

Neuroanthropology: a humanistic science for the study of the culture–brain nexus

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In this article, we argue that a combined anthropology/neuroscience field of enquiry can make a significant and distinctive contribution to the study of the relationship between culture and the brain. This field, which can appropriately be termed as neuroanthropology, is conceived of as being complementary to and mutually informative with social and cultural neuroscience. We start by providing an introduction to the culture concept in anthropology. We then present a detailed characterization of neuroanthropology and its methods and how they relate to the anthropological understanding of culture. The field is described as a humanistic science, that is, a field of enquiry founded on the perceived epistemological and methodological interdependence of science and the humanities. We also provide examples that illustrate the proposed methodological model for neuroanthropology. We conclude with a discussion about specific contributions the field can make to the study of the culture–brain nexus.

Keywords: neuroanthropology; brain; culture; humanistic science

INTRODUCTION

Until recently, the relevance of culture for brain development, structure and function remained unrecognized. This is changing, however, with the emergence of cultural neuroscience, a cross-disciplinary field of study that integrates cross-cultural psychology, cognitive neuroscience and, in one formulation, molecular biology to study how neural development, structure and function vary from one cultural group to the next (Park and Gutchess, 2002, 2006; Chiao and Alamy, 2007; Han and Northoff, 2008). The first generation of cultural neuroscience studies has yielded a number of important insights. First, culture seems to have a pervasive effect on all levels and dimensions of neural activity: from low-level perceptual (Gutchess *et al.*, 2006; Goh *et al.*, 2007; Sui and Han, 2007) and attentional (Hedden *et al.*, 2008) processes to high-level cognitive, affective and social functions including language (Shaywitz *et al.*, 1998; Paulesu *et al.*, 2000; Temple *et al.*, 2003; Mechelli *et al.*, 2004; Siok *et al.*, 2004, 2008; Tan *et al.*, 2005; Hoefl *et al.*, 2007), music (Morrison *et al.*, 2003; Nan *et al.*, 2006, 2008), mental calculation (Tang *et al.*, 2006), emotions (Chiao *et al.*, 2008), mental attribution (Kobayashi *et al.*, 2006, 2007) and self knowledge and awareness (Zhu *et al.*, 2007; Han *et al.*, 2008; Chiao *et al.*, 2009; Chiao *et al.*, 2008).

Second, cultural differences appear to be reflected either by different arrangements of neural circuits or by differing

levels of activation. Current findings also indicate that cultural experiences not only modulate but also determine pre-existing patterns of neural activity and they are thus constitutive of that experience (Han and Northoff, 2008). The constitutive character of cultural experience is particularly salient when considering preliminary evidence that cultural differences can be expressed in actual brain structural changes (e.g., gray-matter volume; Park and Gutchess, 2002; Draganski *et al.*, 2004; Mechelli *et al.*, 2004; Han and Northoff, 2008; Turner and Whitehead, 2008).

The influence culture plays in cognitive processes, and more broadly in subjective experience, is a core concept within an area of enquiry closely related to cultural psychology, namely, anthropology and more particularly sub-disciplines such as cognitive, psychoanalytic and phenomenological anthropology. Anthropology can be defined as the study of the origin and character of the human condition in all its dimensions, and its past and present manifestations. At the heart of the anthropological endeavour is a particular appreciation for the central role culture plays in human affairs. Anthropologists made culture an object of systematic enquiry in the mid 19th century. They regard culture as the definitive attribute of the human condition. Since its inception, the culture concept has been refined by means of the careful observation, recording, analysis and interpretation of cultural practices from societies across the world.

To date, cultural neuroscience studies have not directly considered the understanding of culture gained from anthropology. In this article, two anthropologists and two neuroscientists argue that a combined anthropology/neuroscience approach can make a significant and distinctive contribution

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to the study of the relationship between culture and the brain. Furthermore, we advocate that anthropology and neuroscience should be integrated within a field of study that can appropriately be termed neuroanthropology. We start by providing an introduction to the culture concept in anthropology. We then present a detailed characterization of neuroanthropology and its methods, together with illustrative examples. We conclude with a discussion about specific contributions the field can make to the study of the culture-brain nexus in the context of other related disciplines such as social and cultural neuroscience.

AN ANTHROPOLOGICAL DEFINITION OF CULTURE

There is wide agreement in anthropology that culture is socially transmitted and thereby shared. There is also agreement that culture can constrain human action even more than biological needs. However, much debate surrounds the efforts at characterizing culture in a more detailed manner. The particulars of this debate need not concern us here (Wolf, 1982; Clifford, 1988; Abu-Lughod, 1991; Goody, 1994; Keesing, 1994; Fox, 1995; Trouillot, 1995; Strauss and Quinn, 1997; Brumann, 1999), but we suggest that they are due to culture's intrinsically dual characterization, possessing several pairs of contrasting but complementary attributes. This duality may be key to apprehending the anthropological understanding of culture in its diversity and complexity.

First, culture is an abstract, general concept characterized by being, as noted above, socially created, reproduced and transmitted. However, one can also talk meaningfully about a concrete culture formed by a group of people who may or may not share a sense of belonging to their group, but who nevertheless constitute a distinct system of social activity. Second, culture can be conceived as the shared structures of meaning in terms of which people do things and understand each other. At the same time, culture can correspond to the practices people perform that mediate and embody those meanings.

Third, culture is modal, inter-subjective, public, social and distributed, whilst also having particular, individual, private and psychological dimensions. The first set of attributes is undeniably definitional of culture. Shared understandings and mutually intelligible practices must have some modality and general validity across a group of people, and must be inter-subjectively created, publicly available, socially reproduced and distributed in a population. However, each one of us has direct access only to our own experiences, psychological and private in nature. As Strauss and Quinn have argued, shared understandings 'are the product of current events in the public world interacting with mental structures, which are in turn the product of such interactions with the public world' (1997: 6).

Culture has also a 'thing' and a 'process' aspect. As a thing, culture, a culture, has a degree of stability, coherence, identity and endurance. On the other hand, the 'thingness' of culture is strangely elusive, transitory and fuzzy. This is

perhaps due to the fact that culture is also a process, a perpetually unfolding stream of meanings and practices. Culture's thingness is intimately linked to its processual character. Thus, the stability present in culture and cultural forms emerges from the ongoing activity of individuals. Cultural stability is therefore dynamic. For this same reason, culture and cultural forms, are always threatened with dissolution. This is intimately linked to the fact that, within any culture, there is much variability, with many, if not all, cultural meanings being constantly negotiated and contested. The negotiated, contested character of cultural meanings and practices highlights another fundamental dimension of culture, i.e., power. Power can be understood as the effect of social and cultural practices by means of which outcomes are secured, resources are appropriated and distributed, and people are coerced or vie for control (Giddens, 1984).

Finally, culture is both real and constructed. That is, culture is at the same time a fact, something that can be objectively described with a certain degree of confidence, and a fiction, in the sense that culture is, "something made," something fashioned—the original meaning of the Latin *factio*, not that it is false or unfactual (Geertz, 1973: 15; see also, Clifford, 1986). The description of culture and of cultures is thus bound to be an analytic as well as an interpretive endeavour and this description is therefore continually contested, but by the same token, it stands to be continually refined.

NEUROANTHROPOLOGY: A HUMANISTIC SCIENCE

Definition and scope

Since culture has a psychological dimension, one can also meaningfully talk of culture having a neural dimension. This has been recognized by a small group of anthropologists since the 1970s (Laughlin and d'Aquili, 1974; Paredes and Hepburn, 1976; d'Aquili *et al.*, 1979; Laughlin *et al.*, 1990; Turner, 1983, 1985; Reyna, 2002; see also sociologist TenHouten, 1976a, 1976b, 1985, 1992, 1999). Recently, anthropology has re-engaged with neuroscience as evidenced by the American Anthropological Association conference session (Lende and Downey 2008) entitled 'The Encultured Brain: Neuroanthropology and Interdisciplinary Engagement'.

In this article, we propose a research strategy to study the relationship between culture and the brain from a distinctively anthropological perspective. Lewis (unpublished data) introduced the term neuroanthropology to designate a 'new science that draws, *inter alia*, on evolutionary biology, neuroscience, memetics, cultural anthropology, semiotics, linguistics and neurolinguistics'. This use is independent of two other separate instances where the term was earlier introduced by TenHouten (1976a, 1976b) and d'Aquili *et al.* (1979). Turner, reflecting on the neural instantiation of culture, suggested that cultures 'and their associated worldviews represent relatively coherent and systematic biases in brain functional anatomy' (Turner, 2001: 167). He has argued that anthropologists and neuroscientists

have much to gain from collaborating with each other and much to lose if they scorn each other's insights (2002; Turner and Whitehead, 2008).

Domínguez (2007) has integrated these perspectives, coming up with the current, unified definition of neuroanthropology, followed in this article, as the study of the experiential and neurobiological aspects of cultural activity. In this formulation, neuroanthropology can guide exploration of brain function with respect to culture to address the neuroscientific question: 'what are the neural instantiations of socially shared meanings and practices?' It can also assist with a traditional anthropological question: 'how [do] people appropriate their [cultural] experience and act on it, some times to recreate and other times to change the public social world' (Strauss and Quinn, 1997: 8). Strauss and Quinn rightly note that we need to know how the mind works in order to answer this question. Neuroscience clearly provides the most fundamental perspective yet available in this regard. Two additional central questions defining the scope of neuroanthropology are: (i) 'what are the neural mechanisms enabling cultural understandings and practices?'; and (ii) 'how did these mechanisms evolve?' Note that these questions issue largely from various dual attributes of culture mentioned above—they refer to meanings and practices and they capture the idea that culture, being both a shared and an individual level phenomenon, structures social experience as well as psychological processes.

Neuroethnography

Integrating research methods from neuroscience and anthropology provides one way to address the above questions (Domínguez, 2007). The neurosciences conform to a generalistic, nomothetic and context-independent form of enquiry known as 'Explanation' in philosophy of science. Research involves highly formalized laboratory experiments aimed at uncovering clear cause-effect relationships between cognitive function and brain structure and activity. Observational methods are used, such as functional magnetic resonance imaging and electroencephalography, together with manipulation and interference techniques such as lesion studies and electrical stimulation. Experiments are designed to be subtractive, factorial or parametric, in order to test hypotheses by means of statistical deductive/inductive analytic tests. There are also data-driven approaches with no *a priori* assumptions about expected regularities in the data, but they still require precisely controlled experiments in which the covariates of interest can at least be estimated.

Much anthropological research is based on a similar scientific, explanatory approach, but currently, the anthropological study of culture more often conforms to a humanistic, but still empirical strategy. From this perspective, anthropology's goal is to 'understand' cultural practices and the meaning of symbols. In the humanistic tradition, 'Understanding' refers to an interpretive activity that works by considering particular practices and symbols with respect

to their context, i.e., their history, the specific situations in which they occur, and other practices and symbols relevant to them. Understanding is said to occur when the relationship between the particular and its context is grasped (von Wright, 1971; Ricoeur, 1990, 1991). Figuring out someone's intentions and grasping the meaning of a symbol, or even a word in a sentence, are thus eminently interpretive rather than analytic processes. Instead of deduction and induction, these interpretive strategies rely predominantly on a form of natural probabilistic inference known as abduction (Peirce, 1960) that can lead to adequate conclusions depending on background knowledge and previously established assumptions (Domínguez, 2007; Ginzburg, 1980; Clifford, 1988). Bayesian probability theory is a rigorous implementation of abduction. In order to understand cultural activity, anthropologists undertake fieldwork by living and integrating with the people they study for extended periods of time. They become participant observers and observing participants of the studied people's realities (Tedlock, 1991). In other words, anthropologists acquire (to a certain extent) the culture of the people they study. This is the essence of the ethnographic method—ethnography literally meaning the writing down of the social life of people.

We contend that 'understanding' of cultural activity must guide enquiry about the relationship between culture and the brain. Research into the neural instantiation of a domain of cultural activity requires a profound understanding of that domain. The canonical methodological paradigm we propose for neuroanthropology consists of generating neuroscientific investigations from actual ethnographic fieldwork in particular populations. This involves embedding neuroscientific experiments in ethnography. Doing research in this fashion entails the use of constructs and variables derived from ethnographic fieldwork that can be operationalized and manipulated in the neuroscience laboratory. This research model is consistent with that of cognitive anthropology (Garro, 1988, 2000; Caulkins, 1995; Caulkins and Hyatt, 1999; Ross, 2002a, 2002b, 2004), and is composed of two phases: an exploratory ethnographic phase providing 'in-depth knowledge of the research subject and clear, theoretical expectations', and a second experimental phase in which appropriate protocols are developed (Ross, 2004: 81). This second phase involves actual experiments such as those currently performed in social and cultural neuroscience, which may in turn be derived from cognitive anthropology/cognitive psychology experiments, themselves informed by ethnographic fieldwork. Results from the experimental phase are, in turn, expected to suggest new avenues of enquiry for further ethnography/experimental cycles. We can describe this method as neuroethnography.

Addressing scientific and humanistic questions

Neuroethnographies can obviously address scientific and humanistic questions at the neural, experiential and behavioural levels. This combined scientific/humanistic approach

is well suited to deal with the dual character of culture and the implications of this duality for brain development, function and structure. Issues of scientific character such as identifying species-wide invariants as well as cross-cultural regularities and differences can be tackled by means of the methodological repertoire available from social and cultural neuroscience research. This repertoire includes cross-cultural comparisons, cross-sectional and experience-related longitudinal strategies, as well as the combination of these experimental protocols. In cross-cultural, comparisons, culture, conceived as a discrete system of activity, is used as a grouping variable. By comparing cultural groups thought to differ with respect to some neurocognitive mechanism, it is possible to isolate differences in neural organization and behavioural responses between the groups (Park and Gutches, 2002). Cross-sectional and longitudinal studies can, in turn, shed light onto the neuroanatomical and functional correlates of cultural learning and experience and their temporal dynamics (Poldrack, 2000; Draganski *et al.*, 2004, 2006; Draganski and May, 2008).

Humanistic questions can also be addressed neuroethnographically by taking a particularistic, interpretive approach to cultural experience and the neural bases of that experience (Domínguez, 2007). This approach is illuminated by comparing ethnography with clinical research, of which neurology is a classic example. Anthropology and clinical research both deal with a set of signifiers: symptoms in the case of clinical practice, and intentions and symbolic acts in the case of anthropology (Geertz, 1973). In clinical settings, 'symptoms (even when they are measures) are scanned for theoretical peculiarities—that is, they are diagnosed' (Geertz, 1973: 26). Each individual's clinical history is thus examined independently leading to a diagnosis, the hypothesized physiological changes associated with a disease or injury. This diagnosis is specific to the individual and is based on the interpretation of his or her symptoms with reference to the available body of knowledge about brain diseases and lesions. Clearly, the pre-dominant form of inference in clinical research is, as in anthropology, abduction. Rather than reaching a diagnosis, the aim of anthropology is, in contrast, to uncover 'the conceptual structures that inform our subject's acts' based on the interpretation of the intentions and the symbols associated with those acts (Geertz, 1973: 27). We suggest that the model of clinical research can be used to study the healthy brain, and more precisely, the cultural brain of individuals. Given that the conceptual structures that inform people's acts have a physiological manifestation, a neural instantiation, interpreting symbolic acts in the light of what neuroscience has unveiled about cognitive function of the healthy brain should ultimately aid us in uncovering the neural expression of those structures. The reverse is also true: a better understanding of neural mechanisms has an important role to play in the interpretation of cultural meanings and practices.

We noted above the role of clinical history in diagnosis. Investigating the neural instantiation of cultural forms will similarly require compiling and examining what we may call the cultural history of particular brains. We expect the in-depth and longitudinal view such a history affords to enable researchers to: (i) identify likely cultural sources of variance in brain structure and function by correlating neuro-metric data with those sources; (ii) determine to what extent neural measurements associated with different sources of variance are mutually dependent; and (iii) elucidate the temporal dynamics of structural and functional changes associated with different sources of cultural variance by taking neural measurements at different points in time to build a life history of a cultural brain. By the above means, neuroethnography will be able to investigate the unique ways culture is manifested in the lives of individuals, which are otherwise obscured by the homogenizing effects of generalizing methods. Several life histories can, of course, be collected and specific themes or events within them can be investigated to arrive at group generalizations, a research strategy known as case series.

Neuroanthropology is defined by the integration of research methods from science and the humanities to address both scientific and humanistic questions. For this reason, we conceive of it as a humanistic science. Valid, pragmatically useful knowledge is, from this perspective, the outcome of enquiries that integrate the forms of intelligibility characteristic of the sciences—deduction and induction—and the humanities—abduction (Domínguez, 2007; see also von Wright, 1974; Weick, 1979; Cialdini, 1980; Ricoeur, 1990, 1991; Stocking, 1992; Koepping, 1995; Bernard, 1998; Changeux and Ricoeur, 2000; Fine and Elsbach, 2000; Bohman, 2003a, 2003b; Bertilsson, 2004). Thus, predictions are deductively derived from hypotheses. The observation of separate instances of a prediction lends inductive support to the associated hypothesis. Hypotheses and other related useful concepts are generated, however, by means of abduction (Peirce, 1960). Science and the humanities are thus dialectically related. They are two moments in the wider cycle of intelligibility and must be jointly and iteratively deployed in order to advance our comprehension of the world.

ILLUSTRATING THE NEUROETHNOGRAPHIC METHOD

No published study yet conforms to the neuroethnographic method. In this section, we present a few examples from cognitive anthropology, cultural psychology and social neuroscience, as well as a study we have designed that illustrate the main features of this method, combining ethnographic investigation with experimentation, quantitative manipulation and the use of culturally defined variables. More specifically, these examples show how ethnographically based understanding of a cultural phenomenon contributes, among other things, to the formulation of testable hypotheses and the interpretation of results. Finally, the example

from social neuroscience and our own study explicitly demonstrate the actual integration of theory and methods from anthropology and neuroscience in order to tackle specific research questions.

Cognitive anthropology

The integration of participant observation fieldwork with quantitative experimental science has been a feature of cognitive anthropology (D'Andrade, 1987, 1995; Garro, 1988, 2000; Caulkins, 1995; Atran *et al.*, 1999; Caulkins and Hyatt, 1999; Ross, 2002a, 2002b, 2004; Ross and Medin, 2005; Medin *et al.*, 2007). An illustrative example is Ross's (2002a) study of ecological knowledge among the Lacandon Maya of Mexico. Ethnographic fieldwork revealed the existence of differences in environmental cognition, decision-making and behaviour between the older and younger Lacandon generations. Ross confirmed the presence of these differences and determined their character and extent by applying a principal component analysis on a subject-by-subject matrix containing informants' responses to questions of ecological knowledge. This technique, known as consensus analysis in cognitive anthropology, assumes that widely shared information is reflected in high agreement among individuals (Romney *et al.*, 1986). A decontextualized interpretation of these results would suggest that the difference in ecological knowledge is due simply to level of expertise between the two generations and that it will be overcome with time. The understandings arrived at and the information collected through ethnographic fieldwork suggested instead that this difference reflects a fundamental shift in the underlying model of the world of the younger generation brought about by changes in the social, economic, religious and settlement spheres of Lacandon life. The formal experimental and analytic approach in this study allowed the exploration of patterns of agreement among Lacandon informants and lent support to the hypothesis of the existence of an intergenerational difference in ecological knowledge amongst them. However, ethnographic knowledge led to the formulation of the hypothesis, the choosing of an appropriate informant pool and the meaningful interpretation of the results.

Measures of cultural consensus can be used to quantify the identifiability of a given representation or practice in, for example, a brain imaging experiment. The greater the consensus, the greater the statistical power of the experiment. In addition, consensus analysis can also be useful for neuroanthropological research involving cross-cultural comparisons in that it can substantiate the assumption that the groups under study indeed differ along the dimension being investigated. The presence of varying degrees of consensus, however, indicates that cultural models are not fully shared within a group. There is thus a need to 'explore the distribution of cognitions not only across but also within cultural groups' (Ross, 2004: 130). By the same token, it should be possible to explore the distribution of neural representations

both across and within cultural groups by applying consensus analytic techniques to functional and structural brain data. An important aspect of neuroanthropology will be then to examine the neural substrates of variation or consensus in cultural models. Cultural consensus measures may also help to account for patterns of individual variation in brain imaging experiments. Brain activity patterns revealed in an imaging experiment may, in turn, help to elucidate differences in the cultural models that individuals within a group use. Together with the approach of the life history of the cultural brain, attention to varying degrees of consensus will help disentangling cross-cultural, intra-cultural and culturally related individual variability from each other.

Social and cultural psychology

Not without some resistance and in a limited manner, social and cultural psychologists have also acknowledged the mutual relevance of ethnography and experimental methods (Rogler, 1989, 1993; Greenfield, 1996; Miller, 1997; Fine and Elsbach, 2000; Kitayama, Duffy and Uchida, 2007). Miller (1997), for example, reported that interpretive ethnographic methods were needed for her to understand the cultural context in which she conducted traditional and formal developmental and social psychological research. Some of Miller's research hypotheses concerning interpersonal responsibilities in the Indian Hindu family household have been inspired by her observation of the strong sense of interdependence that exists among the members of those households. Similarly, she quantitatively tested for cultural differences in interpersonal motivation suggested by first hand observation of how duty impacts on everyday behaviour and is affectively experienced by Indians. Interpretive ethnographic knowledge also allowed Miller to devise culturally sensitive research methodologies. She discovered by this means that psychological scales used to assess perceived control in terms of an 'internal-external' dimension were inadequate to deal with Indians' interdependent attitude toward control. On this basis, Miller has strongly argued that interpretive ethnographic knowledge is central to assessing the ecological, cultural validity of quantitative findings. On the other hand, (in Miller, 1997) have also used quantitatively derived results to question claims coming from ethnographic research.

Social neuroscience

One recent social neuroscience study adopted a methodology similar to that advocated here and illustrates the potential of taking into account anthropological knowledge when researching brain function. The study was conducted by an interdisciplinary group led by anthropologist Helen Fisher, and included also a psychologist and a team of brain imaging neuroscientists (Aron *et al.*, 2005). The group investigated the neural underpinnings of early stage romantic love. They relied on a survey of ethnographic material from

166 contemporary societies (Jankowiak and Fisher, 1992) and included qualitative interviews typical of anthropological research. Each participant also completed two self-administered questionnaires: the passionate love scale and the affect intensity measure. The survey provided evidence of attributes associated with what is known in English as romantic love in most of the societies sampled. The interviews and questionnaires indicated the range, intensity and duration of the participants' feelings. Aron and colleagues also drew on findings from physiological and behavioural psychology, which coincide with the results of the ethnographic survey regarding the indices of romantic love. These indices include very intense emotional responses such as euphoria and focused attention. The authors integrated this information with knowledge about the neurobiology of emotions and hypothesized that 'reward and motivation systems in the human brain could be involved' (327) in the experience of early stage romantic love and that this form of love may have developed from a mammalian drive to pursue preferred mates. In response to a photo of the beloved person, volunteer subjects showed brain activity in the right postero-dorsal body and medial caudate nucleus, ventral tegmental area, as well as in the left insula and putamen-globus pallidus. The activity in the nucleus accumbens, a dopamine-rich area associated with reward, correlated with intensity scores for romantic passion. Activity in the other areas, which have been implicated in reward and emotion, correlated with attractiveness and affect intensity.

A neuroethnography of kinship

Finally, we present a specific study that we have designed following the neuroanthropological methodology outlined in this article. Research in anthropology has revealed a great diversity in systems of classification and relationships of kin. For example, in the English kinship system (Figure 1) the consanguineal father's brother and mother's brother belong to the same category, labelled 'uncle', and are differentiated from the 'father' category. In other systems, such as the Tamil from South India, the consanguineal father and his brother are terminologically merged into the category 'appa' and differentiated from the consanguineal mother's brother who is termed 'maman'. Attitudinally, the relationship between a male and his father is considered in the English system to be distinctly different in character to that between the child and his consanguineal father's brother. In Tamil society, in contrast, these two relationships are regarded as equivalent. Furthermore, the consanguineal father and father's brother stand jurally and attitudinally in opposition to the consanguineal mother's brother. These socially constructed and approved forms of relationship have crucial importance in determining life chances and prospects for participants in all cultures. We will use the reported cross-cultural differences in kinship systems to study whether and how neural mechanisms for face recognition vary in relation to these differences.

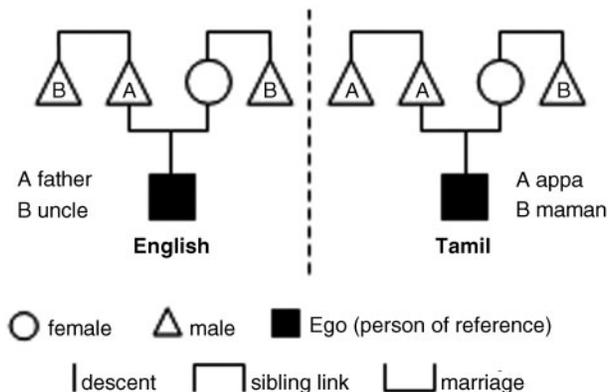


Fig. 1 Kinship terms for males of the first ascending generation in English and Tamil.

To this end, we have embedded a brain imaging experiment investigating neural responses elicited by a face recognition task in a comparative ethnography of two communities with two different kinship systems. The genetic relationship is controlled, while the cultural kinship rule is the independent variable. Ethnographically gathered information will be combined with anthropological literature on kinship (Buchler and Selby, 1968; Lévi-Strauss, 1969; Fox, 1974; Keesing, 1975; Barnard and Good, 1984) as well as earlier neuroimaging results for facial recognition for different social categories of kin (Aron *et al.*, 2005; Bartels and Zeki, 2000, 2004; Leibenluft *et al.*, 2004; Nelson *et al.*, 2001; Nitschke *et al.*, 2004; Gobbini and Haxby, 2007) to derive spatial hypotheses. Voxel-by-voxel analysis will also be performed, which may reveal further relationship-dependent differences in neural activity. This should enable us to refine our understanding about those relationships and may guide future ethnographic enquiry.

NEUROANTHROPOLOGY'S CONTRIBUTION

We have made reference throughout the article to the distinctive contributions neuroanthropology can make to the problem of the relationship between culture and the brain—e.g., the ethnographic study of cultural activity, research progress through the iteration of understanding and explanation, and attention to intracultural diversity and the life history of particular cultural brains. In this section, we focus on two further contributions we consider to be at the heart of neuroanthropological enquiry. While distinctive, we regard these contributions as both complementary to and dependent on the work conducted in social and cultural neuroscience. After all, in our formulation, theory and methods of research from these fields are an essential component of neuroanthropological investigations.

The critique of the culture concept in psychology

Cultural neuroscience's conception of culture is primarily psychological. This conception has been criticized by anthropologists (Holland and Cole, 1995; Fiske, 2002; Medin,

Unsworth and Hirschfeld, 2007) and by psychologists with an anthropological orientation (Greenfield, 1996; Miller, 1997; Fish, 2000) in that it pre-dominantly regards culture as a variable or set of variables affecting behaviour (and in the case of cultural neuroscience the brain) and does not include culture itself among the objects of study. Conceiving of culture as unproblematic leads to causal accounts of group practices and beliefs that are reduced to broad distinctions assumed to have a unidirectional causal effect on individuals (Holland and Cole, 1995; Greenfield, 1996; Fiske, 2002; Medin, Unsworth and Hirschfeld, 2007). An example is the individualism/collectivism dichotomy used widely in cross-cultural psychology (Markus and Kitayama, 1991; Triandis, 1995; Oyserman *et al.*, 2002) and more recently in cultural neuroscience (Gutchess *et al.*, 2006; Goh *et al.*, 2007; Hedden *et al.*, 2008; Chiao *et al.*, 2009; Chiao *et al.*, 2008). In consequence, the actual social processes by which cultural knowledge is constituted escape examination. Rather than characterizing how individualistic or collectivistic an individual or a group may be, a process perspective on culture applied to the individualism/collectivism constructs has led to the recognition that they can be even strategically integrated by an individual to handle different aspects of the same situation (Greenfield, 1996). Such a perspective has also suggested that the individualism and collectivism constructs conflate (and we would say confound) different types of autonomy and sociality respectively (Fiske, 2002; see also Greenfield, 1996). Evidence from ethnography indicates, in addition, that these different types of autonomy (and sociality) do not positively correlate with each other and therefore may not be subsumed under a single variable (Fiske, 2002).

To understand the bi-directional relationship between culture and the brain, rather than merely the after effects of culture on the brain, we need to elucidate the socio-cultural processes by which cultural knowledge is constituted. Such an understanding is offered by an anthropological perspective, together with a conception of culture as the medium, the environment of activity within which individuals are embedded. From this perspective, cultural cognitive and neural mechanisms cannot be adequately accounted for simply in terms of individual variables. They can be better described as occurring in an emergent and distributed manner in a population (Hutchins, 1995; Medin *et al.*, 2007). Whilst culture may often have to be treated in experimental settings as an independent variable having an 'effect' on the individual as the dependent variable, this should generally be combined with an attempt to unpack it (Whiting, 1976) into component cultural meanings and practices, and the social processes at work. In our kinship study, for example, we have unpacked the cultural grouping variable into kinship relationships between people fulfilling different kinship roles. Our aim is to capture the relationships between the many components that constitute the domain of cultural activity we are interested in, rather

than assess the effects of a putatively cultural variable. This approach is better suited to culture's system and process nature (Greenfield, 1996; Fiske, 2002), which can also be quantitatively assessed by means of techniques like consensus and correlation analysis, and longitudinal studies, mentioned above, as well as structural equation modelling, and analyses of covariance structures (Greenfield, 1996). All of these techniques make it possible to examine the relationships between cultural elements and processes. Note, however, that the initial identification and characterization of these elements and processes is eminently a qualitative affair. For this reason, research strategies like direct or participant observation are essential.

The 'distinct worlds' problem

Consistent with culture being constructed and negotiated, ethnographic fieldwork and the interpretation of cultures do not lead to an unproblematic, objective and transparent annotation of events. On the contrary, fieldwork is unavoidably mediated by the cultural lenses of both the researcher and the people under study, both of whom live in '*distinct worlds*, not merely the same world with different labels attached' (Sapir, 1949: 162; emphasis added). Furthermore, the knowledge derived from such fieldwork is the product of the negotiation of contested meanings, which takes place not only between researchers themselves but also between researchers and the people under study. Far from simply being observers and observed, researchers and those being studied are engaged in a very active dialog motivated by their own agendas and interests (Geertz, 1973; Dwyer, 1977; Clifford, 1986, 1988; Hastrup, 1990, 1992).

The 'distinct worlds' problem is compounded in cross-cultural comparisons because ethnographers deal with the worlds of meaning associated with not one but two or more cultural traditions. It is questionable how adequately the constructs used by ethnographers (or indeed psychologists and neuroscientists) to designate phenomena within their scope of study reflect meaningful phenomena within the worlds of experience of those studied. A neuroanthropological perspective could be seen as vital to detect and minimize the projection of researchers' own cultural values and the biases associated with their fields of study onto the cultural groups under consideration. This can be achieved by complementing, statistical analyses of cross-cultural measurement bias using latent factor analytic procedures (Poortinga, 1989) with critical theory (Foucault, 1972, 1977; Bohman, 2003a, 2003b) and reflexive ethnography (Geertz, 1973; Asad, 1986; Clifford and Marcus, 1986; Clifford, 1988; Hastrup, 1990). By historically, socially and politically contextualizing the circumstances under which enquiry takes place, these latter two approaches can expose biases in researchers' assumptions and lack of cross-cultural validity in their constructs, theories and findings. Another legitimate anthropological alternative is not to rely so much on cross-cultural comparisons. A great deal of

anthropological research is not comparative. If comparisons are to be carried out, a viable option is not to directly compare the same task across different cultures but to make comparisons at higher theoretical levels (also suggested by Greenfield, 1996).

CONCLUDING REMARKS

While published examples of the methodology introduced in this article have not yet been applied to the study of culture–brain interactions, we believe that it holds great promise for this purpose. Of course, not every future study has to conform to every detail of the methodology: some studies may focus on generalizations rather than particularities; others may look into species-wide features instead of cross- and within-cultural variation; some other studies might not have an ethnographic phase at all and instead be experiments derived from the available ethnographic, archaeological and paleoanthropological records—yet another powerful reason to integrate anthropology into the study of culture–brain interactions given these records' remarkably broad range and depth. Any studies exploring the culture–brain nexus that are motivated by an anthropological understanding of culture and its relationship with the individual or the methodology we have outlined, may be considered to be of neuroanthropological character.

We regard such investigations to be intimately linked with social and cultural neuroscience, as they integrate experimental strategies from the latter with ethnographic research. In the final analysis, we regard these fields of enquiry as addressing in complementary and mutually informative ways the eminently anthropological question who we are.

Conflict of Interest

None declared.

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