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Human Evolution and Social Cognition

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The massive and complex information-crunching capacities of the human brain were designed to help our ancestors make functional decisions in an environment that included other people as a prominent feature. Some of those people were relatives; some were strangers. Some were socially dominant; some were meek. Some were potential allies; others were potential enemies. Some were potential mates; others were potential competitors for those mates. Many aspects of human cognition – especially the processes that define the conceptual territory of social cognition – are adapted to the recurrent problems and opportunities posed by these other members of ancestral human populations.

So, if we are to understand social cognition fully and deeply, it is useful – perhaps even essential – to employ the following scientific strategy: First, identify the set of fitness-relevant "problems" recurrently posed by human social environments (what opportunities and dangers have other people traditionally posed?). Second, employ an evolutionary cost–benefit analysis to deduce plausible cognitive adaptations that would have helped "solve" those problems. Third, deduce the specific implications of these adaptations for human cognition in contemporary social environments. And, fourth, test those hypothesized implications rigorously with empirical data.

This evolutionarily informed approach to the study of human social cognition produces at least two substantial scientific benefits. First, this approach can yield a deeper understanding of many well-documented social cognitive phenomena – an appreciation not only for the proximate triggers of those phenomena in the contemporary workings of the human mind, but also for the ultimate causes of these phenomena within the history of the species. When considered in an evolutionary light, human social cognition is not merely one domain of inquiry within the small scientific province of social psychology; it is instead a topic of relevance to any scientist who cares about the evolution and behavioral ecology of mammalian species in general. Beyond connecting social cognition to these broader questions, the other benefit is its powerful heuristic potential. To those whose primary goal is simply to predict human social cognition and behavior, the evolutionary approach to social cognition yields novel and important discoveries about the contemporary workings of the human mind.

1. The problem set: perils and prospects of social life

So just what were the enduring social problems that imposed selection pressures on ancestral populations? A number of different social scientists have attempted to answer this question. Some answers focus on fundamental domains of sociality – whether defined in terms of elementary forms of social relationships (A Fiske 1992), algorithms of social life (Bugental 2000), or social geometries that govern interpersonal interactions (Kenrick *et al.* 2002, 2003). Other answers focus on fundamental human motives that are aroused by and govern behavior within different kinds of social interactions (S Fiske 2004; Kenrick *et al.* 1999). Across these

various conceptualizations, there emerges a set of enduring problems that likely exerted substantial influence on the evolution of human populations. This set of problems can be broken down into two subsets: (a) a set of social prospects or opportunities, the successful obtaining of which would have had a positive impact on inclusive fitness; and (b) a set of social perils, the successful avoidance of which would have had a positive impact on inclusive fitness.

Table 1 lists some examples of specific prospects and perils pertaining to specific domains of social life. We will elaborate just a bit on several of them for illustrative purposes.

Consider first the positive impact of other people. Affiliating with others offers the potential for interpersonal bonds and social support, and the successful attainment and maintenance of these interpersonal relationships can have important positive consequences for fitness (Dunbar 1997; Taylor and Gonzaga in press). Social interactions also provide the necessary means for selectively distributing resources to one's offspring and other kin, and more generally provide the opportunity to help ensure the reproductive success of those kin. And, of course, it is the act of reproduction itself that is the preeminent prospect offered by social interaction. Mammals don't reproduce alone; reproductive fitness has depended crucially on successful mating. This requires that individuals not only successfully solve the problem of attracting a mate, but also the problem of selecting a mate (or mates) bearing characteristics optimal to one's own inclusive fitness. Of course, given differences in parental investment that have characterized so much of human evolutionary history, different mating tendencies have had different fitness-relevant costs and benefits for males and females. Thus, when faced with the prospect of selecting a mate who optimizes one's own inclusive fitness, one expects to witness sex differences in the behavioral strategies employed by men and women, and in the goals that they look to satisfy (Buss and Schmitt 1993; Kenrick *et al.* 1990).

Social interactions are not only a source of potential benefits; they are the source of many fitness-relevant perils as well. The set of perils includes threats to health and well-being (e.g., Kurzban and Leary 2001; Neuberg and Cottrell in press; Schaller *et al.* 2003). Such threats may result from another's intention to do harm, or they may be unintentional, such as the threat of contracting parasites or pathogens from someone who is already infected. A rather different sort of peril arises in the guise of cheating, stealing, or other forms of social contract violation, such as when another individual fails to reciprocate a resource-consuming prosocial act (Cosmides and Tooby 1992). Even if one's own health or welfare is not at stake, any such threat to one's kin would also have consequences on inclusive fitness. The set of perils is not merely limited to other individuals who engage in behavior that affects oneself (or one's kin) directly. To the extent that one's fitness outcomes are dependent on the presence of a social group and the efficient functioning of that group, then any individual who engages in behavior detrimental to the functioning of the group can also be viewed as a source of peril. In addition, given that many fitness outcomes have historically depended upon group living, a fundamental form of social peril lies in the potential to be cast out or rejected from one's social group (Baumeister and Leary 1995).

These and other social problems – prospects to be achieved and perils to be avoided – have endured for countless generations in human evolutionary history. These problems are likely to have exerted nontrivial selection pressures on the evolution of human social cognition.

2. The solution set: evolved features of social cognition

With this quick review of fitness-relevant problems in mind, we can now address the central question: Just what evolutionarily plausible cognitive adaptations might have arisen to

help solve one or more of these problems? Table 2 provides an illustrative list of examples, most of which pertain to specific attentional hypersensitivities or information-processing biases. To understand the evolutionary origins of these cognitive adaptations, it is useful to first deconstruct each fitness-relevant problem into a set of smaller subproblems. After all, although each problem is defined in terms of behavioral outcomes, the solution may require a cascade of cognitive events that precede and promote specific kinds of behavior.

At the very least, there are two kinds of cognitive steps implicated in any functionally useful behavioral response to social stimuli. One must first attend to any set of social stimuli so as to identify and differentiate between individuals with different implications for one's inclusive fitness. And, after fitness-diagnostic clues have been perceived, one must have some means for efficiently facilitating a functionally beneficial behavioral response. Therefore, in discussing the evolved features of social cognition, we begin with these two subproblems – one that implicates attentional processes and the other that implicates a variety of higher-order cognitive processes – and review possible cognitive adaptations that help to solve them.

2.1. Hypervigilance and selective allocation of attentional resources

In order to solve any of the fitness-relevant problems of social life, one must identify those individuals who pose specific kinds of perils or prospects. In order to avoid contracting contagious diseases, for instance, one must identify individuals who are already infected and discriminate them from those who are not. In order to choose an optimal mate, one must identify those individuals who have desirable characteristics and discriminate them from those who do not. Successful social identification and discrimination requires the allocation of attention to features that are actually diagnostic of those specific dangers or opportunities.

Attention is a limited resource. To the extent that attention is allocated to specific kinds of features or to specific individuals in the social environment, one is less able to allocate attention to other features or individuals. It would have been adaptive for individual animals to selectively allocate attentional resources to particular pieces of information in the social environment that are especially relevant to recurrent problems of social life and that most readily compel fitness-optimizing solutions to those problems.

Plenty of evidence in the behavioral ecology literature indicates that animals selectively acquire information that is relevant to survival and reproduction (Dukas 2002). Conceptually similar findings are well documented in the literature on human perception and cognition. Most of this research focuses on visual attention. For instance, compared with other less threatening kinds of visual stimuli, people are especially quick to visually detect the presence of snakes and spiders (Öhman *et al.* 2001). This finding is buttressed by neural correlates of attention: Studies assessing event-related potentials (ERPs) in the human brain indicate a faster response to emotionally negative stimuli than to either emotionally positive or neutral stimuli (Carretié *et al.* 2004). It appears that visual attention is selectively allocated to the detection of threats in the natural environment.

Does this conclusion apply also to threats unique to the social environment? Yes. There is a burgeoning literature on the effects of human faces and facial features on visual attention. People are uniquely attentive to the features of human faces, especially those features – such as the eyes, eyebrows, and mouth – that are most strongly diagnostic of facial emotions (e.g., Lunqvist and Öhman 2005; Ristic *et al.* 2002). People seem to be particularly attentive to facial expressions that connote threat. Compared with other kinds of social stimuli – including more emotionally positive facial expressions – angry faces are especially quick to grab and/or hold

attention (Fox *et al.* 2001). As with nonsocial stimuli, these effects are buttressed by ERP results indicating a more immediate neural response to angry faces (Schupp *et al.* 2004).

People selectively allocate attention not only to potential sources of threat, but also to potential sources of reproductive reward. In a study that assessed the temporal duration of eye-fixations on male and female faces of varying physical attractiveness, Maner *et al.* (2003) found that men allocated substantially more time looking at attractive (relative to unattractive) female faces. Given that facial attractiveness serves as a cue indicating fitness and fertility (Fink and Penton-Voak 2002; Thornhill and Gangestad 1999), this finding is consistent with the hypothesis that men selectively allocate attention to individuals who offer the greatest promise of reproductive reward. (Men did not show any such attentional bias toward attractive male faces – a context in which physical attractiveness would not serve as a cue to reproductive fitness. Further, women showed a qualitatively different pattern of results – consistent with logic derived from the theory of differential parental investment, indicating that physical attractiveness serves a somewhat different function in the mating strategies of men and women.)

In many circumstances, there is a positive relationship between the attention allocated to a target individual and later memory for that individual's identifying features. Consequently, allocation of attention can sometimes be indicated indirectly by memory measures. Using such an approach, various lines of research suggest that attentional resources are selectively allocated to those individuals who appear to be potential sources of reproductive prospect or peril. For instance, several studies have examined whether "cheaters" – individuals who violate social contracts – are especially memorable. It appears that they are (Mealey *et al.* 1996; Oda 1997; Yamagishi *et al.* 2003).

In sum, the human mind seems to be hypervigilant to cues connoting fitness-relevant perils and prospects. The evolutionarily enduring problems of social life have left their mark on the highly automatized processes of social attention.

2.2. Activation and manipulation of social knowledge structures

Selective attention alone is insufficient to solve the recurrent problems of social life. Animals must not only gather fitness-relevant information about the world around them; their minds must do something with that information. Therefore, animals likely evolved specific kinds of higher-order cognitive processes that provide quick, efficient means of facilitating adaptive behavioral responses whenever fitness-relevant information is detected.

Theory and research in this broad domain of inquiry can be loosely lumped into two categories: (a) research that focuses on reasoning and human decision processes, and (b) research that focuses more simply on the activation of knowledge structures into working memory.

Within the realm of reasoning, it has been argued that there evolved cognitive algorithms of information integration that facilitated accurate diagnosis of those individuals who violate social contracts (Cosmides and Tooby 1992). The plausibility of a special "cheater-detection" mode of reasoning has been the focus of an extensive line of research. Abundant evidence suggests that people show enhanced facility for a specific form of propositional reasoning under conditions in which the reasoning task is clearly relevant to social contract violations (e.g., Cosmides 1989; Fiddick *et al.* 2000; Sugiyama *et al.* 2002). Indeed, neuroscience data have indicated that a somewhat different set of brain structures is involved in fitness-relevant versus fitness-irrelevant forms of the same logical reasoning task (Adolphs 1999; Stone *et al.* 2002).

Other lines of research on reasoning and decision-making have focused on the evolutionary implications of other kinds of social problems, including problems related to the

allocation of resources to kin versus nonkin (Burnstein *et al.* 1994) and problems pertaining to the navigation of social hierarchies (Cummins 1999). There are several lines of research that focus specifically on predictable biases in social judgment and social decision-making (e.g., Nesse 2005; Haselton and Nettle in press). For instance, within the realm of mating, there is a predictable bias such that men misjudge women to be more desirous of sexual relations than they actually are – a bias that can be readily predicted from an evolutionarily informed cost–benefit analysis indicating that for men (compared with women), ignoring a willing mate incurs heavier fitness costs than approaching an unwilling one (Haselton and Buss 2000). Conceptually similar analyses have been applied to many other domains of social interaction, yielding hypotheses specifying adaptive "errors" and biases across a broad range of judgment and decision-making. The empirical database supports these evolutionarily informed hypotheses (Haselton and Funder in press; Haselton and Nettle in press).

Research on reasoning yields conclusions that pertain primarily to processes through which information, already in working memory, is manipulated and integrated. But how does that information get into working memory in the first place? In some cases, the information is perceived directly and concurrently from the external environment – thanks in part to the selective allocation of attentional resources, discussed above. In addition, other potentially useful information may have been acquired previously (e.g., learned associations) and archived in long-term memory. It would have been adaptive for individuals to have selective access to whatever archived information is especially pertinent to the adaptive problems of social life – information that most readily compels fitness-optimizing solutions to those problems. Thus, there is another class of evolved cognitive algorithms. These are simple stimulus–response algorithms in which some perceived cue acts as a stimulus, automatically activating into working memory specific cognitions that dispose individuals to respond in ways that confer fitness benefits.

When one perceives a potentially threatening individual, for instance, adaptive behavior (e.g., avoidance or the adoption of a defensive posture) is facilitated by the automatic activation of cognitions characterizing the individual as a threat. This stimulus–response algorithm not only influences cognitive responses to obvious sources of social peril (e.g., individuals with angry facial expressions), it also leads to predictable biases in the stereotypes that are activated when people encounter members of racial or ethnic outgroups. Ethnic group membership represents a contemporary analog to the sorts of coalitional group memberships that have played a substantial role in social life throughout human evolutionary history (Kurzban *et al.* 2001). Throughout that history, coalitional ingroups were sources of support and safety, whereas encounters with outgroup members (perhaps especially unexpected encounters with outgroup males) represented potential threats to personal welfare. Consequently, perceptual encounters with unknown outgroup members may automatically activate cognitions connoting threat. This is evident not only in the semantic contents of cognitively accessible stereotypes about ethnic outgroups (Schaller *et al.* 2003), but also in the fearful emotional responses to these outgroups (e.g., Cottrell and Neuberg 2005). These patterns of cognitive response are bolstered by data indicating that the perception of ethnic outgroup members stimulates greater activity in brain structures associated with fear and triggers a physiological threat response (Blascovich *et al.* 2001; Phelps *et al.* 2000).

Other perceptual cues – associated with other kinds of potential peril – automatically activate qualitatively different kinds of threat-relevant cognitions into working memory. Morphological anomalies, such as physical disabilities and facial disfigurements, are likely to

have historically served as heuristic cues indicating parasitic infection; consequently, humans and other primates respond aversively to individuals bearing such anomalies (Goodall 1986; Kurzban and Leary 2001; Park *et al.* 2003). Underlying these behavioral reactions, it appears that the very perception of these morphological anomalies automatically activates disease-relevant cognitions into working memory – even under conditions in which perceivers explicitly know that the disfigured individual poses no health risk at all (Park *et al.* 2003).

Cues connoting potential fitness-relevant opportunities have similar algorithmic consequences, activating specific kinds of cognitions that promote adaptive behavior. In the realm of mating, men erroneously detect exaggerated levels of sexual arousal from the objectively neutral facial expressions of physically attractive women, compared with unattractive women or with attractive men; no such effect occurs among women (Maner *et al.* 2005). These results suggest that when men perceptually encounter physically attractive opposite-sex others (a constellation of cues that connotes a fitness-enhancing opportunity), this activates a set of optimistic attributions about additional characteristics of those women. It is exactly this sort of attribution that increases the likelihood of actually pursuing a mating opportunity.

Finally, there is plenty of evidence indicating that the perception of kinship cues triggers highly automatized cognitive responses. Animals rely on crude heuristic cues to infer the extent to which a conspecific is genetically related; and like many other animal species, humans use cues pertaining to familiarity and phenotypic similarity (Hepper 1991; Lieberman *et al.* 2003; Rendall 2004). If indeed these cues serve as stimuli triggering an evolved stimulus–response mechanism, then the perception of such cues in another person – even if that other person is known to be genetically unrelated – should immediately trigger emotional and cognitive responses that (a) inhibit sexual intercourse and (b) facilitate prosocial allocation of resources. Empirical evidence is consistent with these predictions. For instance, perceived facial similarity triggers attributions indicating both greater trustworthiness and decreased sexual attractiveness (DeBruine 2002, 2005). Greater attitudinal similarity – even in a total stranger – automatically activates semantic cognitions connoting kinship and is associated with a variety of prosocial intentions (Park and Schaller 2005).

In sum, just as the enduring problems of social life have left their mark on low-level attentional processes, they have left their mark on a variety of higher-order cognitive processes as well. And in doing so, they exert a predictable influence on social cognition in contemporary environments.

2.3. Costs, benefits, and the functional flexibility of evolved social cognition

Evolved psychological mechanisms may operate automatically, but that doesn't mean that they are invariant in their operation. Quite the contrary: These mechanisms are highly flexible and predictably influenced by regulatory cues in the immediate environment. This point – easily deduced from an evolutionary cost–benefit analysis – has enormous implications for social cognitive phenomena.

Evolved psychological mechanisms are associated with specific benefits (animals that had these capacities had greater reproductive fitness than those that didn't) but their actual operation typically entails some potential costs as well. Attentional hypervigilance consumes metabolic resources (or reduces the time available for acquiring those resources), as does the activation of knowledge structures. This is the case especially when these cognitive processes are accompanied by specific affective responses as well, as they often are. Moreover, because of the finite metabolic resources available to an organism at any moment, the engagement of any

one specific adaptive mechanism limits the extent to which other adaptive mechanisms might be engaged. Thus, to be more optimally adaptive, these evolved cognitive mechanisms should have evolved in such a way to be functionally flexible; they are especially likely to be engaged when additional information in the immediate environment indicates that the functional benefits are especially likely to outweigh the functional costs (but are less likely to be engaged when additional information indicates either lower benefits or higher costs). For example, the perception of a sudden loud noise automatically triggers a startle response. This acoustic startle reflex is surely adaptive in the promotion of self-protection. But it is also variable: The response is stronger under conditions – such as ambient darkness – in which people feel especially vulnerable to harm (Grillon *et al.* 1997).

Information signaling potential costs and benefits, and thus potentially moderating the engagement of evolved social cognition processes, may lie not only in individuals' external environments (physical and social contexts that may change from moment to moment), but also in the cognitive environments that individuals carry with them chronically (acquired attitudes, personality traits, and other dispositions). Thus, for instance, attentional hypervigilance to spiders occurs more strongly among arachnophobes, and hypervigilance to snakes occurs more strongly among individuals who are more chronically fearful of snakes (Öhman *et al.* 2001).

The same point applies to social cognition, too. Regardless of whether cost–benefit information is implied by chronic individual differences (e.g., individual differences in mating motives; Simpson and Gangestad 1991) or by transitory aspects of one's immediate social context, this information leads the human mind to prioritize implicitly the adaptive problems that need to be solved at any given moment. Because of this adaptive functional flexibility, evolved social cognitive phenomena vary predictably across individuals and in response to specific kinds of contextual cues.

In the realm of social attention, hypervigilance to social threat varies as a function of the perceiver's chronic feelings of vulnerability: Angry faces capture attention more quickly – and hold attention for longer periods of time – among more highly anxious individuals (Bradley *et al.* 2000; Fox *et al.* 2001). Conceptually similar effects have been found in the domain of mating. People who chronically adopt an "unrestrictive" approach to mating (and who thus chronically seek mates) are especially likely to allocate visual attention to physically attractive members of the opposite sex (Maner *et al.* 2003).

Evolved mechanisms of reasoning, judgment, and decision-making are also engaged flexibly in response to heuristic cost–benefit information. For instance, in altruistic judgment tasks, people predictably discriminate in favor of closer kin; but this effect itself shows up more strongly in life-and-death situations than in other situations in which the costs of not helping are less profound (Burnstein *et al.* 1994). Even the paradigmatic example of an evolved reasoning algorithm – the form of propositional reasoning that serves a "cheater-detection" goal – is moderated by the perceiver's social status (Cummins 1999). Compared with low-ranking individuals, high-ranking individuals (who have more resources and so are more likely to suffer costs from the presence of undetected cheaters) are more likely to demonstrate error-free propositional logic when reasoning about social contracts.

There is also abundant evidence of functional flexibility in the activation of adaptive knowledge structures into working memory. People who are chronically worried about the dangers posed by other people or have been made to feel temporarily vulnerable to harm are especially prone to the automatic activation of threat-relevant stereotypes when they perceive members of an ethnic outgroup (Schaller *et al.* 2003). This phenomenon not only affects

stereotypic judgments about the entire outgroup, but also influences inferences about the characteristics of individuals. For instance, people who are in a temporarily fearful state are especially likely to erroneously perceive anger – but not fear or other negative emotions – in the face of an outgroup member (Maner *et al.* 2005). These effects occur even if the actual outgroup poses no realistic threat whatsoever, and even if the sense of vulnerability is the result of a blatantly artificial manipulation (e.g., a temporary lack of ambient light in a psychology laboratory or a few minutes viewing of a Hollywood movie). Conceptually similar evidence of functional flexibility emerges in the automatic responses to cues that connote parasite infection and transmission (Faulkner *et al.* 2004; Park *et al.* 2003). For example, Faulkner *et al.* (2004) hypothesized that the subjective foreignness of an ethnic group might serve as a heuristic cue connoting the threat of parasite transmission. Consistent with this hypothesis, xenophobic attitudes toward foreign peoples was especially pronounced among individuals who felt chronically vulnerable to disease and among individuals for whom the risk of parasite transmission was temporarily salient. Further support is provided by evidence that newly pregnant women (e.g., in the first 10 weeks of pregnancy, a time during which the developing fetus is especially vulnerable) show an enhanced sensitivity to disgust and stronger xenophobic attitudes toward subjectively foreign groups (Navarrete *et al.* 2005, unpublished manuscript, University of California at Los Angeles).

Finally, in the domain of mating, the tendency for men to optimistically perceive sexual arousal in the faces of attractive women is stronger among men for whom a mating motive has been artificially induced, and it is also stronger among men who are sexually unrestricted and thus have a chronically more active mating motive (Maner *et al.* 2005). Meanwhile, among women, the menstrual cycle moderates the strength of adaptive sexual responses to specific stimulus features in men. During the most fertile phase of the cycle, women are especially likely to respond positively to men who are symmetrical, masculine, and have various other characteristics indicative of high reproductive fitness (Gangestad *et al.* 2004; Gangestad and Thornhill 1998; Penton-Voak and Perrett 2000).

The picture that emerges from these and other results is a portrait of a human mind that evolved in response not only to the perils and prospects of the social environment, but also to the fact that specific perils and prospects matter more under some circumstances than others. Functional flexibility is an adaptation of profound importance, and implications of this adaptive functional flexibility can be found everywhere within the social cognition literature.

3. Thinking ahead: perils and prospects of evolutionary social cognition

Inquiries into evolutionary processes, particularly when applied to contemporary human social cognition and behavior, attract an unusually high number of detractors. Some of these criticisms appear to be motivated by personal ideologies that have little to do with science. Others, however, implicate epistemological challenges that are unique to – or at least unusually acute for – the enterprise of evolutionary psychology.

Any hypothesis about the evolutionary bases of contemporary cognition implicates several very different kinds of causal processes, operating at very different levels of analysis – evolutionary processes operating on ancestral populations over very long stretches of historical time, ontogenetic and developmental processes operating on individuals across the lifespan, cognitive processes operating within individuals' neural structures over the course of mere microseconds. Evidence regarding all the presumed levels underlying a given hypothesis can rarely be provided, even by the most perfect results obtained with the typical tools of

psychological research (Conway and Schaller 2002; Schmitt and Pilcher 2004). Thus, despite their consistency with evolutionary arguments, controversy and criticism often attend evolutionary conclusions based on empirical results of the sort summarized above.

How does one respond? The most productive responses rise to the epistemological challenge by attempting to directly engage some of the thorniest issues that emerge in the study of evolution and social cognition. We close with a brief discussion of three issues and their implications for new directions in the study of evolutionary social cognition.

3.1. Neuroscience

Evolutionary psychologists speak of cognitive adaptations in much the same way that behavioral ecologists speak of behavioral adaptations – with the tacit assumption that these observed phenomena are the product of some set of more specific adaptations that exist at more purely biological (e.g., neurophysiology) levels of analysis. Explicit attention to these deeper levels of analysis is not a necessary condition for meaningful progress in evolutionary psychology. Nevertheless, just as an evolutionary perspective may be useful tool toward accurately articulating the functional physiology of the human brain (Duchaine *et al.* 2001), attention to the functional physiology of the brain may usefully inform the theory and research in evolutionary psychology (Panksepp and Panksepp 2000). As the tools of neuroscience become more advanced and integrated into the psychological sciences, they provide a potentially valuable means of addressing important questions that are often raised in the realm of evolutionary social cognition.

One question is this: Just what is to be considered a cognitive adaptation? A particular cognitive phenomenon may be functional in the sense of solving some fitness-relevant problem, but that may not necessarily mean that the phenomenon evolved as a direct consequence of that particular enduring fitness-relevant problem. It's possible that the phenomenon is simply one application of cognitive mechanisms that evolved for entirely different reasons altogether. How is one to distinguish between a problem-specific adaptation, and some generally useful set of cognitive operations? Just as some researchers have argued that domain specificity is a diagnostic hallmark of cognitive adaptations (e.g., extraordinary prowess at propositional reasoning should be specific to the domain of cheater detection; Cosmides and Tooby 1992), others have argued that true cognitive adaptations are implicated by the presence of neural circuitry dedicated specifically to their operation (Öhman and Mineka 2001; Schmitt and Pilcher 2004). The only way to address that latter criterion is through rigorous application of the methods of cognitive neuroscience.

There is now abundant neuroscientific evidence indicating that there do appear to be specialized neural structures devoted to such social perceptual tasks as face perception and the detection of eye gaze (e.g., Hoffman and Haxby 2000; Kanwisher 2000). Other neurological evidence is consistent with additional speculations about the adaptive basis of other prominent social cognitive capacities, hypersensitivities, and biases (e.g., Adolphs 1999; Duchaine *et al.* 2001). Much of this evidence is very preliminary, however. Moreover, there remain difficulties in relating neuroscientific evidence to social psychological phenomena, and there are differing opinions about the kinds of neuroscientific evidence that are most relevant to hypotheses in evolutionary psychology (Panksepp and Panksepp 2000; Willingham and Dunn 2003). The field of cognitive neuroscience is maturing rapidly, however, and our knowledge of the functional physiology of the brain is accumulating quickly. As this evidentiary database becomes more sophisticated, we will have an increasingly useful source of information to inform and constrain

hypotheses connecting human evolution to social cognition. And as the methodological tools become more sensitive, we will have increasingly rigorous means of testing those hypotheses.

3.2. Learning

Critical appraisals of evolutionary psychology sometimes proceed from the misperception that an evolutionary approach ignores the important role of learning and other developmental processes (e.g., Lickliter and Honeycutt 2003). Responses to these criticisms often remind readers that, in fact, development and learning are fundamental components of evolutionary inquiry (e.g., Tooby *et al.* 2003).

The developmental psychological literature suggests that there are innate constraints and predispositions that allow infants to learn about specific kinds of recurrent features of the social world quickly and efficiently (Gergely and Csibra 2003; Hirschfeld 1996; Springer 1992). The concept of an innate preparedness to learn also figures prominently in research on the evolved basis of fear. When Öhman and Mineka (2001) argue that there is an evolved basis for the common human tendency to fear snakes, they do not suggest that there is an innate fear of snakes. Rather, they suggest that there is an innate predisposition to learn to fear snakes – a specialized adaptation that manifests in the extraordinarily efficient acquisition of specific stimulus–response algorithm through which the perception of a snake triggers a fear response. Does fear of snakes truly result from the operation of this hypothesized problem-specific learning module? Or might the rapidly acquired fear of snakes result from the flexible application of some other, more general learning mechanism (of which there are many; Moore, 2004) that might have evolved for different reasons altogether? If we really want to know what evolved mechanisms underlie psychological phenomena, these are nontrivial questions. There now exist data that bear on these questions (Öhman and Mineka 2001).

The same logical template may be productively applied to a broad range of topics in social cognition. As we reviewed above, people respond to angry faces and other danger-connoting features in others in ways that are conceptually similar to the way they respond to snakes. We might assume that people learn those danger-connoting features at a young age. But just what is the nature of that learning process? Is it a highly specialized domain-specific associative learning process, of the kind that underlies taste aversions and – as Öhman and Mineka (2001) suggest – snake phobias? Or is it a more domain-general associative learning process that is applied broadly across any domain of perception and cognition? Or is it some other learning process entirely? Similar questions can be raised in areas of social cognitive inquiry. How exactly do people acquire the set of cues that we use to distinguish kin from nonkin? The role of learning processes – imprinting, associative learning – in kin recognition is implicated across many animal species within the behavioral ecology literature (e.g., Hepper and Cleland 1999; Sharp *et al.* 2005), but it has yet to receive more than cursory attention within the literature on human kin recognition. How exactly do people acquire the set of cues that they use to distinguish those who might be carriers of contagious pathogens? How exactly do men and women acquire the set of cues that they use to functionally distinguish desirable from undesirable mates?

These are not easy questions to answer, and there are many different evolved learning processes to consider (Moore 2004). Still, by raising questions like this – and attempting to address them empirically – we will eventually be in a position to draw more accurate inferences about what specific psychological mechanisms did evolve, and why, and how they contribute to observed social cognitive phenomena.

3.3. Culture

Not only did people evolve to learn specific things about other people, we also evolved to learn *from* other people (Henrich and Boyd 1998; Henrich and Gil-White 2001). In part because of the power of imitation, modeling, and other social learning mechanisms, we are cultural animals. Individual-level cognitions and social interactions are importantly influenced by the specific cultural context within which individuals develop (for a review, see Lehman *et al.* 2004). And, of course, the reverse is also true: Cultures – and the social norms that define them – are importantly influenced by the cognitions of and interactions between the people who make up those cultural populations (Lehman *et al.* 2004; Schaller and Crandall 2004). An evolutionary analysis of social cognitive processes, and their interpersonal implications, can help us more fully understand the specific beliefs, myths, and other norms that define a culture.

Many cultural norms are socially constructed. They are sculpted and maintained, often unintentionally, through processes of interpersonal communication (Harton and Bourgeois 2004; Latané 1996). Communication isn't random. People are motivated to communicate about some kinds of information more than others, and these more highly communicable knowledge structures are more likely to become culturally popular (Schaller *et al.* 2002). The social construction of culture is, therefore, constrained by individual-level cognitive processes. As we have seen, many cognitive processes may be adaptations designed to solve specific problems of social life. Thus, just as some cognitive adaptations may contribute to cultural norms independent of social transmission (Tooby and Cosmides 1992), cognitive adaptations may also influence the transmission processes through which cultures are socially constructed.

Many aspects of culture show evidence of these evolved constraints on the transmission and spread of socially shared knowledge structures. One set of studies (Heath *et al.* 2001) revealed that individuals are more inclined to transmit an urban legend if it more strongly elicits the evolutionarily adaptive self-protective emotion of disgust; consequently, more highly disgust-arousing urban legends are more likely to become and remain a part of popular culture. Other research documents the popularity of erroneous belief in the so-called "Mozart effect" (the alleged – but actually nonexistent – effect whereby children who listen to classical music become more intelligent; Bangerter and Heath 2004). The unusual success of this false belief may be attributable to the presumably adaptive parental desire to produce children with qualities – such as intelligence – that will help them to eventually compete successfully for mates. Consistent with this reasoning, Bangerter and Heath (2004) reported that the Mozart effect was especially popular within populations in which there was greater collective anxiety about the quality of early childhood education. Other research implicates the role of cognitive adaptations in the interpersonal transmission and eventual popularity of folktales, stereotypes, and other kinds of cultural knowledge (e.g., Norenzayan *et al.* in press; Schaller *et al.* 2004).

These lines of empirical research complement many other lines of inquiry that explore the influence of evolutionary processes on human culture (e.g., Boyd and Richerson 1985; Dunbar *et al.* 1999; Kenrick *et al.* 2003; Krebs and Janicki 2004; Tooby and Cosmides 1992). Inquiry into the evolutionary underpinnings of social cognition helps to illuminate not only the complex nature of the human mind, but also the nature of the social worlds that human minds create.

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Table 1: Examples of evolutionarily relevant opportunities and dangers that emerge in different domains of social life.

DOMAIN OF INTERACTION	GOAL	SOCIAL OPPORTUNITIES	SOCIAL DANGERS
Alliance Formation	Develop and maintain cooperative alliances	Shared resources Material support Emotional support	Exposure to disease Cheating Incompetence Excessive demands Rejection
Status	Gain and maintain prestige within group	Status-enhancing alliances	Loss of respect Loss of power
Self-protection	Protect oneself from others who desire one's resources	Strength in numbers	Violence from outgroup Violence within group
Finding mates	Locate mates with features indicating fitness	Sexual access to desirable partners	Intrasexual competition
Maintaining mates	Preserve alliances with fit partners	Long-term parental alliances	Sexual infidelity Mate-poaching
Kin Care	Successfully raise children and care for other relatives	Enhanced fitness Account-free resource sharing	Especially high costs imposed by close relatives

Table 2: Examples of adaptive social cognitive sensitivities and biases

DOMAIN OF INTERACTION	EXAMPLES OF ADAPTIVE COGNITIVE BIASES
Alliance Formation	Hypersensitivity to disease-linked cues in others Hypersensitivity to unfair exchanges Hypersensitivity to rejection cues Dampening of such sensitivities for close relatives
Status	Sensitivity to cues indicating one's own position in hierarchy Heightened sensitivity among males
Self-protection	Attention to cues indicating ingroup vs. outgroup membership Sensitivity to local ratio of ingroup vs. outgroup members False positive bias regarding signs of potential threat in outgroup males
Finding mates	Attention to fitness-linked features Attention to age-linked fertility cues by men Attention to men's status by women Attention to competitor attractiveness by women Attention to competitor status by men Overinterpretation of sexual interest by men Conservative bias in evaluating signs of men's commitment by women
Maintaining mates	Diminished concern with equity between mates Enhanced concern with behavioral cues to infidelity Hypervigilance for cues that other members of one's own sex might be mate-poachers
Kin Care	Concern over equity between siblings (amplified for step-siblings) Diminished concern over self-other equity when dealing with offspring (excepted for step-parents)