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Introduction

Science! Thou fair effusive ray
From the great source of mental day,
Free, generous and refined!
Descend with all thy treasures fraught
Illumine each bewilder'd thought
And bless my labouring mind!
Mark Akenside, *Hymn to Science* (1744)

Since Darwin, the emphasis in scientific research on the nature of human beings has been on the *similarities* between us and other animal species. The importance of such research in revealing who we are, as biological organisms, can hardly be overstated, and no modern intellectual can afford to ignore the academic edifice known as evolutionary theory. But, as real as biological evolution is, it still needs to be said that an eight-year-old walking around a zoo shows more psychological insight than an academic in his lab coat who refuses to acknowledge the gargantuan gap that separates *Homo sapiens* from all other animal species. Despite profound, diverse and numerous similarities with monkeys, chimps and gorillas, human beings are special in an objective, verifiable sense. It is not simply the case that "our tribe is different." We inhabit a cognitive world that is utterly beyond what other animals experience; we have certain (easily identified) behavioral capabilities (speech and tool use), certain other (less obvious, but measurable) perceptual capacities (music and pictorial art) and complex social lives that are fundamental to what it means for us to be human beings, but that are entirely absent or barely recognizable in other species. This book is about those unusual, characteristically human, psychological talents.

The motivation for elaborating on the theme of human "uniqueness" is not some strange need to justify our superiority over animals nor is it

a call to return to prescientific, religious thinking in light of our "higher-level" capabilities. The aim is, more simply, to understand our cognitive strengths, and to do so requires examination of the talents that most clearly differentiate us from animal species – even from our closest cousins, the chimpanzees and bonobos. Insofar as we are active participants in our own biological, social and intellectual evolution, any progress in understanding how it is that we have come this far will help us to develop those strengths further and, indeed, allow us to make our best traits truly universal among all human beings.

There is of course no virtue in gloating about the splendid uniqueness of *Homo sapiens* or in enumerating the psychological deficiencies of the laboratory rat, but a focus on the unusual aspects of human behavior is essential for explaining the predominance of human beings on Earth. Surprisingly, just asking why we are so different quickly reveals how little we understand about the specifically *human* aspects of cognition. On the one hand, on the basis of just whispers of physical evidence, paleontologists have reconstructed the steps that our ancestors took in becoming human, and have provided what is a plausible "best guess" about human evolution. The path from squirrel monkey living in the trees; to bipedal hunter/gatherer; to primitive *Homo sapiens* taming fire, constructing huts, growing crops and so on is a fascinating story in its own right. But underlying those gradual anatomical, behavioral and social changes, there must have been changes in mentality that were equally revolutionary and equally decisive in separating those of our ancestors who dared to walk upright, fashion objects with their hands, play with fire and communicate with words – and those who did not. The question that remains largely unanswered is: Just what is the nature of the cognitive revolution that led to this demarcation between thoughtful, creative, ambitious, adventuresome human beings and playful, pleasant, placid, but – in terms of tangible, real-world achievements – rather uninteresting apes?

The biologist will remind us that we are genetically more than 98 percent the same as the chimpanzees, and we can be certain that all of our human talents have biological origins – traces of which can often be found in species that have had remarkably little impact on the world at large. But, even though we also are essentially primates with countless humble cousins among the mammalian line, we are nonetheless unusual – and it is this stark unusualness that is the source of the nagging skepticism about the modern, scientific worldview. Religious dogma simply declares that "Man is special!" and, regardless of the truth or fiction of the process of evolution, there is no further need for believers to glance back: Unseen

powers have chosen us, it is said, for a special role in life on Earth. In contrast, evolutionary theory explicitly links us with the material world and ties us to all other biological species. The implication is that, in essence, we are not more unusual than, say, anteaters or jellyfish – remarkable maybe, different for sure, but just another ephemeral leaf on the evolutionary tree of life that has somehow emerged on this lukewarm planet in this typical solar system.

As a consequence, in acknowledging the truth of evolution, we inadvertently accept a quite counterintuitive view of humankind. Despite mountains of behavioral evidence, the entire history of human civilization and our undeniable feeling that we have an internal cognitive life that is starkly different from anything else in the animal world, the modern scientific worldview classifies us squarely with our furry friends, and does not acknowledge any material basis for our fond fantasies of "higher-level" existence. Details aside, the broad strokes of evolutionary theory have thereby left a curious void at the heart of the scientific explanation of human existence. All of our higher-level aspirations – however we may individually formulate them in terms of political activism, spiritual faith, intellectual rigor, creative enterprise or ethically upright behavior – are in the "big picture" of evolutionary theory essentially irrelevant. Beguiled by the scientific rigor of molecular biology, we have modestly accepted the view that we are psychologically a slight variation on the primate theme – another nimble ape adapted to a particular biological niche. "Despite what you may think," the biologist teases us, "the high-minded ideas you say motivate your life are nothing more than delusions – stories constructed after the fact to justify your biological urges to yourself and others!"

To be sure, when seen through the lens of cellular biology, we are quite explicable as just another example of fanatically replicating "selfish genes" – bundles of biological instincts that, by chance and good fortune, have become rather dominant on Earth over the past 100,000 years or so. And when seen through the lens of physics or chemistry, we are typical of all organic life-forms in consisting of mostly carbon compounds and water. But when addressed at the psychological level, our unusualness is striking: The behavior that flows from our unusual minds has surprisingly few antecedents among animal species. Those remarkable talents are deserving of as much careful study by psychologists as scientists have already devoted to clarification of the physical, chemical and biological worlds.

As judged from our complex behavior, we are cognitively unique. We communicate with each other using symbolic languages that make absolutely no sense to other species. We make tools that we then use to change

the external world around us but that are as meaningless as tree stumps to other species. And we create and enjoy art and music for reasons that are sometimes hard to explain but nonetheless have deep meaning for us, but no meaning for other species. What precisely is it that makes us behaviorally so unlike our biological cousins? It is not pride that motivates this inquiry, but curiosity – and that simple curiosity concerning how other species think is something that has not been reciprocated! At the psychological level – thinking about thinking – we are alone.

But if we are unusual in many identifiable ways, it is nonetheless a curious fact that we still have difficulties explaining in concrete terms how and why that might be true. Modern science can catalog the differences among animal species – from gross behavior to DNA sequences – but questions about whether or not we actually think differently from monkeys will be answered with blank expressions. "If you want to get into the problem of why human beings are special, you really don't belong in the Faculty of Science, but should move to the Faculty of Arts and Letters, or Theology – or just give up and study Linguistics!" is a sentiment that lies just below the surface in the world of cognitive neuroscience.

Despite the merits of such career advice, however, it is precisely our cognitive unusualness that needs to be clarified to consolidate our evolutionary successes. In order to transcend the fractious, short-sighted debate about which form of human culture should be considered the transient "winner" in modern times, we need to identify the cognitive roots of our behavioral dominance – not by retreating to the philosophical discussions of previous eras, and certainly not by declaring with the linguists (or is it the theologians?) that we alone miraculously have The Word, and all else follows from there. On the contrary, language is one of the enigmas that need to be solved on the basis of the principles of verifiable cognitive neuroscience. What we, as a species, still need is a deeper understanding of what *Homo sapiens* is and how we got here.

It may well be that the philosophers and poets are on target when they discuss the nature of the human soul using the psychological categories and terminology that Shakespeare, Dante and scholars from the Renaissance would have understood, but those insights need to be translated into the lingua franca of the modern world: empirical science. Just what is language (and music and art, fun and work, awe and wonder, justice and responsibility) in a material world? Despite the deep pessimism among some scholars on the possibility of answering such "big questions," genuine progress has been made in cognitive psychology in modern times and some important insights have already been established. The story is still far

from complete, but it is today possible to explain – in broad outline and in some detail – how it is that we are simultaneously standard-issue biological entities entrenched in the messy business of biological survival, and yet remarkably "mindful" – perceiving, cogitating and behaving in a material world in ways that are undreamt of among lower species.

In order to clarify the psychological roots of our higher-level behavior, we must address these issues in the somewhat unusual terminology of cognitive psychology and neuroscience. While "thinking about thinking" and wading through the details of some low-level mechanisms, however, it is important that we stay focused on our ultimate goals at the higher end of human psychology – and not get sidetracked by topics that can be dealt with adequately by the sociologist or the biochemist. In other words, cognitive psychology is a scientific field in its own right and can provide answers to questions about the essential operations that allow for human cleverness – not by abandoning cognitive psychology and attributing our mental strengths and weaknesses to sociopolitical or molecular factors, but by addressing them in terms of the underlying cognitive mechanisms themselves. Above all else, we must ask: What are the mental gymnastics that we undertake in using language and tools, in understanding art and music, and in transcending our individual egocentricity to participate in social organizations? The answers are not as simple as pointing out a special gene or an unusual neurotransmitter that explains all, but the good news is that the answers are understandable in the modern scientific terminology that has been developed for discussing cognitive mechanisms.

1.1. THE BASIC QUESTION

The basic question that will be addressed in the pages that follow is: What distinguishes human beings from similarly big-brained animals, such as chimpanzees, bonobos and gorillas, and from our early ancestors of more than 100,000 years ago? Anatomically, physiologically and even genetically, we are all extremely similar, but only *Homo sapiens* embarked on a rampage of cognitive development that has allowed for the unusual behaviors underlying human civilization. We are justifiably proud of those mental talents and, with only infrequent interludes, we exercise and indulge them throughout the waking day – most notably, in behaviors that involve language, tools, music, 3D visualization and social cooperation – often exploring complex combinations of those talents simultaneously. Other species show hints of such abilities, but only we have turned them into lifelong obsessions, full-time careers and the focus of incessant, large-scale social

activity. Where did the human talents come from? And how can they be explained on a scientific basis?

Harmony, Perspective and Triadic Cognition is an attempt to answer these "big questions" in human psychology – not by pontificating on the importance of language or symbolic thought, morality or the exalted state of the human spirit but by focusing on the small-scale psychological miracles that we perform daily. The main themes to be discussed here concern the cognitive functions that are universally acknowledged to be well developed in human beings but are totally absent (or present only as faint traces) in other species. In concrete terms, what precisely do we perceive, think and do when we undertake our characteristically human behaviors? What does it mean to use a language? To handle a tool? To understand a photograph? To enjoy music? To lend a hand? In order to answer these questions, a comparison with infrahuman cognition is sometimes relevant, but the main topic must be our understanding of how the individual human mind works. Once we understand the basic cognitive processes occurring in one human brain, then we can address the next level of inquiry: how the human mind allows one individual to cooperate with other human beings in achieving goals that none of us alone could possibly achieve.

As will become clear, the theme of this book is *human* cognition (not generalized primate intelligence, much less rat neurophysiology), and the focus will remain relentlessly on how our minds can use language, manipulate tools, create art and make music. The topic of interest is how we *think* – not the issues of the shape of the pelvis, the larynx or the thumb that allow particularly efficient walking, talking and grasping. Without doubt, we have bodies that are well adapted to our unusual minds, but it is in the realm of the mind where we are special, and where the academic field known as cognitive psychology has the potential to contribute profoundly to our understanding of the human condition.

One of the main lessons of nineteenth-century *biology* was that there are deep *similarities* among all animal species – similarities that can be explained in terms of evolutionary theory. But – given that evolutionary foundation – the *dissimilarities* with even our closest biological cousins present twenty-first-century *psychology* with its greatest challenge. Yes, we resemble vertebrates, mammals and particularly the apes in many ways, but the unusualness of human behavior is the central issue that the science of *psychology* must clarify. If successful, elucidation of the cognitive mechanisms underlying our unusual minds should bring some benefits in the form of practical applications in education, clinical psychiatry and social engineering, but more importantly an understanding of the human mind

would provide insight into the ways in which we are more than beasts in the struggle to survive. We already have some reason to be proud of human civilization and our unusual status on Earth, but our propensity for intra-species murder; for putting each other into locked cages; for placing more importance on rituals than on common decency; for falling into the ridiculous conceits of "papal infallibility," "enlightened perfection" and "sacred words"; and the pervasive tendency to regard a small gang of our compatriots as "decent folk" and the rest of humanity as "infidels" are human foibles not to be overlooked. Just maybe, there's still room for improvement.

1.2. TRIADIC PERCEPTION, TRIADIC COGNITION AND TRIADIC SOCIAL INTERACTION

Most of the topics mentioned in textbook discussions on human cognition will be examined in the following pages. Individual chapters are devoted to language and symbolic thought, tool use (toolmaking and handedness), music (harmony) perception, and pictorial depth perception (seeing 3D depth and mentally manipulating the objects represented in 2D pictures), and brief discussion is made of social cooperation ("joint attention") and the "moral mind." There are in fact technical arguments for maintaining that related behaviors, cognitions and perceptions do occur to some extent in nonhuman species – and such arguments constitute important support for the common evolution of all animal species. But, despite that thread of biological continuity, what is nonetheless striking is that many of our normal ways of thinking are either impossible or notably difficult for all other animal species.

On the one hand, apes, dolphins, parrots, cats and dogs that are raised in essentially human-controlled environments and that receive intensive training can achieve certain behaviors that reveal a potential cleverness not seen in the wild. And even in the wild, modern animal research continues to reveal social hierarchies, vocal communications and tool-usage talents suggestive of higher cognition that, only a few decades ago, was thought impossible for infrahuman species. For driving home the continuity argument known as evolutionary theory, such research is of interest, but, for understanding the underlying cognition, it is far more important to examine what precisely the human forms of those talents are.

For all of us who have received a normal human upbringing, the "intensive training" that was our childhood releases a huge repertoire of sophisticated "higher cognitions" – cognitions that eventually become easy, natural and the focus of our daily lives. "Of course, I can speak a language!

And can understand the 3D scene in that painting! And can hear the sadness in that melody! And can light a match! And can imagine the shape of Florida! And can do simple arithmetic in my head! And can turn my attention to what you point out!" and a thousand other things that tax the upper limits of a chimpanzee trained for months on simple versions of such tasks. Those behaviors are so easy for us that we don't often ponder their significance, but they lie at the heart of all forms of human civilization and are – in the biological world – far from typical.

In fact, many books written during the past century have documented aspects of the evolution of the human talents that are discussed here, but *Harmony, Perspective and Triadic Cognition* is unusual in proposing a cognitive mechanism that underlies them all. That mechanism is the raison d'être for this book and fills in the blank space where typically even the most demanding, hard-headed scientist hopefully pencils in "random mutation" when trying to explain the unusualness of *Homo sapiens*. "Random mutation" is, of course, the accepted evolutionary jargon for "Hey, something remarkable that we haven't a clue about must have happened!" and indeed the genetic argument might boil down to something as simple as a few well-placed errors in DNA replication. But, whatever the genetics, the psychological argument for how we, but apparently not other species, *think* must be explained at the level of cognitive mechanisms. For that reason, the following chapters address the question of what is happening in our minds when we use language, hear harmony, handle a tool, see depth in a flat picture or attend to a conversational topic that someone has just raised. In other words, just as an understanding of biological life requires a close examination of cellular processes (and cannot rely solely on lower-level arguments from physics or chemistry), an understanding of human psychology requires an examination of cognitive processes (and not a reliance solely on the anatomical, cellular or molecular topics favored by nonpsychologists).

The theme that unifies the diverse, characteristically human behaviors discussed here is that, in each case, the individual must deal with *three* distinct streams of information at once – must have "three things in mind" simultaneously. Whether words, musical tones, ideas or baseballs, "juggling" with three objects is simply beyond the capabilities of other species, but it can be mastered by all normal children in a variety of domains – usually through mere exposure to the behavior of adults or early basic training. Juggling three sensory cues, physical objects or thought processes is what this book is about.

To clarify how different we are and, indeed, to justify the notion of "higher" and "lower" cognition, many familiar topics in human psychology

will be covered here, but what distinguishes this book is an insistence on framing familiar questions about the unusual character of the human mind in the simplified terminology of cognitive psychology. The coherence of the answers will become apparent individually in consideration of specific human behaviors, but, in every case, the cognitive mechanism that brings these diverse behaviors together is that our uniquely human talents are (merely!) one step more complex than simple "two-component, dyadic associations." I maintain that what we do so easily, so naturally and so well is "triadic cognition."

The forms and contents of triadic cognition are diverse, but its "higher" character can be clearly explained in comparison with *dyadic cognition* – thought processes that involve only two elements. Associations between this and that, pairing between conditioned and unconditioned stimuli, and one-to-one correlations between stimulus and response are sufficient for operant conditioning – and *all* animal species, including *Homo sapiens*, can "think" at that level (Macphail, 1987). In other words, the basic learning capabilities that even a primitive nervous system provides are enough to handle most forms of "two-body" associations. Depending on the perceptual processing that precedes the dyadic associational mechanism, the content of such thinking will differ markedly from species to species, but the simple linkage between, for example, a sensory stimulus and a favorable or unfavorable outcome will be enough for most brains to link the perceptual event with appropriate motor behavior. In terms of neuronal mechanisms, stimulus followed by response, correlation between *X* and *Y*, and all other two-element connections are inherently easy and do not tax the learning capacities of the cockroach, much less cats and dogs. But, for all the strengths of associationism (and the associational, Hebbian learning mechanisms that underlie the psychological theory known as behaviorism), "the association between *X* and *Y* dependent on the state of *Z*" is a logic of a higher form – a psychological operation that suddenly separates the men from the boys, the adults from the children and, indeed, us from all other animal species. I will show that the gateway to so-called higher cognition is the ability to handle just this type of three-body "conditional association" – seemingly not such a complex undertaking, but the start of the cognitively unprecedented human revolution nonetheless.

The abstract idea of three-body cognition is inevitably a controversial theme – and most researchers interested in the evolution of the human mind will be anxious to return to discussion of mirror neurons, the acoustics of vowel production, the verbal exchanges in social interactions, and other specific examples of cognitive talents that don't have the aroma of

a metaphysical "trinity!" While those concrete issues are all in fact part of the story of human uniqueness, I will show that triadic cognition is the underlying mechanism – and that it provides a conceptual framework within which those specialist topics are best understood … with absolutely no metaphysics implied! On the contrary, it is the concreteness of the triadic argument that is its strength. Depending on the specific topic, it can be said that various triadic talents are (i) already empirically well understood, (ii) currently the focus of experimental research or (iii) a familiar, if still rather vague, idea. Details and examples are provided in the chapters that follow, but it is the intrinsic "threeness" of the underlying cognition that is so unusual.

Discussion of various three-body computations necessarily leads into the academic fields of linguistics, brain physiology, art history, music theory, developmental psychology, neural networks and other disciplines that are normally of concern to specialists only. The scope is inevitably broad, but I maintain that the core arguments in these diverse fields are not of such extreme complexity that they must remain out of reach to the non specialist. On the contrary, the underlying thesis about triadic cognition is so easily stated that it is spelled out here in this introductory chapter. As a result, the reader should be able to put the more technical and less familiar arguments in the following chapters into their proper contexts – and to understand why it can be said that human cognition is at once endlessly complex, and yet the basic processes are thoroughly easy.

Let it be noted that many scholars have previously advocated "triadic," "ternary," "tripartite," "trichotomous" or "tertiary" cognitive models to explain specific aspects of the human mind. The fact that others have advocated three-way explanations of human cognition does not place them above our normal skeptical evaluation, but it does indicate that the general argument concerning triadic cognition falls more or less within orthodox thinking in several branches of human psychology. Moreover, as demonstrated later, the triadic argument turns out to be surprisingly concrete. Although various abstract models will help guide our search, ultimately the three-way mental gymnastics that we are so good at are comprehensible *because* they are so familiar. Countless examples from everyday life are available and explicit support for the idea that the human psyche has a triadic core comes from experimental results in cognitive psychology and cognitive neuroscience. In other words, the argument is scientific, not philosophical, and provides many opportunities for empirical testing.

In Chapters 2 and 3, the three-body argument is explained in the *perceptual* realm – specifically, in terms of musical harmony and pictorial