COGNITIVE GADGETS
In memory of Donald T. Campbell
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WHAT MAKES US SUCH PECULIAR ANIMALS? Compared with other creatures, we humans lead very strange lives. No other animals have so completely transformed their environment, become so dependent on cooperation for survival, and constructed, along the way, the vast edifices of knowledge and skill in which all human lives are embedded: technology, agriculture, science, religion, law, politics, trade, history, art, literature, music, and sports. Why? What is it about the human mind that enables us to live such unusual lives, and why do our minds work that way?

In this book I argue that the answer to these questions is “cognitive gadgets.” We humans have created not just physical machines—such as pulleys, traps, carts, and internal combustion engines—but also mental machines; mechanisms of thought, embodied in our nervous systems, that enable our minds to go further, faster, and in different directions than the minds of any other animals. These distinctively human cognitive mechanisms include causal understanding, episodic memory, imitation, mindreading, normative
thinking, and many more. They are “gadgets,” rather than “instincts” (Pinker, 1994), because, like many physical devices, they are products of cultural rather than genetic evolution.¹ New cognitive mechanisms—different ways of thinking—have emerged, not by genetic mutation, but by innovations in cognitive development. These novelties have been passed on to subsequent generations, not via genes, but through social learning; people with a new cognitive mechanism passed it on to others through social interaction. And some of the new ways of thinking have spread through human populations, while others have died out, because the holders had more “students,” not just more “babies” (Sober, 1991).

Psychologists often use gadgets as metaphors. They suggest that various aspects of the human mind operate in the same way as circuit boards, cisterns, search lights, search engines, thermostats, resistors, and the bristles of a Swiss Army knife. But, if I am right, the resemblance runs much deeper. Distinctively human ways of thinking are products of the same process—cultural evolution—as machines in the outside world; they are pieces of technology embodied in the brain. Genetic evolution has given humans more powerful general purpose mechanisms of learning and memory, tweaked our temperaments, and biased our attention so that it is focused on other people from birth. But—drawing on comparative and developmental psychology, cognitive neuroscience, philosophy, anthropology, behavioral economics, and theoretical biology—I argue in this book that it is the information we get from others, handled by general purpose mechanisms, that builds distinctively human ways of thinking.

The first three chapters lay some foundations for cultural evolutionary psychology. Chapter 1 says more about the cognitive gadgets theory—what it is, and what it is not—explaining how and why cultural evolutionary psychology builds on evolutionary psychology and cultural evolutionary theory. Chapter 2 draws on the phi-
losophy of biology, arguing that, although we now know that some versions of the nature-nurture debate were deeply misguided, it is important to discover, for any particular feature of human cognition, the ways and extent to which the feature is shaped by: (1) genetically inherited information; (2) culturally inherited information; and (3) information derived directly from the environment in the course of development. Chapter 2 also includes an overview of contemporary cultural evolutionary theory, showing how it can be applied, not only to cognitive products (“grist”), but also to cognitive mechanisms (“mills”). Chapter 3 focuses on features of distinctively human cognition that have been shaped primarily by genetically inherited information. It surveys behavioral and neurological evidence that, far from being “blank slates,” or just like the minds of chimpanzees, the minds of newborn human babies are equipped with high capacity mechanisms of learning and memory, species-specific attentional mechanisms, and a tendency to find social cues especially rewarding.

Chapter 4 examines the nature of cultural learning that enables cultural inheritance—the cultural analogue of DNA replication—and provides an introduction to the heart of the book, Chapters 5–8. Each of these chapters examines a type of cultural learning (selective social learning, imitation, mindreading, and language) and argues, from the available evidence, that its distinctively human characteristics depend on culturally inherited information. I focus on the mechanisms of cultural learning—the cognitive gadgets that enable humans to learn from others with extraordinary efficiency, fidelity, and precision—for two reasons. First, these distinctively human cognitive mechanisms are especially important because they are gifts that go on giving: culturally inherited skills that enable the cultural inheritance of more skills. Second, evolutionary psychologists and cultural evolutionists disagree about the origins of many cognitive characteristics, but both parties are convinced that the mechanisms
of cultural learning are cognitive instincts, not cognitive gadgets. This consensus suggests that the mechanisms of cultural learning are the hardest nuts to crack—the cognitive mechanisms that are least likely to be explicable as products of cultural evolution.

Social learning is said to be “selective,” or to involve “social learning strategies,” when the impact on behavior of observing another agent varies with the circumstances in which the encounter occurs, or with the characteristics of the observed agent, or “model”—for example, when older models have more impact than younger models. In Chapter 5, I argue that most selective social learning—found in nonhuman animals, children, and adults—is due to domain-general learning and attentional processes, that is, to processes that have not been specialized for social interaction, let alone for cultural inheritance. However, a small proportion of social learning strategies, found only in adult humans, depend on explicit metacognition—on thinking about thinking. These, and only these, behavioral effects are genuinely “strategic,” and genuinely examples of cultural learning. The evidence suggests that, like other explicitly metacognitive rules, these metacognitive social learning strategies are learned through social interaction—culturally, rather than genetically, inherited.

Imitation occurs when an observer copies the topography of a model’s action; observing the way that parts of a model’s body move relative to one another causes the observer to produce movements in which the parts of his or her own body move in a similar way. In Chapter 6, I agree with the century-old view that imitation is “special”—much more highly developed in humans than in any other species, and dependent on mechanisms that are not involved in other kinds of learning. I also agree that these mechanisms contribute to the fidelity of cultural inheritance. My rebellious streak comes out only in relation to the question of where imitation comes from. Offering an original theory of the mechanisms mediating imitation, and a wide
range of empirical evidence in support of that theory, I argue that the capacity to imitate is acquired through sociocultural experience.

Mindreading involves the ascription of mental states, such as beliefs and desires, thoughts and feelings, to oneself and to others. In Chapter 7, I suggest that genuine mindreading contributes to cultural inheritance primarily by enhancing the effectiveness of teaching, but that many of the behavioral effects attributed to mindreading—the “implicit” or “automatic” effects reported in apes, infants, and adults under time pressure—are not genuine cases of mindreading; they are due to domain-general psychological processes. These processes can generate predictions about behavior that simulate the effects of mindreading, and when they do, the agent may be described as “submentaling.” Where does real mindreading come from? From the same kinds of conversation-based social interactions that support the development of print reading or literacy. It is culturally inherited.

No one doubts that language—communication using words or signs in a structured and conventional way—is a hugely important form of cultural learning. When it comes to language, the crucial question is not whether it is a form of cultural learning, but where the language faculty originated: genetic or cultural evolution. In Chapter 8, I approach this debate as an outsider—neither a linguist nor a language scientist—and with an open mind. Indeed, it would have been convenient for the purposes of this book if I had found in the language debate a compelling case for an innate language faculty; a rock-solid cognitive instinct on which cultural evolution had constructed cognitive gadgets. But that is not what I found. Insofar as the two ideas can be tested against one another, I find the case for the cultural evolution of language at least as strong as the genetic alternative.

The core chapters, Chapters 5–8, have particular selling points. Chapter 5 addresses very directly a question which cultural evolutionists have tended to avoid: Exactly what is it about selective social learning that promotes cultural evolution? Chapter 6, on imitation,
looks in detail at how a new cognitive mechanism can be constructed by domain-general cognitive processes through social interaction. Chapter 7 presents an innovative view of mindreading, offering an alternative to the long established nativist and theory-theory perspectives. Chapter 8 gives an informed but dispassionate overview of the current status of the debate about the origins of language; I have read widely, but I don’t have a dog in that fight.

All of the case studies are unusual in bringing to the cultural-evolutionary table theory and evidence, not only from primatology and developmental psychology, but from experimental psychology and cognitive neuroscience.

The final chapter takes a step back to consider how the cognitive gadgets theory measures up against the chronology of human evolution, and what it implies about human nature. Cultural evolutionary psychology implies that human minds are more agile, but also more fragile, than was previously thought. We are not stuck in the Pleistocene past with Stone Age minds, and well-targeted educational interventions have the potential to transform cognitive development, but we have more to lose. Wars and epidemics can wipe out not just know-how, but the means to acquire that know-how. The cultural evolutionary perspective also has disciplinary implications. It does not suggest, as have many evolutionary psychologists, that all research on human minds and human lives must be informed by evolutionary theory. On the contrary, it suggests that research on the developmental and evolutionary origins of human cognition should be informed by the humanities and social sciences.
A QUESTION AND MANY ANSWERS

In this chapter, I first outline how the cognitive gadgets theory differs from other, recent answers to the question “What makes us peculiar?” I locate my answer within the “logical geography” (Ryle, 1945) of contemporary research on human evolution. Then I explain how and why the cognitive gadgets theory builds on some of the other answers, and suggest that the origins of literacy provide a proof of principle for cognitive gadgets.

LOGICAL GEOGRAPHY

Dimensions
Some political and religious groups hold that the differences between humans and other animals are due to supernatural forces and provide moral justification for privileging human interests over all others. In contrast, contemporary scientific enquiry assumes that any differences between humans and other animals, in degree or in kind, result exclusively from natural processes—many of them evolutionary—and
while the differences may inform debate about the ethical treatment of animals, their moral implications are far from self-evident. When scientists ask “What makes us peculiar?” they are not assuming that humans are the only peculiar animals, or that our peculiarities make us morally superior.

By definition, all scientific inquiry about human distinctiveness aims ultimately to explain the manifest differences between our lives and the lives of other animals—the differences in geographical distribution, habitats, and habits that the proverbial Martian would be able to detect while visiting Earth. Scientists look for explanations in a variety of places. Some research focuses on our bodies, for example, tracing the effects of bipedalism and our remarkable manual dexterity. Other work zeros in on the brain, emphasizing that our brains are unusually large, relative to our bodies, and that certain parts have expanded more than others in the course of human evolution. A third focus is on behavior, the things people do. Perhaps a key to understanding human distinctiveness lies in our social behavior, use of tools, or control of fire. The final major focus of evolutionary, scientific inquiry about human distinctiveness is on the mind. Research of this kind tries to identify the mental processes, or ways of thinking, that make humans special.

Of course, these four foci—bodies, brains, behavior, and the mind—are complementary, not competitive. The mind is implemented in the brain, the brain is part of the body, the mind-brain controls behavior, and behavior is enacted by the body. Ultimately, therefore, a full explanation of the peculiarities of human lives must integrate research with all four foci.

Evolutionary answers to the question “What makes us peculiar?” also vary in the extent of their preoccupation with history and forces. Answers that are high on the historical dimension, “narrative theories,” offer a sequence and chronology of key events in human
evolution. For example, they link major changes in brain structure and behavior with climactic or demographic events that may have provoked those changes. Answers that are high on the forces dimension, “force theories,” are concerned with the processes involved in human evolution: cultural inheritance, epigenetic inheritance, gene-culture coevolution, genetic assimilation, genetic drift, and niche construction, as well as natural selection operating on genetic variants. (All of these processes will be discussed in later pages.) The ideal theory would be synthetically high on both historical and force dimensions—it would use chronology as evidence of forces, and forces to explain chronology. There are already some admirably synthetic theories (for example, Sterelny, 2003; 2012), but synthesis is a very tall order. The patchiness of the fossil and archaeological records compels narrative theories to be speculative (they are often dismissed as “just-so stories”), and when detailed narrative is combined with analysis of forces, the resulting story can be intractably complex and untestable.

Evolutionary Psychology

Where does the cognitive gadgets answer lie in this map, defined by foci and preoccupations? How does it compare with the neighbors? The focus of the cognitive gadgets answer is firmly on the mind. In agreement with what is known as “evolutionary psychology”—or, to distinguish it from other evolutionary approaches to the study of mind and behavior, as “High Church evolutionary psychology” (Barkow, Cosmides, and Tooby, 1995; Pinker, 1994)—I am convinced that relationships between the brain, behavior and the world cannot be understood satisfactorily without a middleman—that is to say, without describing those relationships at an abstract, mental level.

Imagine someone hunting in the wilderness with a spear. It may be possible, with the help of immensely complex mathematical
models, to document what typically happens in the hunter’s brain whenever there is a change in the pattern of light entering his eyes as he scans the horizon. It may even be possible to correlate these light-related changes in neural firing with the hunter’s behavior: Type A patterns predict he will continue scanning; Type B patterns predict he will crouch closer to the ground; and Type C patterns indicate he will raise his spear. But this huge, complicated matrix of inputs, brain activities, and outputs would not make sense of the hunter’s action, or provide information about what he is likely to do under different circumstances, unless it were translated into mental terms; for example, into a description of what the hunter “sees,” “misses,” “wants,” and “knows.” Terms like “seeing” and “knowing” refer to the kinds of activities and relations documented in the hunter’s correlation matrix. They do not refer to “extra things” done by the brain or by a spooky mental substance. However, without abstraction of the kind that mental terms provide, behavioral science and neuroscience provide information without insight, and precision without predictive power.

In common with many evolutionary psychologists, I believe some of the most effective abstractions come not from folk psychology (“seeing” and “knowing”) but from cognitive science. “Folk psychology” refers to the blend of wisdom and old wives’ tales that we use to talk about the mind in everyday life. It explains behavior with reference to the thoughts and feelings, beliefs and desires, of whole agents. For example: “Nebeela nodded her head because she wanted to bid for the Miro, and believed the auctioneer would understand her head movement to be a bid.” The term “cognitive science” has been used since the early 1970s to refer to interdisciplinary scientific research on the mind. The disciplinary mix includes experimental psychology, computer science, linguistics, neuroscience, and the philosophy of mind. Many of the explanations offered by
cognitive science liken the mind to a computer, cast thinking as “information processing,” and are pitched at a “sub-personal” level (Dennett, 1969; 1987). That is, in contrast with folk psychology, which takes mental states of the whole person (for example, beliefs and desires) to be the drivers of behavior, cognitive science often explains behavior as deriving from the activities of parts of the mind, and of the interactions among these parts. For example: “Nebeela said ‘blue’ when she saw BLUE written in green ink because two parts of her mind—one responsible for naming colors, and the other for reading words—competed for control of Nebeela’s speech mechanisms, and the reading part won the contest.” The sub-personal explanations offered by cognitive science are not familiar or intuitive, but they burrow deeper into the mind than folk psychology, and many have survived rigorous experimental tests.

Introducing cognitive science to inquiry about human evolution, and vice versa, was one of the primary purposes of evolutionary psychology and is likely to be its most enduring achievement. The forerunner of evolutionary psychology, human sociobiology (Wilson, 1975), attempted to explain the evolution of distinctively human social behavior, especially altruistic behavior, either without mentioning minds at all, or while relying on casually generated, folk-psychological characterizations of how the mind works. Similarly, the still-thriving field of human behavioral ecology (Cronk, 1991; Laland and Brown, 2011) largely ignores the mind as it uses mathematical modeling to investigate whether distinctively human behaviors, especially foraging behaviors, are likely to be adaptive (to enhance reproductive fitness) and, if so, to be adaptations (to have evolved because they enhance reproductive fitness). Adopting a strategy that has been described as the “phenotypic gambit” (Grafen, 1984; Hoppitt and Laland, 2013) and “blackboxing” (Heyes, 2016a), human behavioral ecologists sometimes allude to the brain, but
very rarely to the mind, and when they do say something about the mind, they usually reach for folk psychology. Consequently, although sociobiology and human behavioral ecology have provided valuable information about human evolution, I think evolutionary psychologists were right to point out, some twenty years ago, that it was high time the mind was taken more seriously.

The cognitive gadgets answer is at one with evolutionary psychology in focusing on the mind and emphasizing the importance of cognitive science in explaining human distinctiveness. However, the cognitive gadgets answer is completely at odds with evolutionary psychology—or at least with the part known as “High Church evolutionary psychology”—in its claims about the forces that have shaped, and continue to shape, the human mind. Most evolutionary psychologists argue, assert, or merely assume that genetic evolution is the architect of the human mind. According to this “cognitive instincts” view, distinctively human ways of thinking are “in our genes.” A newborn human baby does not enter the world understanding causality, with a full supply of mental maps, and talking in complete sentences, but she contains in her genes very specific programs for the development of these capacities; programs that are capable of building distinctively human cognitive mechanisms—such as causal understanding, mental mapping, and language—with minimal help from learning. The environment in which a child grows up is seen as “triggering” or “evoking” cognitive development; not, as it is in the cognitive gadgets theory, as forging or constructing distinctively human ways of thinking.

*Cultureal Evolutionary Theory*

Cognitive gadgets is a “force theory” rather than a “narrative theory.” It is consistent with what is known about the chronology of human evolution (see Chapter 9), but it is primarily concerned with the
processes that have shaped the human mind and regards learning—especially social learning—and cultural evolution as dominant among these processes. In emphasizing the importance of social learning and culture in explaining why humans live such peculiar lives, the cognitive gadgets theory is akin to “cultural evolutionary theory” (Lewens, 2015).

Contemporary cultural evolutionary theory emerged in the 1980s (Boyd and Richerson, 1988; Cavalli-Sforza and Feldman, 1981), building on ideas formulated in the preceding twenty years (Campbell, 1965; 1974), and resolutely rejecting the politically stained “social Darwinism” of the Victorian era. It is now a broad church (see Chapter 2). Cultural evolutionists are united in believing that evolution—defined as a change in the distribution of characteristics within a population over time—can be powered not only by genetic inheritance but by cultural inheritance. Characteristics, or “traits,” can increase or decrease in frequency, not only as they become more or less likely to be passed on to biological descendants via genetic mechanisms, but also as they become more or less likely to be passed on to cultural descendants, who may or may not be genetically related to their cultural parents, through social interaction.

The crucial difference between contemporary cultural evolutionary theory and the cognitive gadgets theory concerns the traits they have in their sights. Until now, cultural evolutionary theory has been applied to observable behavior and artifacts. For example, it has been used to explain change over time in the frequency of people in a population who have a small family, or who use a particular kind of fish hook. In contrast, the cognitive gadgets theory applies cultural evolutionary theory to the mechanisms of thought—the mental processes that generate and control behavior. For example, it seeks to explain change over time in the frequency of people in a population who are capable of calculating a shortcut across
unexplored territory (mental mapping), who can entertain a theory about how an instrument works (causal understanding), or who have cognitive equipment allowing them to copy facial expressions (imitation). The cognitive gadgets answer is concerned not with the grist of the mind—what we do and make—but with its mills, the way the mind works (Aquinas, 1272; Heyes, 2012a).

When questions arise about the origins of distinctively human cognitive mechanisms, even the most enthusiastic and pioneering cultural evolutionists begin to look remarkably like High Church evolutionary psychologists. They may deny with great resolution, and on the basis of sophisticated mathematical models, that genetic mechanisms are responsible for the evolution of human behavior (grist), while assuming without comment, or on the basis of meager evidence, that distinctively human cognitive mechanisms (mills) have been fashioned by the genes.
This juxtaposition is particularly striking when it comes to the cognitive mechanisms that enable cultural inheritance—mechanisms known collectively as “social learning” or “cultural learning” (see Chapter 4). The picture painted by contemporary cultural evolutionary theory has the virtue of simplicity (Figure 1.1). Genetic evolution has given humans mechanisms for cultural learning, and, using these cognitive instincts, we learn from others most of what we need for survival and reproduction in the particular geographical area, and particular social group, in which we live. It is a simple picture, but I argue that it does not line up with the evidence from cognitive science. That evidence suggests that the distinctively human cognitive mechanisms involved in social learning are not only processes but also products of cultural evolution.

In summary (Figure 1.2): the cognitive gadgets answer to the question “What makes us peculiar?” is like evolutionary psychology in targeting the mind and drawing on cognitive science, and like cultural evolutionary theory in emphasizing the importance of social learning as a force in human evolution. However, it is quite different from both
of these approaches in suggesting that distinctively human cognitive mechanisms are gadgets rather than instincts; products of cultural rather than genetic evolution. Given these similarities and differences, the cognitive gadgets theory represents a progression from evolutionary psychology and cultural evolutionary theory that I call “cultural evolutionary psychology.”

**Fellow Travelers**

Although the cognitive gadgets theory is at odds with evolutionary psychology and cultural evolutionary theory on the origins of distinctively human cognitive mechanisms, I most certainly am not a lone voice in the wilderness crying “Culture changes the way we think.” For many social anthropologists, especially those who identify themselves as “cultural psychologists” (Shweder and Sullivan, 1993), this is a fundamental tenet of their work. They regard all aspects of the mind as interdependent with the cultural environment in which it develops, to the point where mind-and-environment are inseparable. This conviction, among researchers who have a rich body of direct experience with people from non-Western cultures, provides encouragement for the cognitive gadgets hypothesis. However, cultural evolutionary psychology departs from cultural psychology, and from the approach adopted by most social anthropologists, in being rooted in cognitive science and evolutionary theory. For example, it takes a keen interest in characteristics that are typical of humans, as well as variation between individuals and groups. Also, cultural evolutionary psychology does not seek to abolish the distinction between nature and nurture (see Chapter 2), or to revise our everyday ontology in which minds continuously interact with, but are distinguishable from, the world around them (Greenwood, 2015).

Other voices saying “Culture changes the way we think” come from “cross-cultural psychology.” In this field, where many researchers
draw on cognitive science, experiments in which people from different cultures are given the same behavioral tasks reveal both species-typical human psychological characteristics and fascinating patterns of between-group variation (Haun, Rapold, Call, Janzen, and Levinson, 2006; Nisbett, 2010; Shiraev and Levy, 2014; Winawer et al., 2007). Cross-cultural psychology is, arguably, a methodology rather than a research program with its own theoretical framework. Consequently, there is significant potential for synergy between cultural evolutionary psychology and cross-cultural psychology, with the former providing theory and the latter, evidence.

Within the logical geography of research on human distinctiveness, the theories that lie closest to the cognitive gadgets theory are those of Barrett (2017), Dennett (1991), Karmiloff-Smith (1995; 2015), and Tomasello (2009; 2014). Barrett’s “theory of constructed emotion” has a different focus—emotion rather than cognition—and does not invoke cultural evolution specifically, but, like cognitive gadgets, it is rooted in cognitive science and underlines the importance of social interaction in shaping human minds. Dennett’s “multiple drafts” account of consciousness implies, but does not state explicitly, that cultural evolution can shape cognitive mechanisms as well as cognitive products. Karmiloff-Smith’s theory of “representational re-description” makes no reference to cultural evolution but is a pioneering attempt to specify, within a cognitive science framework, how sociocultural experience could produce new cognitive mechanisms. Finally, like the cognitive gadgets theory, Tomasello’s “shared intentionality hypothesis” is a direct answer to the question “What makes us so peculiar?” focusing on the psychological processes involved in cultural inheritance, and emphasizing the importance in cognitive development of learning through social interaction. However, the shared intentionality hypothesis seeks a single psychological source of human distinctiveness (“shared intentionality”), rather than a set
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