The Motivation to Control and the Origin of Mind: Exploring the Life-Mind Joint Point in the Tree of Knowledge System

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The evolved function of brain, cognitive, affective, conscious-psychological, and behavioral systems is to enable animals to attempt to gain control of the social (e.g., mates), biological (e.g., prey), and physical (e.g., nesting spots) resources that have tended to covary with survival and reproductive outcomes during the species' evolutionary history. These resources generate information patterns that range from invariant to variant. Invariant information is consistent across generations and within lifetimes (e.g., the prototypical shape of a human face) and is associated with modular brain and cognitive systems that coalesce around the domains of folk psychology, folk biology, and folk physics. The processing of information in these domains is implicit and results in automatic bottom-up behavioral responses. Variant information varies across generations and within lifetimes (e.g., as in social dynamics) and is associated with plastic brain and cognitive systems and explicit, consciously driven top-down behavioral responses. The fundamentals of this motivation-to-control model are outlined and links are made to Henriques' (2004) Tree of Knowledge System and Behavioral Investment Theory.

Keywords: evolution; cognition; mind; control; motivation

The processes that compose natural selection are harsh and unforgiving and were thus described in by Darwin and Wallace (1858, p. 54) as a "struggle for existence." Life and reproduction are indeed a struggle for most individuals of most species, and there is little doubt that human evolution was filled with many such struggles, and that people continue this struggle in many parts of the world today. Still, humans do not have to struggle quite

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as hard as most other species simply to exist, that is, to stay alive. As proposed by Alexander (1989), our extraordinary ability to modify (e.g., build damns) and extract resources (e.g., using other species as food) from the ecology, and then use these resources for survival and reproductive ends makes us different from other species. This difference is best captured by Alexander's proposal that at some point during human evolutionary history our ancestors achieved ecological dominance. Once an ability to dominate the ecology was achieved, there was an important shift such that the competing interests of other people and coalitions of other people became, and remains, the central pressure that influenced human evolution. From this perspective, natural selection remains a "struggle for existence," but becomes primarily a struggle with other human beings for control of the resources that support life and allow one to reproduce (Geary, 1998, 2005).

Whether or not the struggle is primarily social, human behavior and that of other species can be conceptualized in terms of an evolved motivation to control. I am not arguing individuals of all species have a conscious, explicit motive to control other members of their species (e.g., mates) or other species (e.g., prey species). Rather, the result of natural and sexual selection (e.g., competition for mates) will be the evolution of brain, cognitive, affective, and conscious-psychological systems that will be sensitive to and process the types of information that have covaried with survival and reproductive outcomes during the species' evolutionary history. The operation of these systems will bias behavior so as to direct it toward the corresponding features of the ecology (e.g., prey) and focus it on attempts to achieve control of these potential resources (e.g., prey capture). In most species and often for humans, the processes typically occur implicitly (i.e., below conscious awareness) and automatically.

Whether these processes operate automatically and implicitly or at a conscious and explicit level, the unifying theme is that individuals of all species have evolved to attempt to organize their world in ways that eliminate predatory risks and enhance survival and reproductive options, or at least to do so in ways that facilitated these outcomes during the species' evolutionary history. My shorthand for these behavioral biases is a motivation to control (see Geary, 2005). Consistent with the central domains in Henriques' (2003) Tree of Knowledge (ToK) System, the foci of these control-related behavioral biases and supporting brain, cognitive, affective, and conscious-psychological systems are three categories of resource, social, biological, and physical. The corresponding human competencies are captured by the domains of folk psychology (Baron-Cohen, 1995; Brothers, 1990; Humphrey, 1976), folk biology (Atran, 1998), and folk physics (Pinker, 1997). The achievement of ecological dominance was necessarily associated with elaborations of certain folk biological and folk physical modular systems, such as those related to tool use (Povinelli, 2000). The succeeding struggle with other people for control of the best ecologies would have triggered an evolutionary arms race (Alexander, 1989). The predicted result is the elaboration of folk systems that support social competition and cooperation (e.g., theory of mind).

In the following sections, I outline the basics of my motivation-to-control model of behavioral evolution, including discussion of major changes in brain volume during hominid evolution and corresponding elaborations of brain, cognitive, affective, and conscious-psychological mechanisms in humans. I then make links to Henriques' (2003) ToK System and Behavioral Investment Theory (BIT).

Hominid Evolution and the Motivation to Control

Hominid Brain Evolution

Among the more important traits that distinguish humans from other species of primate and mammal is brain volume and encephalization quotient (EQ). The latter provides an estimate of brain size relative to that of a mammal or primate of the same body weight (Jerison, 1973). As an example, the EQ of chimpanzees (*Pan troglodytes*) and species of Australopithecus that preceded the emergence of Homo are estimated at about 2.0, indicating that the brain volume of these species is (or was) double that of the average mammalian species of the same body weight (e.g., Tobias, 1987). Since the emergence of australopithecines, about four million years ago, brain volume has roughly tripled and EQ has increased two- to threefold (Jerison, 1973; Ruff, Trinkaus, & Holliday, 1997). The brain has also been reorganized in important ways (Holloway, 1973; Tobias, 1987). In all, it appears that most of the increases in brain volume and EQ, and changes in brain organization have occurred since the emergence of modern humans and the immediate predecessor species, Homo erectus (Ruff et al., 1997).

Three forms of selection pressure have been proposed as driving these evolutionary changes, climatic (Vrba, 1995), ecological (Kaplan, Hill, Lancaster, & Hurtado, 2000; Wrangham, Holland Jones, Laden, Pilbeam, & Conklin-Brittain, 1999), and social (Alexander, 1989; Humphrey, 1976). The theme that runs through all of the proposals is the human brain and mind evolved to anticipate and thus better cope with unpredictable climatic, ecological, or social change within a lifetime. For a variety of reasons described in Geary (2004), climatic variability is not likely to have been the primary form of selection pressure that drove these evolutionary changes. The finding that most of the changes in brain volume and EQ in *H. habilis* and *H. erectus* do not appear to have been coupled with periods of rapid climatic change provides just one example of evidence inconsistent with climatic selection pressures (White, 1995). There is, in contrast, evidence that our ancestors, beginning with australopithecines, became increasingly skilled in their ability to extract resources from the ecology through hunting and use of tools (Foley & Lahr, 1997; Wrangham et al., 1999), which is where Alexander's (1989) ecological dominance proposal becomes important.

Once ecological dominance was achieved (perhaps with *H. erectus*; Geary, 2005), a social struggle for ecological control would follow, if ecologies varied in the quantity and quality of the resources—such as prey species, water, shelter—contained therein. The corresponding pressures would have favored the ability to form large and thus competitive kin-based social coalitions, members of which (the in-group) cooperate to compete with other kin-based coalitions (the out-group) for ecological control (Wrangham, 1999). These dynamics set the stage for a within-species arms race (Alexander, 1989; Humphrey, 1976) and an evolutionary elaboration of the social, conscious-psychological, affective, cognitive, and brain systems that enable individuals to compete in the arms race. This intense social competition results in conditions that will favor the evolutionary elaboration of a host of modular social–cognitive competences, such as the ability to make inferences about the intensions of other people (i.e., theory of mind). These modular systems are not enough, however, as people are not completely predictable. One means to cope with unpredictability is to mentally simulate what other people might do next, which, in turn, requires explicit problem-solving processes and an array of supporting brain and cognitive systems, as I elaborate later. The point for now is the bulk of the evidence suggests that some combination of ecological demands (e.g., hunting) and social competition drove the extraordinary changes in brain volume, EQ, and brain organization during recent (over the past 500,000 years) human evolutionary history.

Motivation to Control

As noted, my proposal is the brain and mind of all species has evolved to attend to and process the forms of information, such as the movement patterns of prey species, that covaried with survival and reproductive outcomes during the species' evolutionary history. These systems bias implicit decision-making processes and behavioral responses in ways that allow the animal to attempt to achieve access to and control of these outcomes, as in prey capture (see Gigerenzer, Todd, & ABC Research Group, 1999). The framework fits well with the general consensus among clinical and research psychologists that humans have a basic motivation to achieve some level of control over relationships, events, and resources that are of significance in their life (Fiske, 1993; Heckhausen & Schulz, 1995; Shapiro, Schwartz, & Astin, 1996; Taylor & Brown, 1988; Thompson, Armstrong, & Thomas, 1998), although there is no consensus as to whether this motivation to control has evolved. The thesis here and elsewhere (Geary, 1998, 2005) is that the human motivation to control is indeed an evolved disposition and is implicitly focused on attempts to control social relationships and the behavior of other people, and to control the biological and physical resources that have historically covaried with survival and reproductive prospects in the local ecology.

The nexus of traits that compose the motivation to control is shown in Figure 1. The figure base represents the folk modules that direct the individual's attention toward and enable the automatic and implicit processing of social (e.g., facial expressions), biological (e.g., body shape of hunted species), and physical (e.g., use of objects as tools) information patterns that have been invariant during hominid evolution and have covaried with survival or reproductive outcomes; an example of an invariant pattern is that generated by the prototypic shape of a human face. These represent the respective domains of folk psychology, folk biology, and folk physics, and are consistent with the fundamental domains of knowledge proposed by Henriques (2003). I elaborate on these

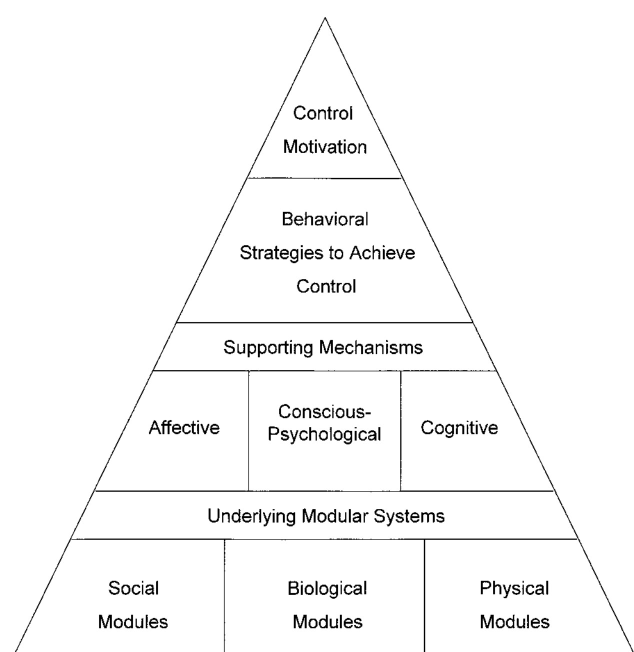

Figure 1. The apex and following section represent the proposal that human behavior is basically driven by a motivation to control the social, biological, and physical resources that have tended to covary with survival and reproductive outcomes during human evolution. The midsection shows the supporting affective, conscious-psychological (e.g., attributional biases), and cognitive (e.g., working memory) mechanisms that support the motivation to control and operate on the modular systems shown at the base.

in the "Domains of the Human Mind" section, and discuss corresponding conscious-psychological, cognitive, affective, and brain systems in the "Control-Related Mechanisms" section.

Benefits of Control

As I stated, the resources that covary with evolutionary outcomes fall into three categories, social, biological, and physical. Biological resources include food and medicine, and physical resources include the territories that contain biological resources and that support homes, agriculture, pastures, and so on. In modern societies, some resources are symbolic (e.g., money, stocks) but are important because control of these resources enhances social influence and facilitates control of quality foods, medicines, housing, and so forth. In traditional societies, coalitions of kin cooperate to control local biological (e.g., cows) and physical (e.g., grazing land) resources, and to compete with other coalitions to maintain control of these resources. Although humans have mechanisms that obscure the fact that they often use social relationships and other people for their own ends (Alexander, 1989), use them they do. Other people are resources if they have reproductive potential, social power, or access (e.g., through monetary wealth) to the biological and physical resources that covary with well being and status in the culture (Irons, 1979). The goal of developing a relationship with an individual who has social power and wealth is fundamentally an attempt to influence the behavior of this individual and through this to achieve access to power and wealth (Fiske, 1993; Geary & Flinn, 2001).

In most contexts and for most people, the motivation to control is constrained by formal laws, informal social mores (e.g., enforced through gossip; Barkow, 1992), and by affective mechanisms (e.g., guilt) that promote social compromise and reciprocal social relationships (Baron, 1997; Trivers, 1971). For most people, adherence to these laws and mores provides benefits that are sufficient to avoid the risks associated with attempts to achieve, for instance, absolute despotic control (Simon, 1990). Moreover, there are also very likely to be basic differences in the personality (e.g., high on need for power, and low on social affiliation) of despots compared to most other people. Still, consideration of history's despots allows a peeling away of these constraints and a more direct glimpse at the motivation to control. By definition, despots are individuals who have considerable social power and whose behavior is not typically constrained by affective or social consequences. With the absence of reciprocal cultural mores (i.e., democracy) and a professional police force and military that will suppress despotic behavior, these individuals and their coalitions gained control of the first six human civilizations—ancient Mesopotamia, Egypt, the Aztec and Inca empires, and imperial India and China (Betzig, 1986, 1993). Across these and many other civilizations, the activities of despots were (and still are) centered on diverting the material and social resources of the culture to themselves and to their kin, typically to the detriment of many other people. On the basis of the historical record, they lived in opulence and the men almost always had exclusive sexual access to scores—sometimes thousands—of women (Betzig, 1986).

In addition to the historical record, recent population genetic studies provide direct evidence for the reproductive benefits of despotism and more subtle forms of ecological and social control (Carvajal-Carmona et al., 2000; Underhill et al., 2001). As just one example, Zerjal et al. (2003) analyzed the Y-chromosome genes of 2123 men from regions throughout Asia. They found that 8% of the men in this part of the world have a single common ancestor who emerged from Mongolia and lived about 1000 years ago. The geographic distribution of these genes fits well with the historic boundaries of the empire of Genghis Khan (c. 1162–1227), who was known to have had hundreds of wives and children. They estimated that Genghis Khan and his close male relatives are the direct ancestors of 16 million men in Asia, ranging from northeast China to Uzbekistan, and the ancestors of about 0.5% of the world's population.

Genghis Khan is, of course, an extreme example. As with other traits, it is almost certain there are individual differences in the intensity of the motivation to control and individual differences in the manner in which it is expressed (Pratto, 1996). Nonetheless, gaining some level of control over the activities of daily life, important social relationships, and material resources affords many of the same benefits, albeit on a much smaller scale, as those enjoyed by despots. Even in resource-rich Western culture, socioeconomic status (SES), that is, the ability to influence other people and control material resources, is associated with a longer life span and better physical health (Adler et al., 1994; Bradley & Corwyn, 2002), although it is not correlated with happiness or the subjective evaluation of well being once basic needs (e.g., food, shelter) are met (Diener & Diener, 1996).

In preindustrial and industrializing Western societies, and in traditional societies today (Hill & Hurtado, 1996; United Nations, 1985), SES was considerably more important than it currently is in Western culture (Hed, 1987; Herlihy, 1965; Morrison, Kirshner, & Molho, 1977; Schultz, 1991). In fact, parental SES often influenced which infants and young children would live and which would die. To illustrate, during the 1437–1438 and 1449–1450 epidemics in Florence, Italy, child mortality rates increased 5- to 10-fold and varied inversely with parental SES even at the high end of the continuum (Morrison et al., 1977). As another example, in an extensive analysis of birth, death, and demographic records from 18th century Berlin, Schultz found a strong correlation ($r = .74$) between parental SES and infant and child mortality rates. Infant (birth to 1 year) mortality rates were about 10% for aristocrats but more than 40% for laborers and unskilled technicians.

Given these relations, it is not surprising that individual- and group-level conflicts of interest are invariably over access to and control of social relationships, other people, and the biological and physical resources that covary with survival or reproductive prospects in the local ecology and culture (Alexander, 1979; Chagnon, 1988; Horowitz, 2001; Irons, 1979; Keeley, 1996). Although these relations are often masked by the wealth and low mortality rates enjoyed in Western societies today, the implication is clear: In most human societies and presumably throughout hominid evolution, gaining social influence and control of biological and physical resources, that is, food, medicine, shelter, land, and so forth, covaried with reproductive opportunity (i.e., choice of mating partner or partners), reproductive success (i.e., offspring survival to adulthood), and survival prospects. A fundamental motivation to control has evolved in humans, because success at achieving control of social, biological, and physical resources very often meant the difference between living and dying.

Control-Related Mechanisms

I cannot present all of the details regarding the brain, cognitive, affective, and conscious-psychological mechanisms that I predict evolved as a result of the social arms race (see Geary, 2005), but the basics of these systems are presented below. These are systems that have evolved to cope with variant or unpredictable information patterns, that is, situations that vary across generations and within lifetimes. These situations are largely social, but can involve some aspects associated with ecological dominance (e.g., hunting; Maynard Smith & Price, 1973). These information patterns are contrasted with invariant patterns (e.g., prototypical shape of the human face or pattern of the human gait), that is, patterns that are consistent across generations and within lifetimes. The latter are represented by the modular domains described in the "Domains of the Human Mind" section.

Conscious-Psychological Systems. The core conscious-psychological mechanism presented in Figure 1 is an explicit mental representation of situations that are centered on the self and one's relationship with other people or one's access to biological and physical resources that are of significance in the culture and ecology in which the person is situated. The representations are of past, present, or potential future states and might be cast as visual images, in language, or as memories of personal experiences, that is, episodic memories (Tulving, 2002). Of central importance is the ability to create a mental representation of a desired or fantasized state, such as a relationship with another individual, and to compare this to a mental representation of one's current state, such as the nature of the current relationship with this other individual. These are conscious-psychological representations of present and potential future states that are of personal significance and are the content on which more conscious and effortful reasoning and problem-solving processes are applied (Evans, 2002; Stanovich & West, 2000).

The predicted evolved function of these conscious-psychological mechanisms is to generate a fantasy representation of how the world "should" operate, that is, a representation of the world that would be most favorable to the individual's reproductive (e.g., fantasy of the "perfect" mate; Whissell, 1996) and survival interests (Geary, 1998, 2005). This mental representation serves as a goal to be achieved and is compared against a mental representation of current circumstances. The cognitive (e.g., working memory) and brain (e.g., dorsolateral regions of the prefrontal cortex) mechanisms described below serve as the platform and problem solving and reasoning processes serve as the means for simulating social and other behavioral strategies that will reduce the difference between the ideal and actual states. If the behavioral strategies are effective, then the difference between the ideal state and the current state will be reduced and the individual will be one step closer to gaining access to and control of the fantasized social and other resources.

Explicit attributions about the self or other people can also be components of these conscious-psychological representations. For instance, people often make attributions about the cause of failures to achieve desired outcomes. An attribution of this type might involve an explicit evaluation about the reason for one's failure to achieve the desired outcome—determining that the failure was due to bad luck—and would function to direct and maintain control-related behavioral strategies in the face of failure (Heckhausen & Schultz, 1995). Another example involves attributions about favored in-group members and disfavored members of an out-group. These attributional biases have been extensively studied under laboratory conditions and are particularly salient during times of intergroup competition and hostilities (Stephan, 1985). Horowitz's (2001) seminal analysis of ethnic conflict in the real world is consistent with these laboratory studies and with the position that conflict is invariably over resource control. Hostile and unfavorable attributions about the character and intentions of the out-group often include rumors of an intended out-group attack or conspiracy to, for instance, poison the in-group's food supply, attack the women, and so forth. These attributional biases justify, facilitate (e.g., gaining support of other members of the in-group), and precede violence. The resulting conflict is often deadly and just as often results in the self-serving elimination of economic or social competitors. The attributional biases not only justify this self-serving violence, they protect individuals from the affective consequences (e.g., guilt) that could result if the violence were directed against the in-group. It is important to note that the existence of such attributional biases is at the core of Henriques' (2003) formulation of the Justification Hypothesis.

Cognitive Systems. The core cognitive mechanisms are the executive functions that include working memory, attentional control, and the ability to inhibit automatic processing of folk-related information or inhibit evolved behavioral reactions to this information (Baddeley, 1986; Baddeley & Logie, 1999; Bjorklund & Harnishfeger, 1995; Cowan, 1995), as well as the ability to systematically problem solve and reason about patterns represented in working memory (Johnson-Laird, 1983; Newell & Simon, 1972). These cognitive and problem-solving processes are the mechanisms that allow individuals to mentally represent and manipulate information processed by sensory and perceptual systems (e.g., sounds, and words), and the more complex forms of information processed by the social, biological, and physical modules. Working memory, for instance, enables the short-term retention of spoken utterances, and allows explicit judgments to be made about the intentions conveyed by these utterances.

However, the most important evolutionary function concerns the relation between these cognitive and problem-solving mechanisms and the generation and manipulation of conscious-psychological representations. In other words, working memory and attentional and inhibitory control are the content-free mechanisms that, for instance, enable the integration of a current conscious-psychological state with memory representations of related past experiences, and the generation of mental models or simulations of potential future states (Alexander, 1989; Johnson-Laird, 1983). Perhaps this fine a distinction between cognitive and conscious-psychological processes is unnecessary, but I have done so to emphasize that the content of mental representations (the conscious-psychological component) is important from an evolutionary perspective. In much of the research in experimental psychology, the focus is on cognitive mechanisms (e.g., working memory) and not on the content on which these mechanisms operate (Miyake & Shah, 1999).

Affective Systems. Following Damasio's (2003) distinction, affective mechanisms are separated into emotions, which are observable behaviors (e.g., facial expressions or social withdrawal), and feelings, which are nonobservable conscious representations of an emotional state or other conditions that can potentially influence the individuals' well being. Affective mechanisms guide behavioral strategies. The associated emotions provide feedback to other individuals (e.g., a frown may automatically signal disapproval) and feelings provide feedback to the individual (Campos, Campos, & Barrett, 1989). The latter provides an indicator of the effectiveness of control-related behavioral strategies. Positive feelings provide reinforcement when strategies are resulting in the achievement of significant goals, or at least a reduction in the difference between the current and desired state, and punishment (negative feelings) and disengagement when behaviors are not resulting in this end (Gray, 1987; Henriques, 2000). Positive and negative affects are also important mechanisms that regulate social dynamics and interactions. For instance, negative affect is predicted to be evoked when other people attempt to influence your behavior for their own motivation-to-control ends, if your behavior is not in your own self-interest.

The supporting brain systems (e.g., the amygdala) should function, in part, to amplify attention to evolutionarily significant forms of information, such as facial expressions, and produce emotions, feelings, and corresponding behavioral tendencies that are likely to reproduce outcomes that have covaried with survival or reproduction during hominid evolution (Damasio, 2003; Lazarus, 1991; Öhman, 2002). For instance, positive affect should function, in part, to maintain the forms of social relationship that are commonly associated with the achievement of survival and reproductive ends, and this appears to be the case. Happiness is strongly related to the strength of reciprocal and romantic relationships (Diener & Seligman, 2002), the former being sources of social support and allies during times of social conflict and the latter obviously related to reproductive goals.

Brain Systems. Areas of the prefrontal (e.g., dorsolateral region) and parietal cortices and the anterior cingulate cortex support the executive, working memory, and attentional systems that enable individuals to form conscious-psychological representations of a variety of social and ecological situations and to explicitly change the form of these representations. When these representations are infused with a sense of self and the ability to mentally time travel, the result is a mental capacity that may be uniquely human. In Geary (2005), I propose that self-awareness and other functions associated with the prefrontal cortex (e.g., executive functions) can be integrated with the motivation to control. Specifically, the motivation to control is facilitated by the ability to mentally simulate potential future social scenarios (Alexander, 1989; Humphrey, 1976) or changes in ecological conditions (Potts, 1998), and then rehearse a variety of potential responses to these situations (Geary, 1998). If these conscious-psychological and cognitive mechanisms are related to the earlier described evolutionary changes in brain volume, EQ, and brain organization, then there should be evidence for evolutionary change in the volume and organization of the brain regions that support these mechanisms (e.g., sense of self). Moreover, if social selection pressures were paramount during recent human evolutionary history, then areas of the brain that process folk-psychological information, such as theory of mind or language, should be expanded or reorganized, relative to that of apes and monkeys.

Although the evidence is not conclusive, in comparison to related species the human neocortex is larger than would be expected based on body size alone. After controlling for overall body size and overall size of the entire neocortex there is evidence for: (a) modest increases in the surface area of some regions of the prefrontal cortex (Zilles, Armstrong, Moser, Schleicher, & Stephan, 1989); (b) reorganization of the dorsolateral regions involved in attentional control and working memory and greater integration of these regions with other brain regions (Kane & Engle, 2002; Preuss & Kaas, 1999); (c) reorganization of the anterior cingulate cortex which is also involved in attentional control and conflict resolution (Nimchinsky et al., 1999); (d) expansions and reorganizations of language-related brain regions, such as Wernicke's area (Rilling & Insel, 1999); (e) reorganization of areas of the prefrontal cortex involved in social cognition (Semendeferi, Armstrong, Schleicher, Zilles, & van Hoesen, 2001); and (f) specialized regions in the right prefrontal cortex associated with a sense of self and mental time travel (Tulving, 2002; Wheeler, Stuss, & Tulving, 1997). Many other changes, along with discussion of debates regarding the functional and evolutionary significance of these changes, are discussed elsewhere (Geary, 2005).

Domains of the Human Mind

As shown at the base of Figure 1, folk systems are the source of information represented in short-term memory, working memory, and provide the content for the above-described conscious-psychological simulations. Although most of this information will be processed implicitly and automatically, when the situation varies from the routine or cannot be coped with by means of heuristics (described below) there is an attentional shift to the corresponding information and a representation of the information in working memory (Botvinick, Braver, Barch, Carter, & Cohen, 2001). Once explicitly represented in working memory, the individual becomes consciously aware of the source of the information that cannot be coped with by means of heuristics and can apply reasoning and problem solving to resolve the conflict.

The folk knowledge at the base of Figure 1 represents social, biological, and physical information patterns that are invariant across generations and within lifetimes and thus are predicted to result in the evolution of modular brain and cognitive systems (Geary &

Huffman, 2002). The concept of invariance and modularity means there is some degree of plasticity within these systems, but only within modular constraints (see Geary, 2005). In this section, I provide a brief overview of the taxonomy of evolved modular domains of the human mind presented in earlier work (Geary, 1998, 2005). The taxonomy is an integration of the work of many other scientists (Baron-Cohen, 1995; Dunbar, 1993; Humphrey, 1976; Mithen, 1996; Pinker, 1997; Premack & Premack, 1995) and is an organized collection of modular systems that coalesce around the domains of folk psychology, folk biology, and folk physics.

Most generally, modularity means there are neural and perceptual systems that selectively respond to certain forms of information (e.g., shape of a face) and result in this information being activated and organized in short-term memory. Once in short-term memory, the information is made available for representation in working memory. Once in working memory, the individual becomes explicitly aware of this information, but this is only the end point of a serious of implicit processes. For instance, the individual is not aware of the systems that detect the prototypical shape of a face, or the mechanisms that result in visually scanning the face to detect specific patterns, such as eye placement, or shape of the smile area (e.g., Schyns, Bonnar, & Gosselin, 2002). The individual can, nonetheless, become consciously aware of the face of a friend; this is the end result of the implicit operation of many brain and perceptual systems. Modules can also represent evolutionarily salient concepts, such as self, around which long-term memories and attributional biases tend to be organized.

Functional Taxonomy of the Human Mind

The taxonomy of folk modules is presented in Figure 2; discussion of corresponding brain regions, neural and cognitive plasticity, and specific evolutionary functions is provided

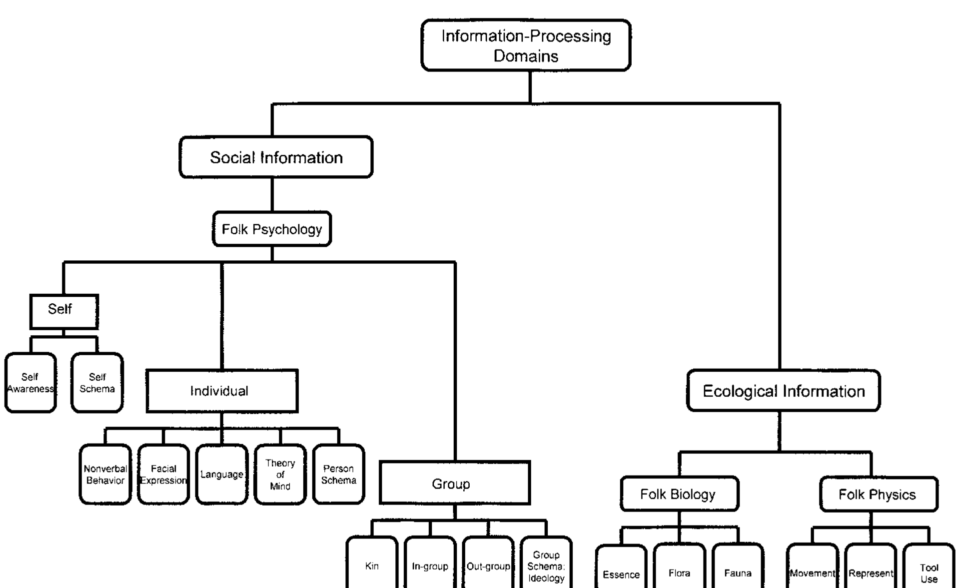

Figure 2. Evolutionarily salient information-processing domains and associated cognitive modules that compose the domains of folk psychology, folk biology, and folk physics.

elsewhere (Geary, 2005; Geary & Huffman, 2002). The most basic function of folk domains is to guide the individuals' behavior toward attempts to achieve access to and control of the social, biological, and physical resources that tended to covary with survival or reproductive outcomes during human evolution. Achieving control, of course, is not an easy task, and is only achieved incrementally, if at all. As an example, the formation of friendships is supported by folk-psychological competencies, but does not, on the surface, appear to be guided by a motivation to control the behavior of these people. At the very least, there is often no explicit, conscious desire to do so. However, the development of these relationships and the associated social support are correlated with physical and psychological health and in some contexts mortality risks (Geary & Flinn, 2002; Taylor et al., 2000). These friendships are thus social resources that can enhance survival and reproductive prospects under the types of conditions found in traditional societies today and presumably throughout human evolution.

Folk Psychology

Building on the work of others, I proposed there are three sets of folk-psychological modules. These direct attention toward and process social information related to the self, other individuals, and group formation (Gardner, 1983; Tulving 2002). The former includes awareness of the self as a social being and awareness of one's relationships with other people. Self awareness is integrally related to the ability to mentally time travel, that is, to project the self backward in time to recall and relive episodes that are of personal importance. Self awareness is also related to the ability to project oneself forward in time, that is, to create a self-centered mental simulation of potential future states (Tulving, 2002). The individual-level modules process the forms of information, such as nonverbal behavior (e.g., gesture), facial expressions, and language that guide one-on-one social dynamics and foster one-on-one social relationships (Bugental, 2000). The group-level modules enable individuals to break their social world into categories of people, including kin and members of favored in-groups and disfavored out-groups. People also have the comparatively unique ability to form in-groups on the basis of ideology, such as nation. The group-level systems enable the formation of large-scale cooperative communities and coalitions which, in turn, often compete with other coalitions for ecological and resource control (Horowitz, 2001).

Folk Biology and Physics

The folk-biological modules support the ability to develop taxonomies of other species and very elaborate knowledge systems about the behavior, growth pattern, and "essence" of these species (Atran, 1998; Berlin, Breedlove, & Raven, 1966). In traditional societies, these competencies support behavioral activities that are directed toward ecological control and dominance, such as hunting and horticulture (Kaplan et al., 2000). The folk-physical systems support navigation, the formation of mental representations of physical features of the ecology, and the construction of tools. Some of these competencies, especially the ability to navigate, are similar to those found in other species and thus are not uniquely human (Tomasello & Call, 1997). The ability to construct and use tools, in contrast, far exceeds the competencies found in chimpanzees and other species (Povinelli, 2000). The evolution of this ability almost certainly contributed to the achievement of ecological dominance.

Bounded Rationality and Heuristics

Simon's concept of bounded rationality (Simon, 1955, 1956) represents the link between cognitive and decision-making mechanisms and the ecological contexts in which these mechanisms evolved. These are cognitive mechanisms that enable the animal to automatically and implicitly attend to and process evolutionarily coupled ecological information, and guide rational behavioral decisions in these contexts. Rational does not mean the animal has evolved to make optimal (e.g., maximize number of offspring) or even conscious behavioral choices. Rather, the cost-benefit trade-offs associated with optimizing would lead to the evolution of cognitive and behavioral systems that result in "good enough" outcomes (Gigerenzer & Selten, 2001). For instance, the search for the "perfect" mate may extend for decades, if not longer, and associated motivational, cognitive, or other mechanisms thus carry a large reproductive cost. Satisfaction with a "good enough" mate, in contrast, would result in a shorter search and thus a higher probability of reproducing.

Simon's (1955, 1956) bounded rationality and associated behavioral heuristics—decision making rules of thumb—represent the evolution of brain, cognitive, and behavioral systems that direct attention toward and process information patterns that have tended to be invariant across generations and within lifetimes. These behavior–cognition–ecology links are integral features of folk domains and operate automatically and implicitly, and operate to recreate the behavioral outcomes that resulted in good enough survival or reproductive outcomes in the specific ecological context. This basically economical conception of behavior is consistent with Henriques' (2003) BIT, and these connections will be explored in more detail later.

Folk Psychology and Social Cognition

If the evolution of brain, cognitive, affective, and conscious-psychological systems was driven in important ways by social selection pressures, then folk-psychological systems should be highly elaborated in humans relative to other species. This is indeed the case (Tomasello & Call, 1997). Social cognition is an integral feature of folk psychology and is predicted to be focused on the self, relationships, and inferences about the behavior and internal states of other people, and group-level dynamics. The description of some of the related research demonstrates how traditional social psychological findings can be placed within an evolutionary framework and provides additional detail regarding the specifics of the folk-psychological modules described earlier. Moreover, on the basis of my motivation to control model and the work of Heckhausen and R. Schulz (1995), folk-psychological mechanisms, such as attributional biases, that facilitate control-related behaviors are also predicted to evolve.

Control-Related Psychological Mechanisms

In a review of the relations among wealth, mortality risks, and psychological factors (e.g., depression), Gallo and Matthews (2003, p. 11) defined SES as "an aggregate concept defined according to one's level of resources or prestige in relation to others." This definition has a clear and substantive social component: The level of actual resources is important but, in addition, one's position in the social hierarchy influences and is influenced by physical health, lifespan, and conscious-psychological functioning (e.g., self esteem). Gallo and Matthews also propose that the strength of the relation between SES and physical health is moderated by a sense of personal control of the circumstances of day-to-day living. Lachman and Weaver (1998, p. 763) found that reported health varied with SES but individuals in "the lowest income group with a high sense of control showed levels of health and well-being comparable with the higher income groups." Control over daily events is correlated with a number of physiological and health-related outcomes, and is related to a longer lifespan in the elderly (Rodin, 1986).

But are there conscious-psychological mechanisms consistent with an evolved motivation to control? Although the question has not been approached from an evolutionary perspective, psychological studies conducted throughout much of the 20th century suggest that the answer is "yes" (Fiske & Taylor, 1991). The concepts of self-efficacy and personal control as related to the regulation of goal-related behavior capture the gist of these research endeavors (Bandura, 1986; Langer, 1975). "Self-efficacy beliefs are conceptualized as highly specific control-related beliefs which concern one's ability to perform a particular outcome. The stronger one's perceived self-efficacy, the more one will exert effort and persist in a task" (Fisk & Taylor, 1991, p. 198). The beliefs involve, among other things, an assessment of one's competencies vis-à-vis the desired outcome and vis-à-vis the perceived competencies of competitors (Langer, 1975).

As described by Rothbaum, Weisz, and Snyder (1982) as well as Heckhausen and R. Schultz (1995; Schultz & Heckhausen, 1996), there are a myriad of conscious-psychological mechanisms that maintain self-efficacy and goal-directed behavior in the face of inevitable failures. These include self-serving attributions that allow people to interpret personal failure in ways that maintain their sense of self-efficacy. Such interpretations might involve attributing failure to external causes ("It wasn't my fault") or maintaining an illusion of control by interpreting the outcome as predictable ("I knew that this would happen"). These same mechanisms are engaged with rituals, belief in psychic powers, and so on, and serve the function of attempting to predict and control potentially significant life events (e.g., finding a mate, the health of kin) and to mollify the fear and anxiety associated with not having complete control over these events. The importance of these conscious-psychological processes becomes clear, when they fail. When these mechanisms fail, the individual is at risk for depression and behavioral inhibition, that is, a cessation of attempts to influence social dynamics and achieve control of desired resources (Seligman, 1991; Shapiro et al., 1996).

Control-related conscious-psychological mechanisms can be integrated with other mechanisms shown in Figure 1. Among other things (see Geary, 2005), control-related attributions might be integrated with models of explicit, controlled problem solving and with activity of the dorsolateral prefrontal cortex and the anterior cingulate cortex. These attributions appear to be more or less automatically engaged in situations in which heuristic-based behaviors do not lead to the desired outcome, and thus may elicit explicit, controlled processing of features of the self, the context, and the outcome. The engagement of explicit processes appears to occur because of the discrepancy between one's desired outcome and the actual outcome. These are situations that appear to result in the automatic activation of the anterior cingulate cortex (Botvinick et al., 2001) and automatic attentional shifts to representations of the self, the goal, and features of the situation that are thwarting achievement of the goal. Indeed, Posner and Rothbart (1998) reviewed neuroimaging and developmental evidence consistent with the view that the anterior cingulate cortex, the amygdala, and areas of the prefrontal cortex become active during physically, socially, or affectively distressing situations. The result is an automatic attentional shift to the distressing features of the situation, presumably as related to the self. The resulting representations would be active in working memory and subject to top-down evaluation and manipulation, as related to generation of control-related attributions. Moreover, activation of this information in working memory enables detection of the source of the distress, and use of self-referenced conscious-psychological simulations to generate alternative routes to the goal.

Social Cognition

The "Domains of the Human Mind" section did not provide any details with respect to the implicit and explicit cognitions that relate to the folk-psychological systems; specifically, cognitions about the self, others, and group-level dynamics. For ease of presentation, I treat cognitions in these areas as separate, but at a functional real-world level they are often simultaneously activated, either implicitly or explicitly (Ashmore, Deaux, & McLaughlin-Volpe, 2004). For instance, self-evaluations and behavioral engagement of the environment may be influenced by contextual cues that trigger representations of group identification and membership, such as sex or ethnicity (Steele, 1997). In these and many other situations, aspects of the self-schema, which include group identifications, are activated along with group-level categorical information.

Self and Others

As emphasized throughout, selection pressures that tend to be similar across generations should result in attentional, information-processing, and decision-making biases that operate automatically and implicitly (Gigerenzer et al., 1999; Simon, 1956). At the same time, other mechanisms that support explicit-controlled processing of social cognitions are predicted to have evolved as a consequence of intense social selection pressures and the corresponding advantages achieved by varying social behavior so that this behavior is not perfectly predictable. The reality of social cognition is a mix of implicit and explicit processes that we are only beginning to understand (Lieberman, Ochsner, Gilbert, & Schacter, 2003), and thus aspects of the discussions that follow are necessarily speculative.

Self. One focus of social psychological research and an important component of the self modules shown in Figure 2 is the *self-schema* (Fiske & Taylor, 1991; Kunda, 1999; Markus, 1977). The self-schema is a long-term memory network of information that links together knowledge and beliefs about the self, including positive (accentuated) and negative (discounted) traits (e.g., friendliness), episodic memories, self-efficacy in various domains, and so forth. Most of the time, this knowledge is implicit. Although the evidence is not entirely consistent, self-schemas appear to regulate goal-related behaviors; specifically, where one focuses behavioral effort and whether or not one will persist in the face of failure (Sheeran & Orbell, 2000). Social regulation results from a combination of implicit and explicit processes that influence social comparisons, self-esteem, valuation of different forms of ability and interests, and the formation of social relationships (Drigotas, 2002). For instance, when evaluating the competencies of others, people focus on attributes that are central features of their self-schema, and prefer relationships with others who provide feedback consistent with the self-schema. Athletes implicitly compare and contrast themselves to others on dimensions that involve physical competencies, whereas academics focus more on intellectual competencies (Fiske & Taylor, 1991). People value competencies on which they excel and discount competencies for which they are at a competitive disadvantage (Taylor, 1982).

Conditions that involve the self-schema and cannot be addressed by means of heuristics or that violate beliefs about the self should, in theory, result in a conscious awareness of the corresponding aspects of the self. Awareness of these features of the self schema appears to contribute to the regulatory processes that allow people to examine competencies, behaviors, social attitudes, and the current situation as these relate to information that is inconsistent with the self schema or is not readily addressable with heuristic-based responses (Fiske & Taylor, 1991; Kunda, 1999). These are, by definition, social problems that must be solved, and self-awareness in these situations should be advantageous. An explicit and conscious representation of relevant information about the self in working memory is amendable to controlled problem solving and the ability to reason and make attributions about the social situation as it relates to features of the self-schema. As I suggested earlier, the controlled problem solving involves a self-referenced conscious-psychological simulation that, in these circumstances, centers in those features of the self-schema that have been activated by the current situation.

Another potentially important feature of self-schemas is the ideal self. Although a comparison of the current self with an imagined ideal self can result in negative affect if one falls short (Higgins, 1987), the combination provides a self-referenced problem space. The problem space provides a working memory platform whereby individuals can evaluate current competencies, traits, and social strategies as these relate to achieving social and other goals. A means–ends problem-solving analysis (Newell & Simon, 1972), for instance, would occur within this problem space and allow the individual to estimate which of her or his competencies or social strategies must be modified to reduce the distance between the current situation and the desired outcome. Anyone aspiring to become a research scientist, chief executive officer, or any other socially-valued position that requires long-term effort must engage in this process.

In short, the schema directs attention to features of the self that are socially or otherwise important and that relate to social comparisons, attributions regarding the self, and conditions that are not readily achieved by means of heuristics. My proposal is that the ability to become consciously aware of and mentally problem solve using self-information represent social cognitions that are part and parcel of an evolved folk psychology that resulted from the social selection pressures emphasized by many other scientists (Alexander, 1989; Henriques, 2003; Humphrey, 1976).

Others. As shown in Figure 2, *person schemas* are an important folk-psychological module. These are constructed for familiar people and people who can influence one's life (Fiske & Taylor, 1991; Kunda, 1999). The schema for each person is a long-term memory network that includes representations of the other persons' physical attributes (age, race, sex), memories for specific behavioral episodes, and more abstract trait information that includes two continuums—sociability (warm to emotionally distant) and competence (Schneider, 1973). It seems likely that the person schema will also be highly integrated with the folk-psychology modular competencies related to others, such as theory of mind (Adolphs, 1999; Frith & Frith, 1999; Leslie, 1987). This would include memories and trait information about how the other person typically makes inferences (e.g., tends to attribute hostile intentions to others, the *hostile attribution bias*), responds to social cues, their social and other goals, and so forth. The person schema is also likely to include affective dimensions, including memory representations that elicit a sense of familiarity and specific feelings based on episodic memories (Brothers, 1990; Damasio, 2003).

During social interactions, the knowledge represented in the person schema is implicit, that is, there is no conscious representation of this information (e.g., where the person is on the sociability continuum) but it can nonetheless influence the dynamics of the interaction (Fiske & Taylor, 1991). However, when their behavior is inconsistent with the schema, then attention is drawn to the inconsistency and the behavior is explicitly and consciously represented in working memory. The explicit representation allows inferences to be drawn about the likely source of the inconsistency and facilitates incorporation of the behavior into the person schema. The person schema is also related to the use of mental simulations—called the *simulation heuristic*—to make judgments about how the person might react in various situations (Kahneman & Tversky, 1982). For instance, the individuals' traits, such as warm to emotionally distant, influence how easy it is to generate one type of behavioral sequence or another. It is easier to imagine—mentally simulate the dynamics—a socially warm friend making a good impression when first meeting your family than it is to imagine the same outcome with an emotionally distant friend.

The literature on person schema and related areas, such as person perception (e.g., stereotypes based on sex) and attributional biases, is considerably richer and more complex than implied in the preceding paragraphs (Bodenhausen, Macrae, & Hugenberg, 2003; Fiske & Taylor, 1991; Kunda, 1999). My point is that much of this research is consistent with the proposal that social cognition has been shaped by social selection pressures (e.g., Brothers, 1990; Dunbar, 1998), and adds to these proposals by filling in, so to speak, the details. The combination of the person schema and Kahneman's and Tversky's (1982) simulation heuristic is of particular importance, as it fleshes out some of the specifics of my self-referenced conscious-psychological simulations. The person schema allows one to more easily simulate how other people will respond in potential future situations and thus enables better prediction of other people's behavior and an enhanced ability to influence their behavior in self-serving ways.

Groups

As emphasized by Alexander (1989) and noted above, one consequence of the achievement of ecological dominance is increased social competition, and a corresponding advantage associated with the ability to form cooperative groups; specifically, groups that will eventually compete with other groups for control of ecological and social resources. These selection pressures set the stage for the evolution of an in-group, out-group social psychology (Alexander, 1979) and group identification mechanisms that facilitate the formation of large and thus competitive coalitions, as I noted in "Domains of the Human Mind" section. Although they tend not to consider the phenomena in terms of selection pressures, social psychologists have studied in-group, out-group dynamics, and group identification for much of the 20th century and now have a considerable understanding of these dynamics at a cognitive and behavioral level (Bodenhausen et al., 2003; Bornstein, 2003; Fiske, 2002; Fiske & Taylor, 1991; Hewstone, Rubin, & Willis, 2002). Hewstone et al. concluded that, "threat is a central explanatory concept in several of the theories . . . and literature on intergroup bias" (p. 586). The theories and literature focus on the details of prejudice, favorable evaluations of, and identification with members of a perceived in-group, derogation of and hostilities towards members of out-groups, as well as other forms of social cognition.

Under conditions in which a groups' status or resources are threatened by the activities or perceived hostile intentions of other groups, the basic tendency of humans to form in-groups and out-groups and process information about members of these groups in ways that are favorably biased toward the in-group and negatively biased against the out-group is exacerbated (Hewstone et al., 2002; Horowitz, 2001). These biases are evident with measures that assess explicit attitudes toward members of in-groups and out-groups, that is, people are sometimes consciously aware of these biases and consciously identify with the in-group (Abrams & Hogg, 1990). There is also evidence for biases that operate on an implicit level. Threats to one's physical well being, even if it is below conscious awareness (e.g., presenting the word "funeral"), result in an enhanced endorsement of in-group ideologies and harsher evaluations out-group members (Arndt, Greenberg, Pyszczynski, & Solomon, 1997). In fact, the amygdala (involved in negative affect) is often activated when individuals process the faces of unfamiliar out-group members, suggesting that out-group members may automatically and unconsciously trigger negative feelings (presumably fear) in many people (Phelps et al., 2000). In keeping with the proposal that these are evolved biases, there is considerable population-genetic evidence for group-level male–male competition among kin groups, with successful groups reproductively displacing less successful groups (Carvajal-Carmona et al., 2000).

My basic point should be clear: The implicit and explicit cognitive and behavioral processes involved in the formation of in-groups, out-groups, and social identification are readily interpretable in terms of social selection pressures. These social-psychological phenomena are the proximate mechanisms that facilitate the formation of cooperative coalitions that, in turn, function to gain access to or control of the social and ecological resources that enhance the well being of group members (see Horowitz, 2001). Enhancement is essentially about control of the resources that facilitate the health and well being of the individual and her or his kin, and about improving reproductive options, as with other species. When viewed in terms of conscious-psychological simulations and the motivation to control, explicit representations of group-level dynamics allow for the simulation of potential future relationships among groups, as well as competitive strategies. These simulations are at the heart of military strategy, and many competitive games (e.g., chess, many video games that appeal to boys).

Links to the Motivation to Control

Henriques' (2003) ToK system and BIT makes a unique and important contribution to our understanding of psychology's relation to other sciences, and proposes several basic principles that cross domains ranging from physics to sociology. One of his most intriguing proposals is that these disciplines can be theoretically and empirically linked at joint points, that is, areas in which the phenomena in question join two levels of analysis across physical, biological, or social phenomena. The modern synthesis, that is, natural selection operating on genetic combinations through time, is the second joint point. The key element of a joint point is that it provides the framework for understanding the complexity building feedback loop that gives rise to a new dimension of complexity.

The life–mind joint point is elaborated in terms of BIT, which is described in greater detail elsewhere (see Henriques, 2004, 2003, 2000). The gist is that the evolved function of the nervous system is to guide the animal such that the expenditure of behavioral energy (e.g., as indexed by caloric use, time budgets) is biased in ways that enhanced fitness in ancestral environments. In other words, the nervous system evolved and gained in complexity during the species' evolutionary history, because it enabled the animal to engage in the types of behaviors that increased survival and reproductive prospects. The biases define the general class of objects in the ecology such as mates or food, the animal has evolved to approach (e.g., mates or food), or as well as objects in the ecology such as predators, the animal has evolved to avoid (e.g., predators).

Behavioral plasticity is also an important feature of the theory, and it allows for behavior-ecology adjustments during the animals' lifetime. Skinner's (1938) operant conditioning represents a central proximate mechanism through which behavioral adjustments are made in response to fluctuations in ecological conditions (e.g., type of prey available). Rewards and punishments operate in a manner analogous with evolved behavioral biases in approach and avoidance tendencies, but work to adjust behavior within a lifetime, as contrasted with the mechanisms of natural selection that operate across lifetimes. Thus, operant conditioning changes behavioral biases within the individual animal, whereas natural selection results in the evolutionary retention of behavioral biases as these are expressed across individuals.

Tree of Knowledge System

Although Henriques (2003) developed his tree of ToK System and BIT independently of my development of the motivation-to-control model (Geary, 1998, 2005), there are many striking similarities. Most generally, in *The Origin of Mind* (Geary, 2005) I propose a model of brain and cognitive evolution that supports the motivation to control, and mechanisms that accommodate modular and plastic brain, cognitive, affective, conscious-psychological, and behavioral systems. The modular systems have been shaped by natural and sexual selection to cope with invariant social and ecological conditions that have covaried with survival and reproductive outcomes during the species' evolutionary history. The plastic systems are shaped by experiences (e.g., through operant and classical conditioning) during the animal's lifetime and enable behavioral adjustment to fluctuations in social and ecological conditions, especially conditions that covary with survival and reproductive prospects.

Within the context of the ToK System, the mechanisms described in *The Origin of Mind* (Geary, 2005) flesh out the details of the life–mind joint proposed by Henriques (2003). The motivation to control captures the focus of this joint point in that it organizes the ultimate function of behavior—and other adaptations (e.g., bipedal locomotion)—as being focused on gaining access to and control of the forms of social, biological, and physical resources that have improved survival and reproductive options during the species' evolutionary history. The brain and mind evolved to enable animals to engage the social world and the ecology in which they are situated and attempt to behaviorally control essential resources. In the above sections, I provided examples of some of the underlying conscious-psychological, affective, cognitive, and brain mechanisms that support attempts to gain behavioral control under situations that have an element of uncertainty and that require mental simulations of various dynamics under these uncertain conditions. I also presented a taxonomy (Fig. 2) of modular domains of the human mind that link the person to features of the social, biological, and physical world that have covaried with survival or reproductive outcomes during human evolution. Elsewhere, I link these domains of mind to underlying brain systems and place them in a broader comparative and evolutionary context (Geary, 2005; Geary & Huffman, 2002). My point here is that these brain systems and their evolution would appear to be the foundation for Henriques' (2003) life–mind joint point.

Behavioral Investment

The motivation-to-control model meshes well with Henriques' (2003) BIT. More specifically, evolution has resulted in behavioral systems that will be biased to invest time and energy in gaining control of the specific forms of social (e.g., mates, social allies), biological (e.g., prey species, edible plants), and physical (e.g., nesting sites, water) resources that covaried with survival or reproductive outcomes during the species' evolutionary history. These general classes of resource should be the foci of behavioral investment for all species, but the specific types of resource within these broader categories will vary from one species to the next (Geary, 2005; Geary & Huffman, 2002). These biases are features of modular brain and cognitive systems and have evolved by means of natural or sexual selection because they are sensitive to and process information about the forms of resource that are invariant across generations and within lifetimes.

Within lifetimes, behavioral adaptation to fluctuations in social and ecological conditions can occur automatically and implicitly by means of operant conditioning, as noted by Henriques (2003). Pavlovian or classical conditioning also fits into the overall motivation-to-control model. As aptly argued by Timberlake (1994), Simon's (1955, 1956) bounded rationality and associated behavioral heuristics can be understood in terms of the relation between an ecological stimulus—one that has covaried with survival or reproductive outcomes during the species' evolutionary history—and an evolved, unconditioned response. Classical conditioning is an evolutionarily old mechanism for behavioral plasticity in that it allows evolved behaviors to be used in ecologically novel contexts (i.e., elicited by a conditioned stimulus), and allows novel stimuli to become associated with evolved behavioral systems, if the novel stimuli are of predictive value (e.g., paired with arrival of a predator).

In contrast to the automatic and implicit mechanisms that support behavioral adaptations by means of operant and classical conditioning, self-referenced mental models and associated biases (e.g., attributional biases) represent mechanisms that enable an explicit representation of the behavioral goal. These mechanisms also include a store of implicit knowledge and information in long-term memory, with only a segment of this becoming explicit at any one time. In any case, the ability to generate explicit mental simulations and rehearse behavioral strategies before engaging the social world or the ecology (e.g., to hunt) dramatically increases behavioral plasticity. The representations are per force symbolic and the ability to mentally manipulate these symbols in working memory and infuse them with a sense of self or at least understand the symbols vis-à-vis one's self interest may represent the key joint point for Henriques' (2003) mind-culture link. In this view, the implicit knowledge from which these representations are constructed represent Freud's preconscious processing (Westen, 1998); the evolved affective processes that underlie the motivation to reproduce and to control self-interested outcomes are aspects of the ID; and, the explicit representations and the rational problem solving that can be used in manipulating and drawing inferences from these representations are aspects of the Ego.

In any event, Henriques' (2003) ToK System, joint points, and behavioral investment are all highly compatible with research in the cognitive neurosciences, comparative psychology, social psychology, among other areas, and are strikingly similar to many of the proposals independently developed as I was fleshing out my motivation-to-control model (Geary, 1998, 2005). In particular, my model seems to fill in many of the proximate mechanisms and evolutionary pressures that define the life–mind joint point, and provides a framework for further development of the mind–culture joint point.

Discussion

For all species, natural and sexual selection will result in the evolution of behavioral biases that support attempts to gain access to and control of the resources that have covaried with survival or reproductive outcomes during the species' evolutionary history. I have cast these behavioral biases and organized the underlying brain, cognitive, conscious-psychological, and affective systems in terms of a fundamental motivation to control (Geary, 1998, 2005), and Henriques (2003) cast these same processes in terms of behavioral investment. The motivation to control and the tendency to bias behavioral investments in one domain or another is not typically explicit or conscious but rather reflects the survival and reproductive function of evolved traits. The resources that covary with survival or reproductive outcomes fall into three categories; specifically, social (e.g., mates), biological (e.g., food), and physical (e.g., territory). The resources in these categories generate patterns of information (e.g., motion pattern of a prey species) that are invariant across generations and within lifetimes. The result is the evolution of modularized systems that draw the animal's attention to these patterns (Gelman, 1990), and guide decision-making and behavioral responses such that the animal attempts to recreate the outcomes, such as prey capture, that resulted in the evolution of these systems.

For humans, the brain, cognitive, affective, conscious-psychological, and behavioral biases that evolved to facilitate attempts to gain control of resources in these domains compose folk psychology, folk biology, and folk physics. Figure 2 presents a taxonomy of cognitive modules in these folk domains. The modules represent the forms of information to which the human mind is drawn (e.g., facial expressions), the content areas (e.g., self schema) around which this information is organized in long-term memory, and the issues around which attributional biases (e.g., regarding out-groups) and decision-making heuristics have evolved. Some aspects of these biases for folk-psychological domains were described. A similar analysis can be done in the areas of folk biology (Medin & Atran, 1999) and folk physics (Povinelli, 2000), but less is known in these areas than in the area of social and folk psychology. The differences across these domains are a natural consequence of intense social selection pressures, and the corresponding focus on other people and associated species-centric research agendas. In other words, the greater elaboration of folk-psychological systems relative to those that compose folk biology and folk physics is consistent with proposals that the primary dynamic that has driven and is currently driving human evolutionary change is competition with other people and groups of other people for resource control (Alexander, 1989; Humphrey, 1976).

In addition to creating pressures for the elaboration of folk-psychological systems (e.g., theory of mind), social competition results in variability in social dynamics and through this creates pressures for the elaboration of brain and cognitive systems that can anticipate, mentally represent, and devise behavioral strategies to cope with these dynamics. The self-referenced conscious-psychological simulation is the mechanism that evolved to cope with the variability created by complex social dynamics and to facilitate resource control under such conditions. These are mental models that enable the generation of a self-centered simulation of the perfect world and simulation of strategies to reduce the difference between this perfect world and current conditions; a perfect world is one in which other people behave in ways consistent with one's best interest, and biological and physical resources are under one's control. The systems that evolved to support the use of these simulations are working memory and attentional control (also general fluid intelligence; see Geary, 2005).

The combination of the brain and cognitive systems that enable the use of explicit mental simulations and the more modularized folk knowledge can be placed within Henriques' (2003) ToK System. More precisely, these systems represent the life–mind joint point, that is, the mechanisms for conceptualized brain evolution and the corresponding evolved functions of mind as these relate to the motivation to control or behavioral investment. As I discuss elsewhere (Geary, 2005), mental simulations necessarily involve symbolic (either language, visual, spatial, or some combination) representations of past states, current states, or potential future states. The folk domains and episodic memories represent the content of these states, as these are related to achieving social goals or goals related to ecological dominance (e.g., hunting in traditional societies). The ability to explicitly represent and manipulate these symbols in working memory free, so to speak, symbolic expression from the more modularized folk representations and through this provides the foundation from which intellectual and cultural advances have been built. These systems also provide a means of understanding Henriques' mind–culture joint point and seamlessly link this to the life–mind joint point. In *The Origin of Mind* (Geary, 2005) and elsewhere (Geary, 2002), I propose several mechanisms that might be involved in the generation of symbols and how this relates to human intellectual history and the learning of non-evolved mental abilities (e.g., reading).

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