cultural neuroscience are interested in understanding the complex relationships among body, brain and environment. In this article, we have argued that the two fields bring complementary theoretical and methodological tools to this area of research. In particular, anthropological insights into the embodiment of social knowledge can provide the basis for ethnographically driven laboratory

studies that go beyond neural mapping to investigate the neural substrates of complex human behavior and experience. For example, we have demonstrated how ethnographic research can contribute rich data on the embodiment of both normal and pathological emotional experience and the embodiment of social knowledge through ritual practice. These data can form the basis for robust hypothesis building, and the development of ecologically valid experimental designs. We have also argued that laboratory studies should be complemented with field research that uses portable measurement devices to provide data on dynamic, *in situ* neurophysiological responses to the flow of social experience.

Finally, a productive engagement of anthropology and cultural neuroscience can aid the development of theoretical approaches to embodiment that help more richly describe the processes and consequences of emotion socialization, throw light on the cultural processes that affect the symptom presentation, subjective experience and severity of mental illness and illuminate the socio-neural interface that makes ritual so powerful and pervasive a force in human experience.

Conflict of Interest

None declared.

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