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Book Review

UNIQUE ASPECTS OF HUMAN EVOLUTION

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A Review of the Book

The Gap: The Science of What Separates Us from Other Animals

by Thomas Suddendorf. 2013.
Basic Books, NY, 358 pages.
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In comparing ourselves with our fellow primates, mammals and all other animals that inhabit this planet we can emphasize either continuity or discontinuity. In The Gap, psychologist Thomas Suddendorf has chosen discontinuity. In consecutive chapters he surveys the six abilities most often cited as uniquely human: language, intelligence, morality, culture, theory of mind, and mental time travel. In each of these six domains non-human animals demonstrate certain limited abilities, but Suddendorf argues that humans possess two traits that account for most of the ways in which our minds appear so distinct: Namely, "our open-ended ability to imagine and reflect on scenarios, and our insatiable drive to link our minds together. It seems to be primarily these two attributes that carried our ancestors across the gap, turning animal communication into language, memory into mental time travel, social cognition into theory of mind, problem solving into abstract reasoning, social traditions into cumulative culture, and empathy into morality." (p. 216).

There is much to like about this appealing presentation of basic research in comparative psychology, informed as it is by evolutionary biology. Suddendorf presents a clear and balanced overview of each of these six qualities. Borrowing from Dan Dennett's dichotomy of "romantics" vs. "killjoys", he skillfully navigates between romantics who posit mental processes in animals that are similar to our own, and killjoys who argue for a greater divide

between animal and human minds. I found his account of those areas of research that I know well (language and theory of mind) to be both well informed and fair, and less tedious than the contentious sparring that too often characterizes debates between the two sides in other academic contexts. While certainly not a "killjoy," Suddendorf sets the bar higher than many more "romantic" investigators. As he argues "if you set the bar low, you can conclude that parrots can speak, ants have agriculture, crows make tools, and bees cooperate on a large scale" (p. 215).

Comparative research makes it clear that despite apparent similarities, significant gaps clearly remain between human and ape cognitive and linguistic abilities. Speech production is severely limited in apes, which possess limited control of voluntary vocalizations. Key cognitive abilities that support the learning and teaching of more elaborate usages of language are either severely limited or completely absent. Other studies have shown that chimpanzees do not have the capacity to represent the mental states of others, including beliefs, desires, and intentions, that we observe in four-year-old children. In general chimpanzees lack the human capacity for abstract causal reasoning, or the ability to posit unobservable constructs to explain observable events, that is central to a human theory of mind. In a recent summary of 30 years of research (Call & Tomasello, 2008), growing consensus from experimental evidence seems to indicate that chimpanzees understand others in terms of a perception-goal psychology, but not in terms of a belief-desire psychology. Humans, of course, clearly do understand others in terms of their desires and beliefs, and they do so at an early age.

While his integration of findings in comparative psychology at the behavioral level of analysis is exemplary, Suddendorf misses the opportunity to connect the dots with more basic levels of analysis, particularly comparative neuroscience and genomics. As a result, the reader is informed about the output of evolved systems that distinguish us from the apes, but relatively uninformed regarding differences in software (neuroscience) or hardware (underlying genetic differences) even though these comparative data are increasingly available. One reason these levels are critical to an evolutionary account about how human minds are different from apes is that they offer potential answers to the question of why apes did not evolve bigger brains since they would clearly find them advantageous, as we did.

The relatively new fields of comparative genomics and Evo-Devo illuminate the genetic processes by which the development of a species undergoes evolutionary change. One such process, heterochrony (hetero "other" and chronos "time") is defined as an evolutionary change in rates and timing of developmental processes between closely related species. It can be the result of relatively small genetic changes that may not even be alterations in DNA sequence, but rather changes in the timing of particular genes being expressed during development.

A number of heterochronies have been described in humans, relative to the great apes. For example, prenatal brain and head growth starts at about the same developmental stage with a similar growth rate between humans and chimps. However, after birth the two developmental pathways diverge significantly and humans continue their brain and head

growth considerably longer than chimps. The emergence of this human capacity to grow a larger brain may have been made possible by alterations in the gene controlling the growth of our jaw muscle (Stedman, et al., 2004). Stedman contends that the ape's tremendous jaw muscle power forces their skull plates to fuse together at an early stage, placing absolute limits on how much the brain can grow. In the great apes these growth plates are fused by about three or four years of age. Stedman's team has shown that all humans share a common genetic mutation that greatly reduces the size and strength of our jaw muscle relative to apes. This genetic "defect" allows the human skull to keep expanding into adulthood, creating a bigger space for our brain. The mutation involves just two base pairs of a gene called MYH16 that renders the gene inactive for producing some of the jaw muscles for chewing and biting. This myosin gene was still intact in all non-human primates, but inactive in all humans worldwide. Using estimates of evolution rates, they deduced the mutation's occurrence to a range of 2.1 million to 2.7 million years ago or just prior to the period in which Homo habilus makes its first appearance in the fossil record.

The date of the MYH16 mutation coincides approximately with another series of mutations that led to the evolution of a pincer grip between thumb and forefinger that is unique to the human species. The emergence of this evolutionary novelty has been clarified by identifying a gene enhancer that is expressed in the development of the human hand and concentrated on the forefinger. The enhancer, named HACNS1, exhibits stronger recurrent selection on the human lineage than any other conserved enhancer sequence known. By testing combinations of human and chimpanzee HACNS1 sequences, Prabhakar et al. (2008) narrowed down the relevant functional mutations to an 81-base pair region containing 13 substitutions that arose during human evolution. This concentration of substitutions is highly unusual with respect to the genome as a whole, implying positive selection on this region during human origins. The functional explanation pertains to the unique evolution of human manual dexterity at a period when hominin toolmaking was on the rise. The flexibility and coordination of the human hand is distinctly superior to all other primates. Evolutionary advances in the structure of the hand, together with brain expansion, provided our hominin ancestors with the ability to make stone tools over 2 million years ago. Similar genomic analyses explain differences in speech production and other essential differences between human and chimpanzee genomes that are reflected in observable differences in behavior.

It may be that the background necessary for the lay reader to incorporate these levels of analysis was simply too daunting a task. However, Suddendorf does deliver a welcome addition to the growing popular science literature that carefully explains an evolutionary behavioral/cognitive psychology to the intelligent layperson. I recommend this book for use in undergraduate, and possibly graduate, courses in evolutionary psychology and to the instructors of these courses. The book would also appeal to evolutionary scholars who lack a background in this domain of research. Besides its clear and accessible style, the book is enriched by a wealth of illuminating quotations from philosophers and scientists who have pondered the same basic question of the animal/human divide over the centuries and

answered it in their own way: Darwin (moral conscience), Aldous Huxley (language), Bertrand Russell (forethought) and Daniel Dennett (culture).

Finally, one of the reasons that we can claim to be so exceptional among primates is because we are the only surviving member of our genus. This is almost never the case and the far more common scenario is to have many closely related species within any given genus. Suddendorf reminds us that many extinct hominins shared some of these six capacities, making them more similar to us than to the great apes. With their extinction Suddendorf argues that we have burned the bridges across the gap, only to find ourselves wondering how we got across the divide. He then asks the provocative question of whether we will continue to widen the gap by driving all current ape species, already endangered, to extinction. One goal of this book then is to further mobilize public opinion towards the humane treatment of the great apes and their preservation in their original homelands.

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Peter LaFreniere is Professor of Developmental and Evolutionary Psychology at the University of Maine. He has contributed over 100 articles to developmental and evolutionary journals, and two books: *Emotional Development: A Biosocial Perspective (1999)* and *Adaptive Origins: Human Evolution and Development (2010), and is editing a third (with Glenn Weisfeld) An Evolutionary Science of Human Behavior: An Interdisciplinary Approach* to appear in 2014.

REFERENCES

Call, J. & Tomasello, M. (2008). Does the chimpanzee have a theory of mind? 30 years later. *Trends in Cognitive Science, 12,* 187-192.

Prabhakar, S. et al. (2008). Human-Specific Gain of Function in a Developmental Enhancer. Science, 321, 1346-50. DOI: 10.1126/science.1159974

Stedman, H. H. et al. (2004). Myosin gene mutation correlates with anatomical changes in the human lineage. *Nature, 428,* 415 - 418, doi:10.1038/news040322-9