EVOLUTION OF COGNITION

Where does intelligence come from? How is the human mind shaped by biological evolution?

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Why are humans such a unique species on earth - or are we? Humans often consider themselves unique particularly with regard to our intelligence (with the broader term 'cognition' more often used in science). But what does 'intelligence' really mean? Why are we so good at solving some problems and yet fail so often at solving others? And how can our own brain size matter when insects can use tools, navigate huge areas, even maybe use 'language' when their brains are no bigger than a pinhead? Research in behavioral ecology has a lot of answers to questions about why animals behave the way they do, and we will examine how this applies to our own life as humans, in particular with regard to cognitive skills. We will also discuss the pitfalls in trying to understand our own minds, and in understanding other minds, and we'll review what is known and what is not understood about animal intelligence.

Anna Dornhaus is Professor of Ecology and Evolutionary Biology, at the UA since 2005, with a PhD from the University of Würzburg in Germany. Her research (>100 peer-reviewed articles) centers on complex collective behaviors in social insects, ants and bees, such as how they communicate or make decisions as a group. She is also engaged in teaching (10 of her former students/postdocs now hold faculty positions) and science outreach (mostly Elementary Schools in Tucson).

General remarks about the course

My aim for the course is both to entertain and fascinate you with how complex and beautiful our world is, and how science can reveal this complexity and beauty. I hope that as a result of this course you will also understand that the scientific method is capable of revealing truths about the world and ourselves even when these are uncomfortable or counterintuitive.

Generally the readings for every class will go in more depth and allow you to engage with each topic in more detail. I will try to give a brief overview of each upcoming reading at the end of each class to help you get started (if you can complete the first reading before the first class that would be ideal to get you into the mood, but it is not required). Some scientific readings can be dense, so with any reading (or lecture material) you find difficult to understand, I invite you to ask questions right at the beginning of the class as well as during and after class; I will attempt to answer all questions either then or during the next lecture. I give optional 'further readings' below for selected classes; feel free to ask for more detail about those.

Finally, it is useful if you can bring a pen and paper for notes during class; it is of course up to you whether to take notes in general, but we will sometimes have discussions where it will be useful if you can write notes about what you concluded before sharing it with the rest of the class.

All readings should be in the box.com folder as pdf files; podcasts are mp3 files (i.e. audio files to listen to). Please feel free to email me with questions or if you are having trouble accessing anything at DORNHAUS@EMAIL.ARIZONA.EDU

Planned schedule for the course

Class date	Topic	Details	Recommended reading	Further reading (best after the respective class)
Sep 24	(1) Animals are intelligent	Course outline and the big questions; cognitive skills across different organisms; how unique are humans?	Gould: Animal cognition	Dornhaus & Franks: Ant Intelligence Pennisi: Social animals prove their smarts Morrell: Animal Minds Greenspan vSwinderen: Bee & fly cognition Mendl Paul: Bee happy
Oct 1	(2) Nature vs nurture and what is an 'explanation'	Intelligence and 'instinct'; how can we tell? Explaining variation, what is heritability; the world is complex, but statistics helps identify relevant factors	Pinker: Why nature and nurture won't go away Gonick & Smith: Hypothesis testing Video lecture: Masel There is no certainty (particularly min 23-27, Fisher and the invention of statistics)	WSJ Gopnik: Genes and environment Plomin: The top 10 replicated findings Visscher etal: Heritability in genomic era (focus on Box 4, Box 2, and Figs. 1&2) Dochtermann etal: Heritability of behavior in animals (focus on Fig 3) Polderman etal: Metaanalysis twin studies (focus on abstract and perhaps Fig. 2d) Podcast: Science Vs Antidepressants

Oct 15	(3) History and evolution of cognition research	Evolution, how it works, and why it is important; mechanistic vs functional explanations; history of the study of animal intelligence: Behaviorism, bias, and Ockham's Razor	Video: Stated Clearly: What is Natural Selection Kliman & Johnson: What every undergraduate should know about evolution Krebs & Davies: chp1 Introduction to Behavioral Ecology (up to page 13)	Video: Stated Clearly: Evidence for Evolution Video: Wellcome Trust: Tree of Life Video: Primer: Simulating Natural Selection Futuyma: Evolutionary Science, Creationism, and Society Krebs & Davies: chp2 Introduction to Behavioral Ecology
Oct 22	(4) The function of cognition in ecology	Why & when did and does intelligence evolve: benefits and costs of cognitive abilities and examples of well-understood evolution of cognition; how are elements of intelligence distributed among animals (and even plants & microbes!)	Dornhaus: book chapter in press on alien intelligence	Yong: studying animal intelligence self control Dukas: review animal cognition (particularly p354ff)
Oct 29	(5) Humans and their intelligence	Human evolutionary history; Evolution of brain size vs. intelligence; different hypotheses about tool use, social skills, mating success	Miller: excerpt from 'The Mating Mind' Bliege-Bird et al., on human hunting Video: AMNH Seven Million Years of Human Evolution	DeMenocal: Climate effects on human evolution Flinn etal: Human intelligence evolution Stix: cooperation in humans Herrmann etal: Children vs chimps Diamond, 'The Third Chimpanzee' – chapter on Human sexual traits Tennie et al.: Ratcheting up the ratchet: on the

				evolution of cumulative culture Video: AMNH Human Population through time Video: Cornell Ornithology Natural and Sexual selection
Nov 5	(6) I don't like what I'm hearing; science, truth, and your mind	The scientific method and what is especially difficult about the study of the mind; introspection is pretty useless; the good and bad of confirmation bias; Bayes and bias; is machine learning intelligent?	Chamberlin: The method of multiple working hypotheses	Podcast: NPR Hidden Brain: Facts are not enough Podcast: Freakonomics Radio: A better way to eat Podcast: Freakonomics Radio: How to change your mind Tschinkel: chp1 of Fire Ants
Nov 12	(7) But how does it actually work?	Mind vs body and the machinery of cognition – biological and artificial (computers and AI), similarities and differences, and we don't understand either that well (does size matter?). Hardware (brains and nerve cells) and software (brains as distributed systems, machine learning). Where is free will?	Deutsch: On Artificial Intelligence Podcast: Science Vs Placebo	Chittka & Niven: Are bigger brains better Roth & Dicke: Evolution of the brain and intelligence, Trends in Cognitive Sciences Trewavas: Plant intelligence
Dec 3	(8) Where cognition fails	'Irrationality' and fine-tuned adaptations, or: only as intelligent as necessary; cognitive rules of thumb; error management; and simple rules for complex problems	Video: TED Talk by Dan Ariely	Video: TED Talk by Dan Gilbert Johnson et al.: The evolution of error Fawcett et al.: The evolution of decision rules in complex environments

Dec 10	(9) Evolutionary Psychology (of humans)	Complicated history; heritability again; altruism, intelligence, and group selection; culture and cultural evolution	Alcock, 'Evolution of human behavior' chapter 14 from 'Animal Behavior'	Wilson 'Man: From Sociobiology to Sociology' chapter 27 from 'Sociobiology: The new synthesis' Mace: human life history evolution Cosmides&Tooby: Evolutionary Psychology review Yeyo (Blog): Testosterone and gender differences
Dec 17	(10) Cognition, science, and how much we don't know	Consciousness; how to recognize science; how much *do* we know about the mind, or the world?	Griffin & Speck: New evidence of animal consciousness	Nagel: What it's like to be a bat Trewavas & Baluska: ubiquity of consciousness Roskies: Neuroscience and free will