Q & A

Marc Hauser

Marc Hauser's research sits at the interface between evolutionary biology and cognitive neuroscience and is aimed at understanding the processes and consequences of cognitive evolution. Observations and experiments focus on human and nonhuman primates, incorporating methods and theoretical insights from behavioral ecology, infant cognitive development, evolutionary theory, cognitive neuroscience, biological anthropology, linguistics and philosophy. Current foci include: the nature of our moral judgments, the computations subserving our language faculty, the evolution of cooperation, economic decision making, conceptual representations in the domains of mathematics, space, language and music and animal communication. Hauser received a BS in Animal Behavior from Bucknell University and a PhD from UCLA. Currently, Hauser is a Harvard College Professor, and Professor in the Departments of Psychology, Organismic and Evolutionary Biology, and Biological Anthropology. He is the co-director of the Mind, Brain, and Behavior Program at Harvard, and adjunct Professor in the Graduate School. He is the recipient of a National Science Foundation Young Investigator Award, a Medal of Science from the College de France, and a Guggenheim Award. His work has frequently been featured in the New York Times, Boston Globe, Wall Street Journal, NPR, ABC News, National Geographic and several international newspapers and magazines.

What turned you on to biology in the first place? Unlike many, who knew they would be biologists from early on, having discovered the beauty of beetles, the mysteries of flight or the thrill of predation, I was interested in sports, fiction and travel until I hit my freshman year of college. In that year, I met a professor by the name of Douglas Candland on the squash courts at Bucknell. We played, and in between sets, chatted about animal behavior and the emerging field of sociobiology. I took Candland's animal behavior course in 1977, where we read and devoured E.O. Wilson's major text. The questions were huge, the implications profound, and the empirical terrain wide open. I was sold. I dropped out of pre-med and dropped into animal behavior, enjoying wonderful courses and laboratory experiences with several primate species.

What is the best advice you've been given? The best advice probably came from my father, a distinguished physicist in his day, and my post-doctoral advisor, Peter Marler. My father never explicitly gave me this advice, but advised by demonstration: never pigeonhole yourself into a particular set of problems or methods, and quit if you no longer delight in the questions. It was always clear to me that what he enjoyed most about science was its questions. This is a healthy attitude, because the results don't always turn out the way you expected. If you have tasty questions, there will always be interesting places to move, independently of how the data emerge. Peter was also rather implicit in his advice, providing an exquisite example of how a well-rounded scientist is a person of many talents, able to ask the right sorts of questions, develop clever experimental methods, articulate results in compelling and interesting ways, both aurally and verbally, and learn from others. Only once can I recall Peter giving me an explicit bit of advice, and this is when my impulsivity was getting the best of me. Peter kindly told me to slow down, reflect more, and publish less. I am sure I have disappointed along these lines, but the message has stayed with me.

My advice to the next generation would include the above mentioned ingredients, with one addition: keep an eye on adjacent disciplines, as a secret to success is the ability to abandon the current ship and join another. During my graduate years at UCLA, and then later in a post-doc at UC-Davis, many of us trained in behavioral ecology started worrying about its future, as well as our own. We had all witnessed the success of adopting the adaptationist's perspective, thinking about costs and benefits and design features. But the success of this approach also seemed to lead to its own demise. In some sense, Darwin, Fisher, Hamilton, Williams, Trivers and Maynard Smith handed us rich theoretical predictions that turned out to be largely true! But now what? Most of my peers at the time began to move laterally, some picking up physiological techniques to explore the mechanisms both allowing for and constraining the adaptive trait; others pursued molecular technologies, using these to explore phylogenetic patterns; and yet others, myself included, looked to cognitive processes, to understand which aspects of human cognition are unique and which are shared with other species, and why such patterns evolved. Personally, I think the most exciting work in biology today sits at the fringes, with different disciplines clashing over theories, methods and interpretations.

Do you have a scientific hero? When my youngest daughter was about three years old, I pulled a cheap trick on her, teaching her that whenever I asked "Who's the man?", she should reply "Darwin!" She does this quite well now. It is hard to imagine any living biologist not thinking that Darwin IS the man, and I am certainly no different. But I have a different hero, and for a slightly different set of reasons. The man is Noam Chomsky. Like Darwin, Chomsky raised a set of questions that literally turned around a discipline, and opened the door to several new disciplines. In Chomsky's case, he turned around the field of linguistics, and gave birth to the cognitive sciences as we know them today. One of the ways in which he turned around linguistics was by noting that the study of language is like the study of any other part of the body, a proper problem of biology. Language, as a computational system, evolved, has distinctive features, can be studied with the tools of the natural sciences, and as such, raises profound questions about maturation, growth and knowledge.

But what I admire most about Chomsky, even when I disagree, is his relentless capacity to challenge what seems obvious, and for many, what appear to be facts. As one example, consider his long-held belief that most philosophers and psychologists have misconstrued the problem of reference, thinking that our words actually pick out real world, identifiable objects, locations and events. In fact, so Chomsky has argued, the connection is extremely fuzzy, as becomes clear when we consider the city of London. Have you ever flown to London? Not really. You fly to Heathrow or Gatwick, and then drive to London. But is the sign that says "London city limits" the only cue that you are in London, and if someone moved the sign, would it feel any different? If the entire city was transported across the Thames, would it still be London? For many, this will appear silly, and outside of the biologist's interests. But they would be wrong. What Chomsky is doing here, as he has so often done before, is challenge aspects of our understanding of the brain's capacity to represent, including both the format and content of these representations. As he has often remarked, human brains may represent the world in fundamentally different ways from the brains of other animals. Whereas nonhuman animal representations are more closely tied to their sensory and perceptual experiences, human animals have evolved the capacity to create abstract representations, variables or symbols that cut across our direct experiences.

Added on to Chomsky's attacks on traditional ways of conceiving of our mental life, has been his dogged attempt to understand the nature of linguistic knowledge, from the descriptive principles that account for the mature speaker of a particular language, to the developmental toolkit that each child has been handed to acquire any of the world's natural languages, and more. Underlying this search for understanding has been a remarkable ability to look critically at his own theories, and change them when they were insufficient to account for the evidence. His most recent attempts are radical, rejected by many, but with extraordinary implications — if true — for how the mind evolved.

What is your greatest ambition? I suppose that I have two complementary goals. First, I hope that by the time I have retired, I will have asked a set of meaningful and novel questions that illuminate new ways of thinking about the human mind, its evolution, ontogeny, and break down as a result of insult. Second, I hope that my passion for asking these questions, and finding out what is (probably) true has infected many others, including the students I teach, and the public audiences that on occasion hear a lecture or interview. Seeing my students go on to have great careers is as thrilling as seeing my own work published, cited, discussed and rejected.

What do you think are the big questions to be answered next in your field? For a couple of years now, I have been working with Chomsky on a project that attempts to move some of the central lessons of biology into the study of human thought. This exploration, only at its most primitive stage, starts with three points. First, when biologists look deeply into a system that is inherently variable, they often uncover a core set of generative mechanisms that is capable of creating such variation. Thus, the molecular revolution has led to the radical position that the variability in animal form is largely illusory, underpinned by evolutionarily ancient genetic mechanisms that can generate such variation, mediated by issues of timing and range of expression. Similarly, the Nobel laureate Niels Jerne claimed that the immune system is largely one that provides all the potentially necessary options for handling problems of immune challenges. Second, change rarely grows out of the invention of new mechanisms, but rather, out of the re-use of ancient mechanisms for new purposes or function. And third, when a generative system outputs variation, the variation is pruned back by environmental selection, fine-tuning the available options to meet the locally presented, and adaptive challenges. These lessons, we believe, are likely to apply to the brain.

Thus, language, music and morality are massively variable cross-culturally, and we have had an obsession with such variation. But, if the lessons of biology apply more broadly, and it is hard to think of a good *a priori* reason why they shouldn't, then underlying linguistic, musical and moral variation is a core set of mechanisms or principles that generates the variation, each culture having only a limited set of options that it can engage to prune back and select a local cultural variant. This possibility, if correct, sets up another profound problem. If there are conserved mechanisms for generating variation within a domain of knowledge such as language, music and morality, then these mechanisms had to interface in some way with novel sensory, perceptual, and learning mechanisms. Thus, for example, the human mind is endowed with a powerful combinatorial and hierarchical system that enables us to create meaningfully novel structures out of smaller parts. Thus, we take words and combine them in new ways to create sentences, take notes and combine them to create symphonies, and take actions and combine them to create morally permissible and forbidden events. But the combinatorial machinery, perhaps constant across each domain, has to interface with different kinds of representational entities: words, notes, and actions. How the brain does this is a deep mystery, but one that is presumably answerable given our increasing understanding of the brain's codes.

Should scientists have an obligation to society and the public at large? At least once a year, I feel great angst about my career. It is not that I doubt my work, or think that I have chosen the wrong professional path. Instead, I worry that my work is about as important as Greek translation is to our well being as a species. Lest I be misinterpreted, I have nothing against Greek translation. I see it as a great scholarly activity that should not vanish from our repertoire of

endeavours, but should not be confused as crucial to our life on this planet. My colleagues and friends quickly point out that I am teaching people important things about the knowledge we have acquired through careful scientific exploration. Yeah, yeah. But the students I teach are already very well educated, and I often feel like the post-dinner entertainment, perhaps marginally better than MTV.

But I do feel strongly that we have an obligation to the public, not only because they are footing the bill through taxes, but because no human being should be allowed to live in today's world without an education in the sciences. Every bit of breaking news is more readily interpretable with a background in the sciences. As I am writing this essay on March 26, 2007, the front page of the New York Times has these headlines: "Anna Nicole Smith's Death is called 'Accidental'", "Northern Ireland Rivals Reach Deal" and "Aged, Frail and Denied Care by Their Insurers". The first makes a critical psychological distinction that bears on legal issues, specifically, the difference between intended and accidental actions with identical consequences; if you are a utilitarian, you might not care too much about this, but then again, recent findings in the neurosciences reveal critical circuitry in the brain that, when damaged, leads to greater utilitarian moral judgments. The second headline links to our evolved capacity to create in-group and out-group distinctions, but as the philosopher Peter Singer has noted, our equally powerful capacity to change who is 'in' and who is 'out'. And the third headline speaks to the science of aging, the technologies now available for bio-engineering, and the ethical issues that accompany these hot button topics. As scientists, we must educate. We must step out of the university and into the public arena, taking every spare moment we have to 'preach' our passion.

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Mountain surprise for threatened snails

At first sight it looks like an ecological disaster: an isolated island group of animals under assault from an alien and ruthless predator. This seemed to be the plight and fate of tree snails in Tahiti. In 1974, a foreign predatory snail was introduced which rapidly eliminated their endemic prey. Thirty years on, three of the island's eight endemic *Partula* species are officially extinct and a fourth exists only in captivity. But in a Correspondence reported on pages R502–R503 of this issue, Diarmaid Ó Foighil at the University of Michigan, Ann Arbor, and colleagues at the International Partulid Conservation Project in Tahiti and the Zoological Society of London, shed a glimmer of conservation light on this otherwise bleak scene.

The researchers were able to get their results because one of the team, John Burch, collected extensive samples of all the nominal Tahitian *Partula* species, apart from one found exclusively in the mountains, four years before the predatory snail was introduced. The specimens were sent live to the University of Michigan where they were then dissected and samples of foot muscle from each individual freeze-dried and stored. From material taken from a sample of the 683 snail muscles preserved in this collection, the authors were able to assign a genotype for a mitochondrial marker amongst both the museum specimens and individuals from current captive and wild populations.

The researchers found five primary clades amongst the snails for this marker and were surprised to find that living snails, mostly from the mountains, could still be assigned to four of these clades despite the massive loss of lowland animals to the introduced predator. The researchers also describe the finding of two nominal species, still persisting at low altitudes in 19 out of 69 valleys investigated, that formed the fifth distinctive clade.

The researchers conclude that the historical diversity of these snails (in terms of this marker at least) remains, though is in a perilous state. And they point out that four of the five main historical clades are due to the presence of genetically diverse mountain populations. "Conservation of the island's remnant tree snail diversity is likely to require proactive maintenance of these threatened montane populations," they say.

Nigel Williams

Refuge: the remote mountain terrain of Tahiti has proved a vital in preserving the genetic diversity of the island's tree snails, decimated at lower levels by an introduced predator. (Photo: Diarmaid Ó Foighil, University of Michigan.)