Cultural variation in elite athletes: does elite cognitive-perceptual skill always converge?

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Abstract

Anthropologists have not participated extensively in the cognitive science synthesis for a host of reasons, including internal conflicts in the discipline and profound reservations about the ways that cultural differences have been modeled in psychology, neuroscience, and other contributors to cognitive science. This paper proposes a skills-based model for culture that overcomes some of the problems inherent in the treatment of culture as shared information. Athletes offer excellent cases studies for how skill acquisition, like enculturation, affects the human nervous system. In addition, cultural differences in playing styles of the same sport, such as distinctive ways of playing rugby, demonstrate how varying solution strategies to similar athletic problems produce distinctive skill profiles.

Keywords: neuroanthropology; skill acquisition; elite performance; perceptual skill; culture and cognition.

Introduction

Of late, cognitive science has developed an interest in cultural difference. As samples have become more diverse, as the participants in the discussion more numerous, and even as the techniques we use to study cognition have grown more subtle and sophisticated, cultural differences have emerged in a range of psychological and neuroscience research, evident even in basic human abilities (see Cohen, 2009; e.g., Chiao et al. 2008; Chua et al. 2005; Gutchess, et al. 2006; Han and Northoff 2008; Kitayama & Cohen 2007; Kobayashi et al. 2007, 2008; Kuhl et al. 1992; Marsh et al. 2003; McClure et al. 2004).

But how do we choose our case studies so that they best highlight cultural difference? And how do we model culture itself in ways that capture the emergence of inter-group differences in cognition? This paper argues that our understandings of the production of cultural difference, our models for conceptualizing 'enculturation,' affect where we search for cultural effects on cognition and, thus, the extent of human neurological variability we can observe. I suggest that, ironically, cognitive scientists may be searching for 'culture' where its effects will not be terribly evident.

This paper explores how a 'skills-based' model of enculturation, inspired by the theoretical work of anthropologist Tim Ingold (2001), might lead us to better conceptualize the nature and origins of cultural differences in cognition. Ingold (ibid.: 416) advocates treating enculturation as 'enskilment,' noting that different individuals within the same culture will achieve unequal proficiency and develop idiosyncratic techniques to accomplish the same ends (see Downey, 2005; Grasseni, 2007). Focusing on the acquisition of skills and, by analogy, enculturation shifts our perspective from a concentration on the end-point, the mature expert or culture-bearing individual, to the developmental processes that produce distinctive perceptual abilities, cognitive patterns, physiological capacities and conceptual resources.

A skills-based approach highlight the culture in every human trait, even if is so ubiquitous as to appear inherent in 'human nature.' In many cases, cognitive enculturation is virtually impossible to discern because the only null cases—where enculturation is entirely absent—are developmental outliers like 'feral' children, individuals with profound cognitive deficits or cases of severe neglect. That is, if cultures have similar effects on development, this development may appear innate or inevitable, as if carried in human DNA rather than in the relation of the human organism to a structured environment, patterns of interaction, even self-stimulation. Through comparison with skills, we can better understand how culture, too, takes hold of the body and nervous system, remodeling and reallocating resources, deeply enculturing the human organism (see Ericsson & Lehmann, 1996).

Specifically, by considering diversity among elite rugby halfbacks, this paper proposes to explore functional differences in skilled 'solutions' to shared athletic problems. Identifying spheres of human activity susceptible to different solution strategies may be a useful preliminary step to illuminating dramatic cultural differences in neurological processing; some activities may be relatively uniform neuro-functionally because task constraints make only one solution strategy viable. Because sports like association football (soccer), rugby union, basketball, tennis, cricket, and baseball are played widely, sometimes in significantly different styles, they would be auspicious environs in which to observe how training regimens and playing experience shape the neurological underpinnings of expertise. The late sociologist, Pierre Bourdieu (1990), for example, identified differences in 'styles' of playing the same sport were crucial for understanding different class-based relations to the practitioners' bodies.

This project is part of an attempt to develop a fully-fledged 'neuroanthropology,' a synthesis of cultural anthropology with contemporary brain sciences (see also Campbell & Garcia, 2009; Domínguez Duque et al. 2009; Downey & Lende, 2009). Dias (2010) has argued that, neuroanthropology will only emerge as a distinctive intellectual endeavour if it identifies 'hard problems' that

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are insoluble by other research methods or theory. Sporting performance and elite skills are such a 'hard problem' because any division between the 'cultural' and the 'biological,' between the effects of developmental dynamics from the innate athletic endowment, is both empirically and theoretically untenable.

Sports commentary may be a recurrent generator of obsolete thinking—racism, essentialism, faith in 'talent' which borders on genetic predestinationism, and the like—precisely because the processes through which human experience and interaction become our physiological condition are so opaque and, frankly, incredible to most observers. The gap between the abilities of an average person and an Olympian yawns so wide that it's difficult to imagine how that physical difference could emerge; surely such profound difference must already be inchoate at the onset of a person's life. The cognitive abilities of exceptional athletes demonstrate the potential to grow extraordinary human brains and finely-tuned nervous systems with relatively mundane means, applied with great persistence, a wealth of hard-won knowledge, and a bit of luck.

Culture and anthropology in cognitive science

Interest in cultural differences in cognition has waxed and waned in cognitive science. Donald Norman (1980) highlighted 'belief systems' in his classic discussion of twelve issues for the field, and Harold Gardiner's *The Mind's New Science* (1985) identifies anthropology as one of the six core disciplines in cognitive science (see Cole, 2003). Nevertheless, anthropology has seldom been a full partner in the study of cognition with rare exceptions, such as Dan Sperber (1996) and Edwin Hutchins (1995).

Anthropologists have absented themselves from the conversation in cognitive science because of disciplinary upheavals around objectivity, ethnographic methods, analysis of individuals, and the relation between science and representation in our discipline. A 'symbolic turn' in anthropology and an express anti-psychologism moved much of the field away from considering cognitive questions; as Patricia Greenfield (2000: 564) has suggested, cultural anthropology 'took postmodernism on the chin' in a way that many parts of cognitive science avoided. Severe self-scrutiny ultimately strengthened the field, but led many anthropologists to avoid collaborating with scholars who seemed much less self-critical or concerned about the political and moral entailments of empirical research.

One of the obstacles preventing anthropologists from collaborating on human cognitive variation, however, is that much of the cognitive research on cultural difference relies heavily upon sampling 'Westerners' and 'Asians' (Cohen, 2009:194; e.g., Chua et al. 2005; Lewis et al. 2008; Masuda and Nisbett 2001; Moriguchi et al. 2005; Nisbett & Masuda 2003; Zhu & Han, 2008; see also Nisbett, 2003). Because most cultural anthropologists specialize in quite specific, carefully defined cultural groups, heavily in fine distinctions among closely-related worldviews, sweeping comparisons between large portions of the world's population may appear to be shallow stereotyping. The tendency to engage in Asian-Western comparisons derives in part from practical issues—such as finding partner researchers with comparable expertise and research infrastructure—but even psychologists have cautioned against disregarding much wider human cultural variation, variation that anthropologists have long documented (see Cohen, 2009).

The recurring contrast of Western and Asian subjects, especially treating them as if they express opposing poles—holistic or analytic thinking, individualist or collective identity—is a form of 'neural Orientalism,' taking a term Edward Said (1978). Said famously criticized scholarly accounts of Islamic 'Others' for demonstrating pervasive Eurocentrism, presenting crude caricatures of Islamic cultures, even when the portraits were romanticized.

Although Said's critique is controversial, he identified a number of intellectual problems posed by the contrast of Oriental and Occidental: rhetorical comparison overly homogenizes and essentializes both extremes, treating differences as timeless and inherent in the groups; dichotomous thinking exaggerates opposition and focuses on contrasting areas, rather than more complicated forms of relation; and Orientalism underestimates human variation, treating West and East as the extremes when they may, in fact, represent a subset of greater variation. Both Asian and Western populations are heterogeneous, and many of the over-arching descriptors of psyche or cognitive style fail to hold true on closer examination (see Oyserman et al. 2002). Exceptions to the 'Neural Orientalist' pattern exist, such as Bang and colleagues (2007) comparative work with Native Americans (Menominee), and Uskul, Kitayama and Nisbett (2008) research on foragers, pastoralists and farmers. Nevertheless, Cohen (2009: 194) suggested that, 'A person reading these literatures could be excused for concluding that there is a very small number of cultural identities.'

Anthropologists now considers obsolete the assumption that cultures are patterned from top to bottom in simple, recurring themes, as if they could be described with single terms. Anthropology experimented with this approach, focusing on 'national character' or 'modal personality' in some of the classic works of the twentieth century (e.g., Benedict, 1934). This 'patterns of culture' model has been replaced in the field by an attention to internal dissension, negotiation, inconsistency, and conflict. Even psychologists close to this literature, such as Triandis (1995), caution that intragroup variation makes simple portraits of cultures potentially misleading (see also Oyserman et al. 2002).

Enculturation as enskilment

The skills-based conception of culture advocated in this paper seeks to involve anthropologists in cognitive science by offering a more nuanced model of culture for collaboration. The skills-based model contrasts with current approaches to culture, which tend to focus on population-level, aggregated psychometric differences, and explains these differences by positing *culture as information*. Current

research treats 'cultures', typically national, language or ethnic groups, as distinct experimental populations (see Hermans & Kempen, 1998). Any significant statistical disparity between the two groups is identified as the 'cultural difference' between them.

Treating a 'culture' as a population poses certain difficulties, including the essentialism and racism that Said warned against. Moreover, if no significant difference appears in psychometric testing or neuroimaging data for the two groups, cultural difference is experimentally invisible. That is, if two groups achieve similar performance, even if they do so using radically different means, the results might not produce the between-group contrast that the population-based method assumes is 'the cultural difference' between them.

In order to explain between-population differences, cognitive theorists usually describe culture as a body of ideas, concepts or schemas, transmitted, with varying degrees of fidelity, to each member of the group. In their wide-ranging discussion of the cognitive foundations of culture, for example, Sperber and Hirschfeld (2004:40) offer a sophisticated version of the 'shared information' culture concept:

> A cultural group is held together by a constant flow of information, most of which is about local transient circumstances and not transmitted much beyond them. Some information, being of more general relevance, is repeatedly transmitted in an explicit or implicit manner and can end up being shared by many or even most members of the group. *'Culture' refers to this widely distributed information, its representation in people's minds, and its expressions in their behaviors and interactions.* (emphasis added)

Cognitive anthropologists have most frequently treated culture as an information-based framework (schema, cognitive structure, system of categories). For example, Roy D'Andrade (1981: 182), described culture as 'the shared information—the cognitive content—upon which cognitive processes operate' and Shweder and Haidt (2000: 398) offered 'meanings, conceptions, and interpretive schemes.'

Although treating cultural groups as a subject population or culture as shared information highlight certain dimensions of human variation, and have produced exemplary anthropological theory, the skills-based perspective on culture helps us to understand better the reasons for between-population contrasts as well as internal diversity within groups. For example, the separation of neuroanatomy and information, 'hardware' and 'software' in metaphorical terms, underwrites the treatment of culture as 'information' but is out of step with the recognition that learning entails material change to the nervous system. A wide range of neuroscience research reveals that skill acquisition and enculturation are not simply the internalization of 'information,' but the remodeling of the brain and nervous system, its architecture, connectivity, responsiveness, speed, reactivity, and biases (see, for example, Bukach *et al.* 2006; Draganski *et al.* 2004; Draganski & May, 2008; Han & Northoff 2008; Karni *et al.* 1995; Maguire *et al.* 2000; Park & Gutchess, 2002; Poldrack et al. 1998; Scholz et al. 2009). Learning is material change in the brain, not merely ideational additions to the 'mind.'

A skills-based model of culture moves us away from thinking of 'a culture' as an unproblematic entity, either as a clearly defined group of people (because skill levels necessarily vary) or as a body of shared information (because skills inherently involve more than information, such as technique, perceptual acuity and physiological conditioning). In addition, treating human diversity as the result of skill acquisition helps us to reconcile animosity toward racist and innatist arguments with an appreciation of emergent organic differences among human brains.

Anthropologists have long struggled with a conflict between appreciating cultural diversity and opposing racism and other hard divisions of the human species. For the 'father' of American anthropology, Franz Boas (1911), the 'psychic unity' of humanity was foundational to anthropology, and it continues to be the 'theoretical and moral bedrock' of the discipline (Shore, 1996: 15). This foundational commitment is ironic because, in practice, the principle of 'psychic unity' has entailed an unstable, inherently contradictory position: assuming that physiological and neural differences among humans were of little consequence in spite of the fact that the discipline's existence depended upon the profundity of cultural difference. As Bradd Shore (1996: 37) has argued, the assertion of uniformity together with an existential commitment to variation produced a 'psychic unity muddle,' the inability to reconcil 'a pluralistic conception of culture with a uniformitarian conception of mind.'

Shore suggests that Boas dispelled the muddle by assuming that the human 'mind' is a uniform container, but that the modes of thought are shaped by culture; Boas drove a wedge between culture and mind, according to Shore (ibid.: 22). As anthropologists have become less confident about asserting a universal 'mind,' some theorists now, according to Shore (ibid.: 32), locate humanity's 'psychic unity' in a fixed and unvarying organic brain. Both the treatment of the brain (or mind) as 'container' and the assumption that the brain is unvarying have made it very difficult for anthropologists to grapple with emerging discussions of neural change as fundamentally material processes, with organic consequences to mental events.

A 'skills-based' model of culture helps to identify the activities where neurological diversity is likely to be most pronounced and suggests how this variation might arise. If a form of training or technique for problem-solving makes use of significantly different neurological resources, we would expect that the developmental trajectories leading to competence would be accompanied by observable psychological and neurological divergence. For example, because many Asian children learn to perform basic mathematics with an abacus, they make use of different

neural resources, including visualization, when doing mental calculations (see Cantlon & Brannon 2006; Tang *et al.* 2006).

In contrast, even if there are profound cultural differences between populations, if they are using very similar neurological resources to perform functions, the 'cultural difference' will be largely indistinguishable in imaging techniques focused on functioning. For example, speakers of diverse languages likely need a similar repertoire of cognitive-neurological skills—parsing of rapid streams of vocal sounds, control of lips, tongue and palate, working memory, object recall, grammatical sophistication, ego- and alterocentric references—so that diverse languages may be neurologically 'indistinguishable.' Only when some substantial difference exists between the language skills themselves—such as literacy compared to non-literate groups, different reading directions, languages with complex politeness norms or context-dependent grammar, predominance of different forms of reference, grammars that force distinctive types of information to be disclosed, formulaic speech or honourifics, multilingual contexts—\ we would expect to see differences in neural dynamics and the resulting architectures. In empirical or neuroimaging comparisons between divergently skilled cultural groups, we are more likely to find empirical evidence of difference when comparing neural apples and oranges, in a manner of speaking, rather than different varieties of apples. As Paul Mason has pointed out to me (personal communication), cultural variation in neurological function is most likely to occur where different brain regions can execute the same or similar functions, called 'degeneracy' by neuroscientists (see Edelman, 2006: 57).

The skills-based approach makes better sense of even long-standing evidence of cultural difference in psychology. For example, as Oyserman and colleagues (2002: 44) discuss, new research show different groups can be primed to express either collectivist or individualist perspectives with varying success, suggesting that collectivist and individualist thinking are both cognitive skills possessed by both Asians and Westerners, but that these skills may not be equally exercised. Rather than citing the statistical difference between subjects in Asia and the United States as proof that one group is 'collectivist' and the other 'individualist,' we might search ethngraphically for the social contexts and cultural patterns that make some forms of thinking easier for a particular group. The skills-based approach means we need not discard an outlying individual as a poor representative of his or her 'culture'; rather, we can seek to understand from a life history perspective how this person acquired such a distinctive cognitive skill set.

Studies of elite performance

Elite athletes from different cultural groups can serve as test case because experts make evident in exaggerated form the divergent expertise produced by distinctive developmental environments. High performing outlier populations like musicians (Kelly & Garavan, 2005; Münte et al. 2002), taxicab drivers (Maguire et al. 2000), and jugglers (Draganski *et al.* 2004) all demonstrate distinctive patterns of neurological development. Skill acquisition typically entails neurological remodeling, but in sports, increased proficiency often leads to more widespread physiological change in skeletal muscle, the cardio-vascular system, and even bone composition (see Ericsson & Lehmann 1996).

Critics may charge that evidence from elite athletes is a weak analogy to enculturation precisely because athletes perform with exceptional skill. From a neurological perspective, however, we might expect skills learned later in life like sports to have even less impact on the central nervous system than early enculturation experiences. Neuroplasticity is more pronounced in the immature brain than in the adult (Huttenlocher, 2002), so early formative training, even in mundane 'skills' like walking, speaking, language comprehension, self-control, and social interaction, likely involves a radical suite of neurological adaptations. Constant 'training' in everyday activities undoubtedly has neurological consequences as profound or even more radical than the refined specialist training regimens of international athletes.

Most studies of elite skills, however, tend to assume that proficiency is convergent; the more proficient an expert, the more like other experts he or she becomes, especially in pattern recognition and fast information processing (see Chase & Simon, 1973). In fact, we know that different training regimens produce different forms of expertise, even within the same team—batsmen don't suddenly become excellent spin bowlers without the appropriate training—but the research does not specifically explore variations in the forms of high level expertise, what makes one spin bowler different to another who has his or her own coaching, background, training experiences, and technique. If task constraints in an athletic endeavour are sufficiently narrow, only one neuro-physio-behavioural configuration of skill might, in fact, be consistent with elite performance. This type of athletic task would be a 'convergent' task space, an activity where all strategies for engaging in the task were less efficient than the preferred method. To the degree that an athlete failed to adopt the dominant strategy, he or she would be condemned to achieve less success.

Prima facie evidence suggests, however, that some athletic tasks are not 'converging,' allowing multiple successful skilled strategies:

1. Local experts reliably recognize style differences among elite players, even national playing styles in global sports. Although indigenous expert discourse is liable to ideological biases, the pervasive commitment that stylistic differences exist and are meaningful at least suggests these differences are worthy of investigation.

2. Similar bodily techniques with closely related kinematics do not evoke the same neurological responses when perceived by experts. Calvo-Merino and colleagues (2004) found that mirror functioning in the premotor areas varied depending upon whether a capoeira or ballet expert was watching a technique performed by another expert in

the same movement discipline or a different one. This suggests that stylistic differences were discernible by the nervous system.

3. Expertise in a variety of sports can lead to different results on tests of basic skills, such as balance or eye-hand coordination. These tests suggests that sports training is leading athletes to develop techniques for doing tasks, such as remaining balanced when standing with the eyes closed (a test of equilibrium), that athletes trained in other sports do not develop, no matter how proficient (see Vuillerme & Nougier, 2004).

4. Elite athletes at the same position are not 'interchangeable,' but may have idiosyncratic playing styles that cause a group strategy to break down. The inability to insert experts into any playing system suggests that not all forms of 'the same' expertise are identical.

5. Research on problem-solving strategies suggests that national groups have developed significantly different problem-solving strategies, evident when they attempt to solve computer-based problems (see Güss et al. 2009; Strohschneider, 2001; Strohschneider & Güss, 1999).

All of these factors, some empirical and some more ethnographic and subjective, suggest that significant cultural differences may exist among elite athletes, likely owing to the distinctive developmental influences on individuals as they become more proficient. The opportunity to explore variation in cognitive enculturation in this fashion leads me to propose a project exploring junior rugby union across cultures, employing mixed quantitative and qualitative research methods to examine how patterns of skill development might emerge in different contexts.

The case of rugby halfbacks: skill diversity

My previous research on diverse physical disciplines and their psychological and perceptual effects (see Downey, 2005, 2008b, 2010) has not allowed for a rigorous comparative analysis. Studying capoeira in Salvador, Brazil, and mixed martial arts fighters in the United States introduced too many complicating elements to allow a systematic comparison of different forms of expertise. International sports, in contrast, make an excellent forum in which to study embodied cognition for a host of reasons: behaviour may be observed directly in its 'natural environment', without the need for artificial experimental constructs; the playing situation itself is uniform and tightly regulated, creating near-experimental conditions; performance is rigorously analysed and exhaustively discussed by indigenous experts; and the same sports are played in a wide variety of places, in distinctive styles.

Cultural difference in sports will likely be most profound in the most complex skills, those demanding an integrated constellation of perceptual, motor, and cognitive refinement as well as physiological adaptation. In contrast, the athletic skills that have been studied most closely in neuropsychology are tightly constrained and limited—hitting a fast pitch, blocking a penalty kick, making a putt, returning a serve in tennis. The task constraints of basic skills may limit possible solutions strategies more than in open-ended skills like captaining a cricket side in the field while also catching and studying opposing batsmen; reading a defense, calling audible changes to the offense and completing a pass as a football quarterback; or deciding whether to pass or shoot while skating toward a congested part of the ice in hockey. In these complex situations, a player can essentially redefine 'the problem' by subtly shifting the unfolding dynamics or focusing upon realizing different opportunities.

Moreover, strategy differences in elite sports would not simply be on-line cognitive processes but also long-term development programs. The reiteration of preferred ways of performing a task, the repetition of training drills and supplementary conditioning, will result in substantial differences in neural architecture, perceptual behaviour and motor abilities. Every virtuoso does not take an identical body or nervous system into a match, so problem-solving strategies are both immediate and developmental. For example, a strategy making greater use of the decision-maker's own mobility will necessitate developing greater agility, acceleration and whole body strength than a strategy that relies more on rapid stationary perceptual reading of the opposition and pattern recognition. That is, strategy is an embodied cognitive trait, not only because it requires whole-body integration to be realized, but also because one's strategy, over time, has developmental implications for a wide range of physiological traits and capacities. To study cultural differences in sports is to study both different playing styles and different developmental programs.

In order to explore cultural diversity in elite skill development, I have chosen rugby union because the sport is widely played in distinctive styles, and for the pragmatic reason that some of the strongest national programs are native to our region (Australia, New Zealand, Fiji, Tonga, Samoa). From my own background in team sports and informal observations, my hypothesis is that there might be as many as four distinctive successful and stable cognitive strategies for performing at a high level as a half-back in rugby union:

Pattern recall and execution of pre-ordained plays A player could perform at a high level by learning a repertoire of pre-designed responses to defensive patterns as part of a team strategy to execute set plays. We would expect this cognitive pattern to make extensive use of quick pattern recognition, recall for team configuration in the pre-designed play, and quick execution of practiced motor actions. To refer to this strategy by a commonly heard sports interview cliché, this would be the idea that victory depended upon 'sticking with the game plan.'

Opportunity perception with perfection of primary skills In contrast, a player and team might be drilled less in whole-team strategic formations and responses, but rather in basic skills and tactics, and taught to react quickly to the immediate playing environment. Like the fixed play recall

strategy, this sort of expertise would require quick pattern recognition, but it would require less recall of one own teammates' pre-designated movements; it might not even include set patterns for one's teammates. This strategy would place different cognitive demands upon players. For example, while playmakers would not have to recall set plays, they would have to monitor or quickly assess the positions of their teammates, if they did not have pre-ordained positions. If the first strategy placed an especially high demand upon recall and fast matching to pre-determined response, the 'opportunity perception' strategy would place much higher demands upon same-time monitoring, multiple target tracking, and quick decision-making. A developmental program that might lead to this sort of expertise might include less early specialization for athletes, allowing them to play in multiple positions to develop different dimensions of the sport's potential skills set (see Baker et al. 2003).

Again, to refer to this strategy by a phrase heard among athletes, this approach might be called a 'Play what's in front of you' style of athletic problem solving. In training, we might expect to see small groups drilled repeatedly in ball-handling and decision-making, with very little attention to planning or creating stable expectations among one's teammates. This sort of 'excellence' might be much more unpredictable than the more well-drilled application of pre-determined plays, and it may be a problem-solving strategy that requires particular, long-term investment in perceptual skill production.

Perfection of an idiosyncratic variant or restricted repertoire of techniques Some high-performing elite athletes in decision-making roles seem to excel at particular plays or situations, to develop a limited subset of the normal skill range at a pivot position, but to do so at a very high level. This pattern of maximal adaptation to the perfection of idiosyncratic excellence may arise when players are not drilled but rather early specialize or develop their own virtuoso patterns. Ironically, these players might be especially hard to defend against as the player's particular specialist solution might be especially odd or unusual to encounter otherwise.

In the language of sports cliché, this is the 'You've got to do what works for you' approach to elite performance. The approach should be relatively easy to diagnose, as it would involve a high level of performance in certain dimensions of the skill set while other facets of the repertoire are not performed at the same high level. Players employing this strategy would choose the same sorts of plays again and again, succeeding because of highly refined, but relatively specialized techniques. We might expect this patter of expertise to arise in range of developmental contexts where certain conditions dominate: absence of uniform drilling (such as both right and left variants), 'home grown' performance against changing opposition (where opposing players are unlikely to recognize and neutralize the player's dominant technique), or specialist training, where an individual is consistently employed in uniform circumstances. We might find that particular training or coaching traditions might produce particular sorts of 'one-dimensional' players, where whole groups demonstrated a distinctive pattern of skewed choices, and disproportionate success with those strategies. Only ethnographic research would be able to supplement observational analysis to suggest the reasons for observed patterns within a group.

Group anticipation and shared expectations Elite performance may also be generated by heavy investments in distributed knowledge and shared awareness among a cadre of players who work together for long periods of time. In a group anticipation form of excellence, virtuoso performance depends heavily on shared expectations and the spontaneous generation of predictable solutions to problems within a team, so that, even without fixed plays or pre-designed options, a group of individuals can depend upon each other to share perceptions of opportunities. Ironically, the social ecology of contemporary elite athletics likely militates against this form of exceptional performance although coaches frequently discuss it as an ideal, because at highly selective levels, players constantly move in and out of squads due to injury, player trades, or competition for selection.

Whereas pattern recall strategies depend heavily on recall of abstract plays, the group anticipation strategy would depend upon intimate awareness of one's teammates' abilities, proclivities and preferences and likely, in part, involve what Cannon-Bowers, Salas and Converse (1993) refer to as 'shared mental models'. This type of expertise, involving investment in a whole group of individuals, might produce a team who, individually, seem to be 'less talented' but together perform at a high level of collective skill. In sporting clichés, we might expect this group to demonstrate that 'the whole is greater than the sum of the parts' or that, 'No one can do it by himself; it was a team effort.' This pattern of expertise might be identified by noting if the individuals' expertise seemed to transfer poorly to other playing situations or if group performance deteriorated quickly with a substitute. In a controlled experiment, we would expert virtuoso players in this situation to perform quite poorly unless the playing scenarios actually involved cohorts performing in ways like their usual colleagues. Ethnographically or historically, groups with high levels of collective expertise should be easy to trace through different age grades or levels of performance as the group stayed together and gained from their shared experience.

Conclusion

Even though anthropologist Clifford Geertz is frequently blamed (or credited) with persuading his field away from psychology, he offers a fitting argument for the necessity of the neuroanthropological synthesis:

> Man's nervous system does not merely enable him to acquire culture, it positively demands that he do so if it is going to function at all. Rather than culture acting

> only to supplement, develop, and extend organically based capacities logically and genetically prior to it, it would seem to be an ingredient to those capacities themselves. A cultureless human being would probably turn out to be not an intrinsically talented, though unfulfilled ape, but a wholly mindless and consequently unworkable monstrosity. (Geertz, 1973: 67–68)

My only reservation with his statement is that, upon closer examination, it is hard to draw any clear line between 'culture' and the 'nervous system,' just as it is to distinguish 'mind' from 'brain.' Culture is the condition of the nervous system; the nervous system the pre-eminent cultural organ.

If elite skills differ, then international-level performers are the tip of the proverbial cultural iceberg, the most dramatic manifestations of differing developmental environments where skills are germinating in plastic nervous systems. Although elite variation may be the product, the systems themselves are what interests me, as they offer powerful analogues for thinking about a whole host of developmental dynamics across cultures, the ways that everyday enculturation regimes shape cognitive capacities, perceptual abilities, motor potential, emotional reactions, and a host of other cultural variables. That is, the emergence of different forms of elite skill may help us to rethink culture itself, to generate rich processual, developmental models of human enculturation.

In practical terms, the project I am proposing may help us to better match novices with training regimens appropriate to their emerging skills, or to encourage students to develop broader, more versatile skill sets. Sports training plays a significant socializing role in the childhoods of many people; improving the quality of training and recognizing better how these formative experiences affect cognitive development can lead to better outcomes overall. The goal is not so much to produce greater athletic excellence but to recognize how even the most pervasive skills, taken for granted in the majority of the population, are themselves the product of a kind of training regimen.

For the field of cognitive science, a skills-based model of cultural difference offers a more sophisticated account of culture and cognition, including a better explanation of the origin of difference. Treating culture as skills allows us to explain exceptions to the patterns we might expect from the over-arching descriptions of particular groups. Asking whether all elite skills converge may help us to identify realms of human activity where we might best observe the effects of enculturation and diverse forms of human achievement.

For anthropology itself, skill acquisition provides a persuasive 'hard problem' for advancing our understanding of biology-culture interactions. Skill acquisition shapes our sense of self, especially the way we embody culture (see Campbell & Garcia, 2009). Sports demonstrate persuasively that culture has biological effects, although this may lead us to reassess the assumption of the 'psychic unity' of humanity. Ultimately, a neuroanthropology that offers a clear account of the emergence of biological differences among people stands the greatest chance of emerging from the muddle caused by conflicting commitments to human universalism and cultural particularity. Although this proposition may be frightening, this robust perspective on emergent differences among humans is one of the most valuable gifts we can offer to our colleagues in cognitive science.

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