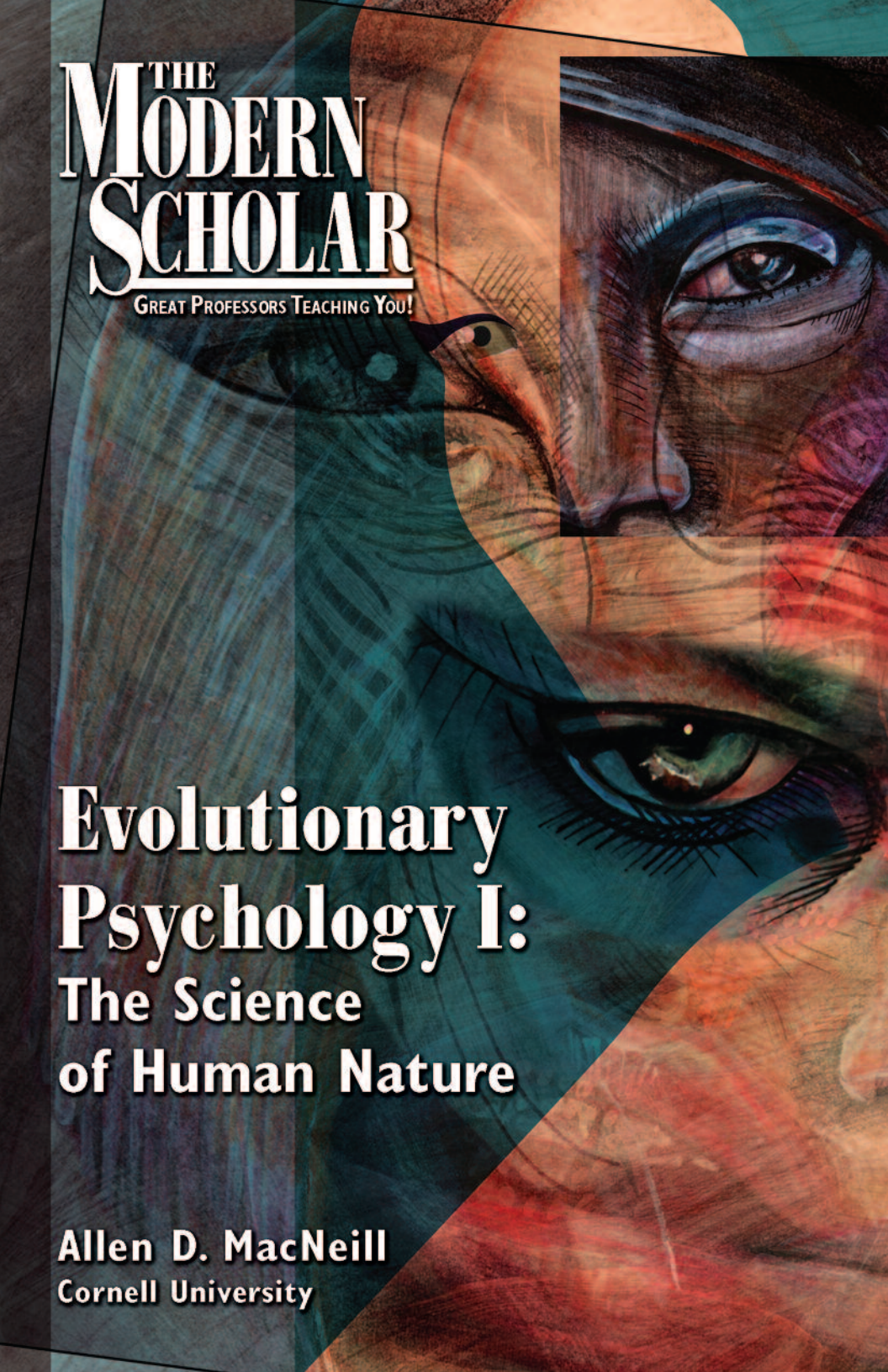


The background of the cover is an abstract, layered composition. It features several faces and eyes rendered in a painterly, expressive style. A large, dark blue face with a prominent eye is on the left. To the right, there's a more detailed face with a blue eye. The bottom right corner shows a face with reddish tones. The overall color palette is dominated by blues, greens, and earthy tones, with visible brushstrokes and textures.

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## Evolutionary Psychology I: The Science of Human Nature

Allen D. MacNeill  
Cornell University

# **Evolutionary Psychology I:**

## **The Science of Human Nature**

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**Allen D. MacNeill**  
Cornell University



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Evolutionary Psychology I:  
The Science of Human Nature

Allen D. MacNeill



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Lecture content ©2010 by Allen D. MacNeill

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#UT172 ISBN: 978-1-4498-3122-6

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## Course Syllabus

### Evolutionary Psychology I: The Science of Human Nature

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## About Your Lecturer

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### Allen D. MacNeill

Allen MacNeill earned a B.S. in biology in 1974 and an M.A. in science education from Cornell in 1977. He has taught the support course for introductory biology at Cornell University since 1976. As a senior lecturer in the Learning Strategies Center at Cornell, MacNeill works with students taking both majors and non-majors introductory biology. In addition, he organizes and carries out in-service training for teaching assistants in biology and related fields. Allen also teaches evolution for the Cornell Summer Session and has taught the introductory evolution course for non-majors at Cornell. He has served as a Faculty Fellow at Ecology House and as an honorary member and faculty advisor for the Cornell chapter of the Golden Key International Honour Society. He has served on numerous advisory committees and editorial boards at Cornell and in the Ithaca community.

Along with his many teaching assignments, Allen has appeared in a number of Off-Broadway plays and in other acting venues.

## Introduction

Why do we crave sweet and salty foods? Why are some people so sexy? Why do babies look so adorable? The evolution of the brain and the capacity for complex behaviors can tell us a lot about human nature. This course examines the remarkable new field of evolutionary psychology—the scientific study of how human nature has evolved. We begin with a brief historical analysis of the similarities and differences between evolutionary psychology and human psychology, followed by an introduction to the theories and methods as used by evolutionary psychologists. We then trace the development of psychology from its beginnings to cutting-edge fields like genetic engineering and neuroscience. Evolutionary psychology, with its roots in cognitive psychology and evolutionary biology, gives us a deeper understanding of our behavior. Like the rest of our organs, our brains (and the minds that live inside them), evolved in response to a specific set of environmental challenges. This course is about that evolutionary history.

This lecture course in evolutionary psychology is divided into two major divisions, consisting of two series of fourteen lectures each. In the first lecture series, we begin with a brief look at the history, research methods, and theories underlying evolutionary psychology and how these are applied to human behavior within individuals, families, and closely related groups. We then consider how these theoretical and practical considerations are applied to the necessities of life: food, clothing, shelter, and health care. We consider how groups of social animals, including humans and other primates, are organized and the role that natural selection plays in such organization. We then proceed to an examination of the theoretical basis for the evolution of cooperation, sex, and sexual behavior. In particular, we ask if humans are monogamous by nature and come to some very surprising (and illuminating) answers. We finish the first series of lectures by applying the theoretical concepts of evolutionary psychology to the details of human sexual behavior and child rearing.

The second lecture series reviews the history of aggression and warfare in our evolutionary past and shows how intergroup conflict, far from being an abnormal aberration, has been an important part of our evolutionary history. We then examine a central question in anthropology and evolutionary psychology: What is religion, and what role does it play in the evolution of human behavior and human cultures? Once again, we come to some fascinating and unexpected conclusions, which have a direct bearing on many of the dilemmas facing us today. We then take a look at how our evolved neurobiology impacts our behaviors and emotions, and how such things as mental illnesses and crime may have evolutionary roots. Finally, we consider what the things we have learned say about ourselves, and about the possibilities for our future evolution.

Our fascination with our own behavior and the behavior of those around us long predates human history. This lecture series offers a fascinating evolutionary perspective on our behavior and provides some surprising (and sometimes unsettling) answers to the question, “Why do we do what we do?”

# Lecture 1

## Evolutionary Psychology: A Conceptual History

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The Suggested Readings for this lecture are John Tooby and Leda Cosmides's "Psychological Foundations of Culture," chapter 1, from *The Adapted Mind: Evolutionary Psychology and the Generation of Culture*, edited by Jerome H. Barkow, Leda Cosmides, and John Tooby, and David M. Buss's *Evolutionary Psychology: The New Science of the Mind*, chapter 1: "The Scientific Movements Leading to Evolutionary Psychology."

**P**eople are curious about people. We have always been fascinated by what people do and why they do it. Most people are compulsive "people watchers," beginning in very early infancy and lasting the rest of their lives. We are endlessly attracted to other people, constantly watching them and trying to figure them out. And not just other people: We carefully observe our own behavior, interpreting and anticipating our own actions as avidly as those of the people around us.

This curiosity about each other and ourselves is a trait we share with other social animals, especially primates. As we will see, this exaggerated curiosity is not accidental, nor is it necessarily bad. On the contrary, it is one of the central reasons for our success, as individuals and as a species.

The subject of the science of evolutionary psychology is *us*, and its primary goal is to understand what we do and why we do it. Put in formal terms:

Evolutionary psychology is the scientific study of human behavior from an evolutionary perspective.

Evolutionary psychologists observe people very carefully, either directly or by analyzing indirect information such as demographic data. Our work sometimes takes us into the field, observing people in their "natural habitat," in much the same way that an ornithologist might observe the behavior of an exotic bird. Some evolutionary psychologists also conduct carefully controlled laboratory experiments, although the "laboratory" may be something as simple as a rickety bridge across a gorge on a college campus. In both cases, the intent is to observe people in the same way that animal behaviorists observe members of other species: without biases or preconceptions about what *ought* to be happening.

Evolutionary psychologists also ask people what they are doing and why they are doing it, although as we will see, such self-reporting is often unreliable. This isn't necessarily bad; even such unreliability can tell us something interesting about human motivations and our capacity for self-deception.

Evolutionary psychology is a branch of psychology, one of the newest branches of one of the oldest of human disciplines. As the name implies, it



has its roots in Charles Darwin's theory of evolution by natural selection. Darwin's theory gives us a theoretical perspective that makes it possible to ask questions about human behavior that have not been asked in a systematic way before. It also provides a practical set of experimental and observational techniques that allows us to make predictions about human behavior in specific contexts.

What evolutionary psychology does *not* do is recycle old ideas about human nature, except insofar as such ideas may coincidentally be based on the unbiased observation of human behavior. Evolutionary psychology is most emphatically *not* social Darwinism, neither in its origins nor in its conclusions.

Again, evolutionary psychology is about what we do and why we do it. Psychologists have historically focused on one of these two subjects, often to the exclusion of the other. That is, psychologists have often either focused on *external* behavior or its *internal* motivation:

Behavior is *what* an organism does, whereas motivation is *why* an organism does it.

Although this division appears simple, it encapsulates a dichotomy that has split psychology into two often hostile camps for over a century. Essentially, this division is between experimental psychologists who believe that only observable phenomena can be studied using scientific methods, and theoretical psychologists, who believe that it is not only possible to infer and thereby study internal motivations and mental states—that is, the “mind”—but that such internal states are the “ultimate” causes of observable behavior.

As we will see, this division is often mirrored in evolutionary biology. On one side are the field and laboratory scientists who conduct carefully controlled observations and experiments testing relatively limited hypotheses. On the other are theoreticians who use mathematical and computer models to formulate synthetic theories that are not always amenable to direct empirical testing.

Does this mean that these divisions are therefore unbridgeable? If history is any guide, the answer is “no.” Evolutionary psychology, like evolutionary theory in general, aims for a synthetic theory that includes both rigorous and unbiased observations of human behavior and an explanation of the underlying causes of those behaviors from the perspective of evolutionary biology. As such, it constitutes what may be the first genuinely unified theory of human behavior, one that is both grounded in direct observation, yet applicable to the many of the most abstract levels of human cognition—such things as epistemology, ethics, and even esthetics.

Many of the explanatory concepts developed by evolutionary psychologists have come from relatively simple observations of people in partially or fully controlled environments. Other concepts have come from answers to questions posed during interviews or on questionnaires. Still others have come from analysis of census data or demographic data collected for other purposes.



Some explanatory concepts in evolutionary psychology are derived from general evolutionary theory. For example, much of what evolutionary biologists have learned about sexual behavior and mating has come from observations that were stimulated by theoretical analyses of the effects of differing amounts of parental investment in offspring. As has often been the case, such abstract theories have suggested empirical tests, which have yielded many interesting (and often surprising) observations and inferences, which have in turn suggested new theoretical analyses.

Finally, some explanatory concepts in evolutionary psychology have come from studies of other non-human animals. This strikes some people (and especially some social scientists and humanists) as odd and perhaps leading to invalid conclusions. After all, people are very different from other animals in many respects. While this is true, it ignores a central concept of the natural sciences:

Similar causes produce similar effects.

The underlying goal of all scientific investigation is to understand enough about the causes of natural phenomena to be able to predict—that is *anticipate*—their effects. And, of course, to satisfy our curiosity. As restated in the parlance of evolutionary biology:

Individuals who are curious about the behaviors and motivations of others survive and reproduce more often than those who are less curious.

Evolutionary psychology as a science is new compared with many of the other sciences. However, trying to figure out the patterns of human behavior and the reasons for those behaviors predates the origins of civilization:

- There are records from Egyptian papyri that indicate that almost four thousand years ago people were thinking about the causes of such psychological conditions as clinical depression.
- The Dead Sea Scrolls, dating to about 100 years BCE, include a description of two different temperaments in humans, an early attempt to find a pattern in the motivations of human behavior.
- In China, psychological tests have been part of civil service examinations for centuries.

The term “psychology” was first used in its modern sense in 1590 by the German philosopher Rudolph Goclenius, who based it on the Greek word *psyche*, meaning “soul” or “spirit.” From this viewpoint, “psychology” means “knowledge or understanding of the human soul or spirit.” European philosophers and theologians had speculated for millennia on the existence and properties of the “soul,” but in 1672, Thomas Willis asserted that the “soul” is a function of the human brain, rather than the heart or some immaterial entity.

Psychology as a science can be dated to 1879, when Wilhelm Wundt founded a laboratory in Leipzig, Germany, to study human behavior and mental states. In 1890, the American educator and psychologist William James published the first edition of his textbook, *Principles of Psychology*. Inspired at least in part by

James's work, American psychologists founded the American Psychological Association in 1892, basing its practices and philosophy on the experimental approach pioneered by Wundt and James.

However, the experimental approach favored by many American psychologists was soon overshadowed by the work of Sigmund Freud, an Austrian physician originally trained in medical neurology. Freud's theory of psychoanalysis was based on a unifying idea: that almost all of human behavior was ultimately motivated by unconscious "drives," such as hunger, thirst, fear, and especially sexuality. Since in Freud's theories such drives are unconscious and exist within the "mind" of the individual, they cannot be observed directly. Instead, their existence can only be inferred, based on the behavior of the individual whose actions they are supposedly motivating. Furthermore, Freud and many of his followers did not generally attempt to determine if these theories were supported by observable evidence.

During the twentieth century, Freud's theories about the causes of human behaviors dominated the science of psychology in Europe, but in America a very different tradition developed. Called "behaviorism," the founders of this tradition rejected Freud's theories about motivation and unconscious mind, and focused instead on behaviors: what animals (including people) do, rather than speculating on why they do it. Behaviorists such as Edward Thorndike, John B. Watson, and especially B.F. Skinner argued that a purely empirical science of behavior could be developed that could be used to predict (and even to shape) animal and human behavior, without speculating about motivations.

However, after a half century of experimental psychology focused almost exclusively on behavior it became increasingly obvious that a full understanding of animal, and especially human behavior required a "theory of mind"—that is, required some theoretical model of *how* the nervous system produced behaviors, and *why* specific behaviors were correlated with specific contexts.

This revolution took hold in four different but related disciplines:

- In linguistics, Noam Chomsky developed a theory of "natural language," which had at its base the idea that human language has a universal "deep structure," and that the capacity to learn language is therefore innate.
- In computer sciences, the development of information processing programs required a computational architecture that included something like a "mind"; that is, a central processor that integrated inputs ("sensations") with outputs ("behaviors").
- In neurobiology, investigations of the structure and function of the sensory, nervous, and motor systems of animals (including humans) pointed to a "functional architecture" that both facilitated behavior and constrained it within patterns set by the cellular architecture of the nervous system.

- In the study of animal behavior, empirical studies of how animals learned showed that the “pure” behaviorism of the American school did not explain why different species of animals (and indeed, different sexes and individuals within a species) exhibited different behaviors in different ecological and evolutionary contexts.

Two new disciplines within the science of psychology have grown out of these four traditions: cognitive psychology and evolutionary psychology. Both are grounded in the use of the scientific method: They depend upon observations of behavior and reject introspection. And, unlike behaviorism, both disciplines explicitly infer the existence of internal mental states.

Ultimately, I believe that the disciplines of cognitive psychology and evolutionary psychology will eventually merge into a synthetic discipline in which behavior and motivation are both explained with reference to the underlying architecture of the nervous system, within which the mind resides, and which is ultimately shaped by the evolutionary history of our nervous systems.

As we will see, the idea of evolution fundamentally alters and, in some cases, directly contradicts some of our most cherished ideas about who we are, where we come from, why we do the things we do, and where we might be going. It does this by asking a deceptively simple question: “How do we know what we know?” and then presenting a deceptively simple answer: “By observing the world around us.” In this lecture series, we will pursue this idea—the idea of observation as the basis of an understanding of our behavior—as relentlessly as Captain Ahab pursued Moby Dick. But fear not! If we have courage and a light heart, once we have harpooned our whale and rocketed through our intellectual “Nantucket sleigh-ride,” Moby Dick will not drag us down into the depths. Instead, if we are lucky (and I believe we are) we will find ourselves adrift in the sunlight on an endless sea of possibilities. We will, to paraphrase Henry David Thoreau,

... put some things behind, will pass an invisible boundary; new, universal, and more liberal laws will begin to establish themselves around and within [us]; or the old laws be expanded, and interpreted in [our] favor in a more liberal sense, and ... the laws of the universe will appear less complex, and solitude will not be solitude, nor poverty poverty, nor weakness weakness.

So, grab the gunnels, mates, and hang on—thar she blows!

# FOR GREATER UNDERSTANDING

## Questions

1. Why might curiosity have been adaptive to our evolutionary ancestors?
2. Which do we know more about: what people think or what they do?
3. What are some ways we can infer the motivations of others?

## Suggested Reading

Barkow, Jerome H., Leda Cosmides, and John Tooby, eds. *The Adapted Mind: Evolutionary Psychology and the Generation of Culture*. New York: Oxford University Press, USA, 1992.

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Buller, David J. *Adapting Minds: Evolutionary Psychology and the Persistent Quest for Human Nature*. Cambridge, MA: MIT Press, 2005.

Wright, Robert. *The Moral Animal: Why We Are the Way We Are: The New Science of Evolutionary Psychology*. New York: Vintage, 1995.

## Websites of Interest

1. The *Center for Evolutionary Psychology* website at the University of California-Santa Barbara provides an excellent brief introduction to the core concepts of evolutionary psychology in an article by Professors Leda Cosmides and John Tooby entitled “Evolutionary Psychology: A Primer.” —  
<http://www.psych.ucsb.edu/research/cep/primer.html>
2. Allen MacNeill’s *Evolutionary Psychology* blog provides further details on the study of this topic. —  
<http://evolpsychology.blogspot.com/2008/09/evolutionary-psychology-conceptual.html>

## Lecture 2

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### Investigating the Unmentionable

The Suggested Readings for this lecture are David M. Buss's *Evolutionary Psychology: The New Science of the Mind*, chapter 2: "The New Science of Evolutionary Psychology" and Robin Dunbar's *Grooming, Gossip, and the Evolution of Language*.



A serious problem has plagued anyone who has attempted to investigate what we humans do and why we do it: We don't necessarily want to know what we're actually doing or why we're doing it, and we certainly don't want other people to figure it out.

We want to know what *other* people are doing and *why* they're doing it, but in general we don't want them to know what we're doing and (heavens forbid) *why* we're doing it. Being able to intuit the content of other people's minds is an ability that confers extraordinary adaptive value. Our minds contain what has been called an "agency detector," which can infer the intentions of others based on a comparison between their behaviors and ours, and then infer their motivations so that we can anticipate their actions in the future.

This ability has extraordinary adaptive value in both competitive and cooperative settings.

And if we can confuse our opponents by masking our behaviors and intentions, we may gain a significant advantage over them, especially if we can accurately judge their intentions and motivations. And if we can take advantage of our "partners" without being perceived as having done so, we can benefit to a degree even greater than if we simply cooperate without such guile.

Social behavior, in other words, is at the same time a potential gold mine and a minefield, in which those individuals with the greatest skill at inferring the intentions of others and masking their own (or disclosing them voluntarily, if doing so is advantageous) are the "winners."

And so, talking about all of this makes many people uncomfortable and strikes them as "tactless" or even "tacky." Indeed, one of the social skills we all have to master if we are to become fully functioning adults is to learn when it is "polite" to talk about such things, and when it isn't.

And what might those subjects be? Why, exactly those subjects that are the focus of the science of evolutionary psychology: politics, sex, religion, and violence. And one even worse and more embarrassing, to ourselves and to others: the actual, unvarnished contents of our own private minds.

What makes this all so difficult for us as children (and even for some adults, those who are socially "clueless") is that we must also learn that exactly the same list of "impolite" subjects is not only *appropriate* as topics of conversa-

tion under other circumstances, but that to withhold our own opinions and examples of them would be considered to be almost a betrayal. I am speaking, of course, of gossip, what anthropologist and evolutionary psychologist Robin Dunbar has proposed as the “glue” that binds human societies together.

One of the things that distinguishes children from adults is the obsession that the latter have with gossip. One of the events that marks “coming of age” in adult society is when we are finally mature enough to be allowed to sit in on the “gossip.”

Furthermore, the topics most often discussed in “gossip” are precisely the same topics that are *not* to be discussed in “polite” company: politics, sex, religion, and violence. Indeed, it appears that “polite” conversation and gossip are two sides of the same coin, and are both essential to the smooth functioning of society.

Dunbar has proposed that gossip plays the same role in human sociality that grooming plays in other primates.

Primates, and especially our closest relatives the apes, spend significant portions of their lives grooming each other. Primatologists have proposed that social grooming helps to forge closer social bonds between members of primate groups, an idea that can be explicitly tied to Robert Trivers’s theory of reciprocal altruism. Essentially, social grooming is a form of daily reciprocal altruism that reinforces the tendency for members of a social group to perform altruistic acts toward each other (that is, cooperate).

Social grooming is also part of the process by which dominance hierarchies are established and maintained in primate social groups. Time and motion budgets have been calculated that show that the amount and intensity of grooming is directly related to position in dominance hierarchies, with more dominant individuals being groomed more often than lower ranking individuals. Furthermore, new relationships are formed by initiation of social grooming, and existing relationships can be strengthened or weakened by increasing or decreasing the intensity of grooming.

Dunbar has proposed that language, and especially gossip, evolved essentially as a substitute for social grooming. Again, time and energy budgets indicate that humans spend roughly equivalent amounts of time “gossiping” as other apes spend in social grooming.

One problem with Dunbar’s hypothesis is that it doesn’t explain the apparent isomorphism between what can’t be discussed in “polite” conversation, but is the subject of most gossip. While it may be true that gossip does play a role in humans that is similar to the role played by social grooming in apes (including sorting out dominance hierarchies), I believe that it also plays an important role in allowing individuals to ascertain which behaviors are “allowable” and which are not, and which individuals are “reliable” and which are not (and, if one is a “cheater,” which individuals might make easy “marks” and which might not).

Indeed, “cheating” of all kinds (including “cheating” in representing one’s role in a social group) is one of the principal topics of gossip, perhaps more than any other. Trivers’s theory of reciprocal altruism includes (indeed, requires) that “cheaters” (that is, non-reciprocators) be identified and punished (or at least avoided). An effective way to do this is via gossip. Along the way, people subtly (and sometimes not so subtly) also indicate their own opinions (and therefore underlying motivations) relative to the behaviors and motivations of the individuals being gossiped about, usually in a way that presents them in as positive a light as possible to other group members.

When we try to ascertain what people are actually doing (as opposed to what they or others say they are doing), and use that information to infer an explanation as to why they are doing it, we will *not* (in most cases) pronounce judgments. There are two reasons for this:

1. Science isn’t about how things *ought* to be (and even less about how we’d *like* things to be), but about how things *are*; science is about *description* not *prescription*.
2. We will also repeatedly see ourselves in the situations, behaviors, and motivations that we will investigate, and this alone should be both humbling and exhilarating.

Oddly enough, science itself (and especially evolutionary psychology) shares a surprising number of characteristics with gossip. It looks unabashed upon those behaviors not talked about in “polite” society; things like copulating surreptitiously with multiple mates, injuring and killing people for personal gain, rape, murder, incest, theft, indeed, the whole list of deadly sins: pride, envy, anger, greed, gluttony, sloth, and lust.

And we won’t always be focusing on sins: humility, admiration, calm, generosity, temperance, industry, and love will also make their appearance and their adaptive value will be considered.

There are a number of methods that evolutionary psychologists use to study human nature.

*Simple Observations:* By unobtrusively observing people in their “natural habitats,” it may be possible to determine what their “natural” (that is, evolved) behaviors are. There are a surprising number of studies in evolutionary psychology in which the researcher simply watched what people were doing, as unobtrusively as possible.

*Controlled Experiments:* By manipulating the conditions in which particular behaviors occur, it may be possible to determine what the causes, contexts, and underlying biology of such behaviors are and how they relate to evolution by natural selection. This technique doesn’t necessarily require a formal “laboratory.” However, the basic principle of experimental science is the same: A specific variable is manipulated in a controlled way to determine how the manipulation of the variable affects the behavior under study (if, indeed, it affects it at all).



*Natural Experiments:* By finding situations in which conditions correlated with particular behaviors occur without direct intervention by the investigator, it may be possible to determine what the causes, contexts, and underlying biology of such behaviors are and how they relate to evolution by natural selection without directly or intentionally manipulating the situation. This technique is especially useful in situations in which the variable under investigation can't be manipulated without committing an extreme ethical violation.

*Comparisons Between Species:* Similar behaviors can evolve as the result of similar ecological circumstances, especially among closely related species. We have already discussed one of the guiding principles behind such investigations: the idea that similar causes often result in similar effects. As we will see, this makes careful study of other primates, especially great apes, very valuable in understanding some of the evolutionary roots of human behavior. We will also see, perhaps surprisingly, that the same can be said about studying the behavior of some of the social carnivores, especially African lions and spotted hyaenas, as their behavioral ecology is similar to that of our Pleistocene ancestors.

*Comparisons Within Species:* Similar behaviors can provide evidence for descent from common ancestors, while differences can elucidate the effects of differing environments. Here we will find a very powerful tool for analyzing human behavior and its evolutionary implications, as different environments are often correlated with different patterns of behavior.

*Comparisons Between Males and Females:* As we will see, differences between male and female behavior can reveal differences in sexual selection between the genders. As both classical sexual selection theory and Price's group selection theory predict, specialization in sex roles is an extremely common adaptive pattern in many species of animals.

*Comparisons Between Individuals:* Differences between individuals can reveal the effects of differing environments, while similarities can provide information about the limits of adaptation. Again, this is an extremely powerful technique to elucidate the behavioral ecology of specific human behaviors.

*Comparisons Between the Same Individual in Different Contexts:* Such differences can highlight the effects of environmental context on the development of behaviors and the expression of the underlying motivations that cause it and shape its development. Such comparisons amount to controlled natural experiments, in which the behavior of individuals in one context serves as a control against which to compare their behavior in other contexts. Both similarities and differences in responses to different situations provide information that can be correlated with selection to yield evolutionary hypotheses about the origins and dimensions of such behavioral patterns.

*Comparisons Between the Same Individual at Different Times:* Differences can highlight the effects of development, maturation, and personal history. Here we are asking a question about how individuals change during their lifetimes, and as we will see the answers can provide many clues to the evolutionary history of the behaviors and their motivations.

*Demographic Analyses:* Since natural selection is essentially a demographic process, data derived from demographic analyses (such as census data) can yield useful clues in the analysis of human behavioral evolution. Although such data may be collected for very different reasons, with evolutionary theory as a guide, it is often possible to tease relevant patterns out of such data, patterns that have clear evolutionary implications. As we will see, reexamination of some widely available demographic data can produce surprising conclusions, especially when viewed from an evolutionary viewpoint.

Once again, courtship and mating patterns (as reflected in marriage and divorce statistics) provide an excellent example; as a result of such demographic analysis, it is reasonable to assert that the overwhelming majority of Americans are polygamous, not monogamous, and that this is true for humans in virtually all cultures.

And so, we have our tools in hand; now it's time to start looking at some actual human behaviors from the viewpoint of an evolutionary psychologist. In the next lecture, therefore, we will learn about what evolutionary psychologists call evolved psychological mechanisms. As we will see, the identification and analysis of evolved psychological mechanisms have played much the same role in evolutionary psychology as the identification and analysis of adaptations played in the development of evolutionary biology.

# FOR GREATER UNDERSTANDING

## Questions

1. Is there an optimal number of people for a human social network?
2. Why do people so revel in gossip, while generally condemning it (at least in public)?
3. How might one obtain reliable evidence for a hypothesis concerning evolutionary psychology?

## Suggested Reading

Buss, David M. *Evolutionary Psychology: The New Science of the Mind*. 2nd ed. Boston: Allyn & Bacon, 2004.

Dunbar, Robin. *Grooming, Gossip, and the Evolution of Language*. Cambridge, MA: Harvard University Press, 1997.

## Other Books of Interest

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Wilson, Edward O. *On Human Nature*. Rev. ed. Cambridge, MA: Harvard University Press, 2004 (1979).

## Websites of Interest

1. The *Fox Professing* website by psychology professor emeritus Dennis Fox (University of Illinois at Springfield) features an article entitled “Psychology, Ideology, Utopia, and the Commons,” which appeared in *American Psychologist*, 40, (1985) pp. 48–58. In the article he discusses psychology’s role in “maintaining an unjust status quo.” —  
<http://www.dennisfox.net/papers/commons.html>
2. Urs Boeschstein’s personal website features a reprint of Professor Robin Dunbar’s article “Why Gossip Is Good for You” from the November 21, 1992, issue of *New Scientist* magazine. —  
<http://www.uboeschstein.ch/sal/dunbar.html>

## Lecture 3

### Natural Selection and Adaptation

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The Suggested Reading for this lecture is Charles Darwin's *On the Origin of Species, Or, the Preservation of Favoured Races in the Struggle for Life* and Richard Dawkins's *Blind Watchmaker: Why the Evidence of Evolution Reveals a Universe without Design*.



As its name implies, evolutionary psychology is grounded in the theory of evolution. But what is that theory, and how is it applied? Most people know that the modern theory of evolution was proposed by Charles Darwin in his most famous book, *On the Origin of Species*, first published in November 1859. What many people who have not read Darwin's book don't know is that he proposed two theories:

- that living species have changed over time, beginning with one or a few ancestral forms, which have diverged into the bewildering diversity we see today and in the fossil record, and
- that the mechanism by which this divergence has occurred is natural selection, which also explains how adaptations—the characteristics of living organisms that appear to serve some function or “purpose”—have come into existence.

Theories of evolution have been proposed for at least the past three millennia. What made Darwin's theory different was that the mechanism that he proposed for change over time also explained the origin of adaptations, and did so without requiring any intervention into nature by a guiding intelligence. In doing so, Darwin brought “natural history” into line with the other natural sciences, such as physics and chemistry, and thereby founded that branch of the natural sciences we now know as “biology.”

A thorough understanding of natural selection is absolutely necessary for any understanding of evolutionary psychology. Natural selection, according to Darwin, has four necessary prerequisites:

- *Variety*: There must be real variations in the characteristics of the individuals that make up a population of organisms. By “real” we mean differences between the structures and functions of organisms, such that the members of any population are not absolutely identical.
- *Heredity*: Some of these variations must be heritable from parents to offspring. Darwin did not propose a mechanism by which variations could be inherited in the *Origin of Species*, he simply pointed out the obvious fact that inheritance of structures and functions from parents to offspring does indeed occur.

- *Fecundity*: Parents must reproduce at a rate that more than replaces them. In Darwin's version of the theory, individuals reproduce at the maximum possible rate, which means that many more offspring are produced than can possibly survive. More recent theories have modified this condition somewhat, but reproduction is an undeniable part of natural selection and an equally undeniable characteristic of living things.
- *Demography*: Some individuals survive and reproduce more often than others. Sometimes who survives and reproduces and who doesn't is essentially accidental. However, Darwin's theory is grounded on the assumption that survival and reproduction is influenced by the heritable characteristics of individuals.

None of these prerequisites require anything special. Indeed, they are conditions that anyone can immediately observe among the living organisms around us. Furthermore, none of them require any intelligent guidance, which means that they are all "natural" processes. Darwin simply took the next logical step: He proposed that the outcome of the operation of these four processes is that:

- The heritable characteristics of those individuals that survive and reproduce more often than others become more common in their population over time. This result—unequal, nonrandom survival and reproduction—is what Darwin called "natural selection."

In the *Origin of Species*, Darwin also proposed that a very similar mechanism, which he called sexual selection, can produce adaptations that are similar to those produced by natural selection. In sexual selection, individuals who can choose their mates do so by basing their choice on their potential mate's characteristics. The characteristics of those individuals who are chosen more often as mates become more common over time.

The heritable characteristics of living organisms that have evolved as the result of natural or sexual selection are "evolutionary adaptations," which appear to accomplish particular functions for the organisms that have them. For example, fur is considered to be an evolutionary adaptation of mammals.

However, while it is very tempting to say that "mammals have fur in order to keep warm," from an evolutionary viewpoint we should say instead that "mammals today have fur because their ancestors that had fur survived and reproduced more often than their contemporaries that lacked fur." This way of thinking about evolutionary adaptations avoids the assumption that adaptations have a purpose, an assumption based on the idea that purpose exists in nature, which is an untestable (and indeed, philosophically unnecessary) assumption.

Our tendency to think about nature in terms of "problems" and "solutions" is itself a behavioral adaptation of humans. Because we are purposeful in our behavior, we tend to infer purpose in the events around us. Some of those events (such as being winked at by a "flirt") do indeed have purposes motivating them, and are produced by intentional agents. Our neurological agency

detector (located in the posterior superior temporal cortex of the brain) correctly infers that such events are the result of intentional agency, and we respond appropriately.

However, as should be obvious to all but the most paranoid, there are events that appear to be the result of intentional agency, but which clearly are not. Instead, such events are the result of purely natural processes, which happen without intentional agency, and which we therefore assume to have natural rather than intentional causes.

- For example, if one is riding a bicycle and encounters a strong headwind, one may be tempted to assume that this is the result of intentional agency: It sometimes feels like the wind “wants” to impede our forward progress. But most adults assume that the wind has no intentions or purposes, but simply “blows” as the result of natural atmospheric processes.

Our tendency to infer the existence of intentional agency in natural processes is a particular problem for evolutionary biologists, and even more so for evolutionary psychologists. As Richard Dawkins has pointed out, evolution by natural selection produces characteristics of living organisms that *appear* to be intentionally “designed” to “solve” problems of survival and reproduction. However, this appearance of purposeful intentionality in natural processes is an illusion, one that is the result of our own evolved mental propensities. The most revolutionary aspect of Darwin’s theory of evolution by natural selection was that it explained the origin and operation of such adaptations by purely natural means.

The tendency to think of evolutionary adaptations as “solutions” to “problems” can lead to difficulties because not every characteristic of an organism is, in fact, an adaptation, and those that are can sometimes be very difficult to verify as such. Our “agency detectors” tend to be biased toward agency detection, even when such agency isn’t there. This bias means that we almost never fail to detect agency when it is present, but we have a tendency to detect it even when it isn’t present.

There is an evolutionary explanation for this bias toward “false positives” by our agency detectors. “False positives” don’t generally result in harm; believing that something is happening “on purpose” when it is not rarely affects our survival or reproduction. However, “false negatives” can easily result in harm; failing to recognize and infer the intentions of an entity intent on doing us harm can be damaging or even fatal. Even being unable to detect “cheaters”—individuals intent on non-reciprocated self-interest—can have long-term negative fitness consequences. Hence, our agency detectors are adapted in such a way as to produce virtually no false negatives, which means that they are inevitably biased toward yielding false positives.

The “gold standard” for determining if a characteristic is an adaptation is showing that there is a direct link between that characteristic and increased

relative survival and reproduction. In the case of evolutionary psychology, this means that to determine if a particular behavior (or the *capacity* to perform a particular behavior) is an adaptation, we must be able to show that the behavior results in increased survival and reproduction relative to some other alternative behavior.

This is often done by arguing that the behavior in question “solves a problem posed by the environment” in such a way as to increase the fitness of the individual performing it. While this technique is quite common, it often runs afoul of our innate agency detectors, which convince us that the behavior is adaptive when it doesn’t necessarily result in differential survival and reproduction. This is often referred to as “telling just-so stories,” in reference to the popular stories by Rudyard Kipling. However, natural explanations do *not* involve either intentions or supernatural entities, and since evolution by natural selection is a natural process, its products (adaptations) must have natural explanations as well.

Related to the problem of purpose is the tendency to assume that adaptive behaviors necessarily result in increased personal happiness and well-being. It is common for people not well-versed in evolutionary biology to assume that if a particular action makes you feel happy or good, it must be adaptive. Nothing could be further from reality; as E.O. Wilson pointed out in *Sociobiology*, we do what we do “not to promote the happiness or survival of the individual, but to favor the maximum transmission of the controlling genes.”

As we will see, happiness and well-being are essentially irrelevant to fitness in an evolutionary sense. Many human behaviors result in pain, misery, and even death, but also have the effect of increasing relative reproductive success. Some human behaviors result in happiness and well-being, but do not have fitness consequences; such behaviors, while enjoyable, do not qualify as evolutionary adaptations: In other words, nature doesn’t—indeed, *can’t*—care about us at all, and natural selection is as pitiless and unforgiving as gravity.

The characteristics of living organisms can be classified into one of three categories: adaptations, side-effects, and accidents.

- An example of a human behavior that is clearly an adaptation is suckling. Newborn humans, like virtually all newborn mammals, suck on their mother’s nipples for nourishment. Suckling behavior, which includes a stereotyped side-to-side searching behavior, locating and grasping (and sometimes squeezing, kneading, or even punching) the breast, taking the nipple into the mouth, and sucking it (hard!), and continuing to do so until satiated, are all innate behavioral adaptations of newborns that have evolved as the result of natural selection. Any newborn that cannot perform this behavior starves to death, and those that perform it less than optimally have a lowered probability of survival (and subsequent reproduction).

Side-effects occur because they share some of the same neuromuscular circuitry as behavioral adaptations, but are not themselves adaptive.

- A surprisingly large fraction of human infants suck their thumbs (or sometimes toes, and other nipple-shaped objects), and seem to derive quite a lot of pleasure from it. However, they do not derive any nourishment from it at all, and there is no evidence that thumb-sucking is adaptive. Therefore, thumb-sucking, which is *not* an adaptation, is a side-effect of suckling, which *is* an adaptation.

Finally, some behaviors are apparently purely accidental.

- When people interlace their fingers, the thumb that is on top is virtually always the same thumb; either the left or the right. Although this characteristic is apparently the result of the expression of a simple Mendelian allele (left thumb on top is apparently dominant, regardless of handedness), it has no measurable adaptive significance.

Of these three kinds of behaviors, only the first two have direct or indirect fitness consequences. This is because only behaviors that are the result of consistent causes produce consistent effects, and can therefore be reliably explained and predicted.

One of the ultimate goals of science is to understand causes and effects well enough to be able to reliably predict the future. Scientists try to do this by observing the present and the past, to see if there are consistent patterns. If there are such patterns, we then try to apply our understanding of those patterns to future events. Underlying all such predictions is a basic principle in the natural sciences: *Similar causes result in similar effects*. It is common among scientists to refer to these consistent patterns of cause and effect as “natural laws.” It is important to keep in mind that such natural laws are neither absolute nor immune to change. Indeed, one of the things that distinguishes the natural sciences from some modes of human explanation is that the “natural laws” that scientists discover are neither absolute nor permanent. Rather, they are constantly being refined (and sometimes fundamentally changed) as a result of new discoveries.



## FOR GREATER UNDERSTANDING

### Questions

1. According to Darwin's theory of evolution by natural selection, is intelligent guidance necessary for the evolution of adaptations?
2. How might a behavior qualify as an evolutionary adaptation? How would one verify that this is the case?
3. Are all of the characteristics of living organisms the result of natural selection?

### Suggested Reading

Darwin, Charles. *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life*. New York: Nabu Press/Random House, 2010.

Dawkins, Richard. *The Blind Watchmaker: Why the Evidence of Evolution Reveals a Universe without Design*. New York: W. W. Norton, 1986.

### Other Books of Interest

Darwin, Charles. *The Descent of Man and Selection in Relation to Sex*. Cambridge: Cambridge University Press, 2009.

———. *On the Expression of the Emotions in Man and Animals*. Penguin Classics. New York: Penguin, 2009.

### Websites of Interest

1. *The Complete Work of Charles Darwin Online* website provides first edition versions of his writing, including those listed above. — <http://darwin-online.org.uk>
2. *The Early Theories of Evolution: 17th–19th Century Discoveries That Led to the Acceptance of Biological Evolution* website maintained by Dr. Dennis O'Neil (Behavioral Sciences Department, Palomar College, San Marcos, California) provides a general overview on evolution, including audio and video links for further understanding. — <http://anthro.palomar.edu/evolve/default.htm>

## Lecture 4

### Evolved Psychological Mechanisms

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The Suggested Readings for this lecture are John Tooby and Leda Cosmides's "Psychological Foundations of Culture," chapter 1: *The Adapted Mind: Evolutionary Psychology and the Generation of Culture*, edited by Jerome H. Barkow, Leda Cosmides, and John Tooby, and David M. Buss's *Evolutionary Psychology: The New Science of the Mind*, chapter 2: "The New Science of Evolutionary Psychology."



An evolved psychological mechanism is a behavioral capacity that is either directly or indirectly adaptive (that is, the result of natural or sexual selection). One of the foundational premises of evolutionary psychology is that the "mind" largely consists of evolved psychological mechanisms, each one performing a particular function.

Suckling is paradigmatic of what constitutes an evolved psychological mechanism. The capacity to suckle is clearly an adaptation, as it has resulted from differential survival and reproduction among our mammalian ancestors. Furthermore, suckling also clearly has both innate and learned components.

As babies mature and gain experience with the process of suckling, two things happen: they get better at it, and they learn how to manipulate their mothers (or other care givers) to maximize getting milk (and comfort and protection and attention and so forth). This process of give-and-take between infant and mother also involves evolutionary processes, and becomes an evolved source of conflict between parents and offspring, as first proposed by Robert Trivers.

So virtually all significant behaviors, and especially those that are adaptive, involve a combination of innate and learned components. Suckling and many other animal (and human) behaviors involve an innate predisposition to learn particular behaviors. This ability is what evolved psychological mechanisms are generally all about. That is, much of our behavior is learned, but we learn certain behaviors much more easily than others, in specific ecological and social contexts and often within pretty strict parameters, and especially when such behaviors have significant effects on differential survival and reproduction.

"Evolutionary psychology" has also been called "human ethology." In that sense, evolutionary psychologists tend to treat humans as just another species of mammal: complex, interesting, even paradoxical at times, but not really all that different from chimpanzees, African lions, wolves, or even some of the not-quite-so-social social insects. The guiding principle when applying the insights of ethology to the understanding of human behavior is "similar causes often produce similar effects." Knowing something about how behavior has evolved in non-human animals can help us understand how it might have evolved among our own ancestors.

One of the basic starting points for all ethologists is an assumption that avoids the “nature versus nurture” trap that has led to so much disagreement between European and American psychology. This assumption is that virtually all animal behaviors have both innate and learned components. Instead, most ethologists are interested in trying to understand how animal behaviors are generated and regulated, and what components of the behavior are modifiable as the result of experience, and what parts are relatively invariant. Ethologists are very interested in how such behaviors develop during the life cycle of an animal, and what the evolutionary (and especially adaptive) context and constraints were that might have shaped the behavior over evolutionary time. In almost every case, ethologists try to determine if a behavior “makes sense” in its ecological and evolutionary context, and how knowing this can be used to formulate predictions about the development and evolution of behavior in similar contexts, albeit among different species, including humans.

Evolutionary psychology is the discovery and investigation of evolved psychological mechanisms—that is, behavioral and cognitive adaptations—using empirical methods. According to David Buss, one of the founders of evolutionary psychology, human evolved psychological mechanisms have several properties in common with the behavioral adaptations of other animals, such as fixed action patterns.

According to ethologists, fixed action patterns are complex behaviors that, despite their complexity, appear to be the result of the operation of partially innate physiological mechanisms.

- Despite their complexity, fixed action patterns are primarily “all-or-none” responses to specific stimuli.
- Once initiated, a fixed action pattern “goes to completion.” That is, it continues until the action is finished, even if the original stimulus that triggered it is removed prematurely.
- Fixed action patterns are highly stereotyped, appearing in very similar contexts and in much the same form in most of the members of a given species.
- Fixed action patterns are species specific. That is, they occur in particular patterns only within particular species.
- Fixed action patterns can be related to a species’ evolutionary history. That is, closely related species exhibit similar fixed action patterns, and in many cases can be shown to be related to similar behaviors in ancestral species, indicating that they have evolved like anatomical adaptations by means of natural selection.

A classic example of a fixed action pattern is the egg-rolling behavior of the European greylag goose. If an egg is dislodged from a goose’s nest, the parent will roll it back into the nest using a stereotyped series of head-wagging movements. These movements continue even if the egg is removed, as if the egg were still in place.

Fixed action patterns are triggered by sign stimuli, which are specific cues and events in the environment that an animal can perceive and react to. Sign stimuli are sometimes referred to as releasers, as they “release” an animal to perform a behavior that it was being driven to perform as the result of internal physiological mechanisms. Sign stimuli are often restricted, consisting of only one part of the environment sensed by an animal. For example, the sign stimulus for territorial defense by male red-winged blackbirds is the particular shade of red-orange in the plumage of the male’s wings. A male red-winged blackbird will go through much of his territorial defense displays when presented with any object of the right color.

Like fixed action patterns, evolved psychological mechanisms are triggered by specific sign stimuli. Like the sign stimuli that trigger the fixed action patterns in other animals, the sign stimuli that trigger our evolved psychological mechanisms do not usually include all of the sensory inputs impinging on us. Rather, our sensory, nervous, and motor systems use a “perceptual filter” that is biased toward particular patterns of activity, and extracts and enhances these features from our overall sensory input. The degree to which such perceptual filters can be thrown off by noise, and the degree to which we react to the sign stimuli they detect is directly related to the fitness effects of detecting versus ignoring such inputs. In other words, sensory inputs that increased the fitness of our ancestors are more easily detected and reacted to than sensory inputs that did not.

Also like fixed action patterns, the specific content of the triggering sign stimuli determines our behavioral response as a result of “decision rules” wired into our sensory, nervous, and motor systems. And, as in most fixed action patterns, such “decision rules” are modifiable by experience. What distinguishes us from other animals is not whether the “wiring” of our sensory, nervous, and motor systems is modifiable as the result of experience, but rather the degree to which they can be modified, especially as the result of learning.

Finally, the responses that are triggered by such sign stimuli can be behavioral, physiological, or can trigger other evolved psychological mechanisms. As E.O. Wilson eloquently stated it in *Sociobiology*, “the [sensory, nervous, and motor systems] of a highly social species such as [ourselves], ‘knows,’ or more precisely it has been programmed to perform as if it knows, that its underlying genes will be proliferated maximally only if it orchestrates behavioral responses that bring into play an efficient mixture of person survival, reproduction, and altruism.” Such “orchestration” often involves both behavioral and physiological responses, which nevertheless can be quite complex.

Furthermore, since our minds consist of multiple evolved psychological mechanisms, our consciousness is often taxed with “ambivalences whenever [we] encounter stressful situations. Love joins hate; aggression, fear; expansiveness, withdrawal; and so on” producing behaviors that ultimately either increase or decrease the probability of our survival and reproduction. Evolved

psychological mechanisms that are correlated with increased survival and reproduction become more common over time—we call them adaptations—and those that do not become less common until, eventually, they disappear.

The ease or difficulty with which an evolved psychological mechanism can be acquired, modified, or lost depends to a large extent on how much of the behavior it produces is conditioned (or learned, in the behaviorist sense) and how much is “hard-wired” in the sense of an innate fixed action pattern. Learned behaviors can be modified during an individual’s lifetime. The more “hard-wired” a behavior is, the longer it takes to modify it, because such “hard wiring” is specified by genes, changes in which take many generations.

Implicit in this relationship between environment and rate of modification of behavior is the rate of change in the environment compared with the lifespan of the organism reacting to such changes. Animals that live only a very short time generally do not experience very significant changes in their environments. Therefore, there are relatively few circumstances in which their behaviors need be modified, and so much of the behavior of such organisms is “hard wired” and therefore not particularly modifiable via learning.

Animals that live a relatively long time are much more likely to experience significant changes in their environments, and therefore natural selection tends to result in evolved psychological mechanisms that are more or less modifiable as the result of learning.

On the other hand, if what is evolving is the capacity to modify behavior in particular ways, the evolution of such capacities paradoxically can take much longer than to “rewire” a mostly innate behavior. The wider the parameters that constrain learning as part of an evolved psychological mechanism, the longer it takes to modify those parameters. This is because the feedback from the effects of mostly learned behaviors is less direct than the feedback from mostly innate behaviors. That is, the more flexible a response (that is, because of learning) the less direct its effects on the underlying genes that code for the “wiring” that produces such behavior.

Leda Cosmides and John Tooby, two of the founders of evolutionary psychology, have captured these relationships in their “primer on evolutionary psychology,” in which they outline the salient characteristics of evolved psychological mechanisms. First of all, evolved psychological mechanisms are properties of our sensory, nervous, and motor systems, which can be considered to be computers that are wired in such a way as to generate adaptive behavior in specific environmental circumstances. Again, this does *not* mean that our behaviors are “hard wired” and therefore unmodifiable. However, it does imply that the underlying capacities to learn certain kinds of behaviors are at least partially innate, and therefore may take many generations of selection to change.

Our sensory, nervous, and neuromuscular wiring, and therefore the behavioral outputs of our evolved psychological mechanisms, have been shaped by differential survival and reproduction in our evolutionary past. Evolutionary biologists often refer to the *evolutionary environment of adaptation*, in which adaptations evolve, and which therefore shape such adaptations.

Much of the activity of the nervous system in producing evolved psychological mechanisms is unconscious and appears to be very simple and straightforward. Such apparent simplicity is often misleading—most evolved psychological mechanisms require complex computation using multiple “decision rules,” which are wired into our nervous systems.

Different neural circuits have become specialized for producing specific evolved psychological mechanisms under specific environmental conditions, a condition sometimes referred to as “massive modularity.” Again, the activities of these “modules” are not necessarily coordinated nor congruent. Indeed, much of the complexity of human behavior stems from the competing demands of modules that have evolved with very different “decision rules.”

Finally, many evolved psychological mechanisms were shaped by natural and sexual selection in specific environments in the distant past, and therefore may not be adaptive today.

## FOR GREATER UNDERSTANDING

### Questions

1. How much of our behavior is innate—that is, “inborn”—and how much of it is learned?
2. What part does learning play in the development of our evolved behavioral tendencies?
3. Why might some of our most deep-seated behaviors be difficult to change?

### Suggested Reading

Barkow, Jerome H., Leda Cosmides, and John Tooby, eds. *The Adapted Mind: Evolutionary Psychology and the Generation of Culture*. New York: Oxford University Press, USA, 1992.

Buss, David M. *Evolutionary Psychology: The New Science of the Mind*. 2nd ed. Boston: Allyn & Bacon, 2004.

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Buller, David J. *Adapting Minds: Evolutionary Psychology and the Persistent Quest for Human Nature*. Cambridge, MA: MIT Press, 2006.

Dawkins, Richard. *The Blind Watchmaker: Why the Evidence of Evolution Reveals a Universe Without Design*. New York: W. W. Norton, 1986.

### Websites of Interest

1. *Evolutionary Psychology: An International Journal of Evolutionary Approaches to Psychology and Behavior*, coedited by Todd K. Shackelford (Florida Atlantic University) and Steven M. Platek (Georgia Gwinnett College) is a peer-reviewed online publication that provides pdfs of articles and book reviews, and links to news and other sites of interest. — <http://www.epjournal.net>
2. The *Psychology Today* website provides an article from its March 7, 2010, issue by evolutionary psychologist Satoshi Kanazawa (London School of Economics and Political Science) entitled “How Did General Intelligence Evolve?: General Intelligence Poses a Problem for Evolutionary Psychology.” — <http://www.psychologytoday.com/blog/the-scientific-fundamentalist/201003/how-did-general-intelligence-evolve>

## Lecture 5

### Deconstructing the Blank Slate

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The Suggested Readings for this lecture are Steven Pinker's *Blank Slate: The Modern Denial of Human Nature* and Edward O. Wilson's *On Human Nature and Sociobiology: The New Synthesis*.

- M**ost people are either “innatists” or “social constructivists.”
- Innatists believe in a model of the human mind that is similar to what many people mistakenly think is the central concept of evolutionary psychology: Most or all significant human behaviors are almost entirely innate and not very amenable to change as the result of experience (learning).
  - Social constructivists believe in a model of the human mind that is very similar to that promoted by the American behaviorists of the early twentieth century: Most or all of significant human behaviors are almost entirely learned and infinitely malleable as the result of experience (conditioning).
  - In other words, innatists and social constructivists come down on opposite sides of the “nature-nurture” debate.

Innatism is a very old tradition, common to many cultures, but most exemplified by the philosophy of Plato. According to this philosophy, humans are born with an innate knowledge of particular ideas, such as good and bad, right and wrong, and the existence of God. Innatists also believe that people are born with particular talents and proclivities, such as a talent for mathematics or music, or a tendency toward criminal behavior; which will eventually be expressed despite social influences to the contrary.

Social constructivists, on the other hand, believe in a model of the human mind that is similar to the one described by the behaviorist John B. Watson in 1930:

Give me a dozen healthy infants, well-formed, and my own specified world to bring them up in and I'll guarantee to take any one at random and train him to become any type of specialist I might select—doctor, lawyer, artist, merchant-chief and, yes, even beggar-man and thief, regardless of his talents, penchants, tendencies, abilities, vocations, and race of his ancestors.

Social constructivism, by contrast with innatism, is a relatively new tradition, limited primarily to the United States, and reaching its apogee in the work of B.F. Skinner. According to this viewpoint, humans have no innate ideas nor any tendency to learn particular behaviors in particular ways and particular times. Rather, human behavior is infinitely plastic and is almost entirely molded by experience within particular social contexts.



Ethologists generally do not participate in the “nature-nurture” debate. The model of animal behavior used by most ethologists is based on the assumption that almost all significant behaviors involve a blend of innate and learned components.

Why does this idea sound peculiar, even threatening, to most people, especially social scientists? And, more importantly, why does this idea generate so much controversy in the public sphere? Beginning in the middle of the nineteenth century, the dominant social theory about human behavior and motivation was what has since become known as social Darwinism. Despite its name, social Darwinism owes few of its main ideas to the work of Charles Darwin. Rather, it is most closely associated with the social theories of English political scientist, philosopher, and sociologist Herbert Spencer.

Central to Spencer's philosophy was the idea that evolution is progressive; it begins with primitive unorganized matter, which then steadily develops into more complex and more perfectly formed systems, from atoms to cells, from cells to animals, and ultimately to humans and human societies.

This idea has been called evolutionism, and actually predates Darwin's theories by at least a century. Lamarck's theory of evolution by means of the inheritance of acquired characteristics, published almost half a century before the *Origin*, was another of the central works of evolutionism. Like Spencer's, Lamarck's theory was relentlessly progressive, assuming that all living organisms evolved into more complex forms in a steady drive toward greater and greater perfection, once again reaching its culmination in the evolution of humans.

Spencer proposed essentially the same idea, but proposed a different mechanism by which such progressive evolution occurred. Spencer called this mechanism “survival of the fittest,” a phrase that Alfred Russell Wallace recommended to Darwin as a replacement for natural selection. Darwin eventually adopted it, using it interchangeably with natural selection in the sixth and final edition of the *Origin of Species*.

Born into the middle class, Spencer intended his theories to counter what he considered to be the socially regressive idea that society should be based on the “natural” superiority of the aristocracy. Spencer was a liberal and believed that merit should depend on individual accomplishments. It is therefore ironic that one of the main ideas underlying Spencer's evolutionism has come to epitomize a regressive social policy that tends to justify the excesses of *laissez-faire* capitalism.

Central to social Darwinism is the idea that *laissez-faire* capitalism naturally produces the “survival of the fittest,” and that therefore those who rise to the top of the economic and social ladder deserve the privileges that their accomplishments have afforded them. Spencer asserted that this process produces the most ideal society possible, and that any attempt to limit the operation of *laizzes-faire* capitalism was socially regressive and opposed to the “natural” progress of evolution. In essence, social Darwinism is a theory of social ethics

that are supposedly derived directly from scientific principles; since “survival of the fittest” naturally produces the best and the brightest, allowing natural selection to take its course is both good and right.

During the second half of the nineteenth century, social Darwinism was associated with the unparalleled increase in material prosperity that resulted from the industrial revolution. Many of the “captains of industry”—people like Andrew Carnegie and Henry Ford—strongly supported the idea of social Darwinism and the closely allied “science” of eugenics. Both Darwin and his strongest and best-known supporter, Thomas Henry Huxley, praised Spencer and his application of evolutionary ideas to the betterment of society. Following the rediscovery of Mendelian genetics in 1900, Mendel’s ideas were applied to the genetic improvement of the human species in the new “science” of eugenics, and once again prominent evolutionary theorists—most notably R.A. Fisher and J.B.S. Haldane—were among its staunchest supporters.

Both social Darwinism and eugenics were adopted by the leaders of Nazi Germany in the 1930s and used to justify their policies of military expansion, totalitarianism, and “negative eugenics.” Following World War II, social scientists (especially in America) decisively rejected social Darwinism and eugenics, and many of them extended their criticism of evolutionary ideas to evolutionary biology itself. This criticism was most intense among Marxists, whose theories of economics and social development were also ironically part of the overall theory of progressive evolutionism.

In the social sciences, the ideas that there is no inherent human nature and that all human behaviors are purely learned are most closely identified with the disciplines of anthropology, behaviorism, social psychology, and sociology. In these fields, the Standard Social Science Model and the concept of the human mind as a blank slate played a central role, both in the founding of those sciences and in their development during the twentieth century.

The rise of behaviorism in the United States paralleled and reinforced the ascendancy of the Standard Social Science Model, as it was based on essentially the same idea: that human behavior had no innate influences of any kind and was therefore essentially infinitely modifiable. This idea also reinforced the rise of liberal economics and politics in the United States during the same time period. Furthermore, since human behavior was assumed to be infinitely plastic and entirely formed by experience (that is, learning), there were no predictable patterns in human behavior beyond what could be predicted as the result of learning and social influences.

The founders of the science of anthropology—Franz Boas, Alfred Kroeber, Claude Levi-Strauss, Margaret Meade, and Ruth Benedict—argued strongly for the social constructionist model of the human mind and human behavior. They asserted that all human behavior and motivations arise out of human cultural interactions. Therefore, like the behaviorists, they asserted that humans and human behavior were infinitely malleable.

Sociology, too, and the closely allied field of social psychology, were based on essentially the same premise. Although the reasons were usually couched in scientific terms, they were more political and social than scientific. As B.F. Skinner advocated in *Beyond Freedom and Dignity*, they all asserted that the route to human perfectibility was clear, and that modification of the human environment would lead directly to a new and better society. And, as their reaction to the rise of sociobiology so clearly indicated, they all believed that any attempt to include evolutionary ideas in the explanation of human social behavior was pernicious and likely to result in misery on a global scale.

Unlike anthropology, behaviorism, social psychology, and sociology, economics and economic theory are founded on an essentially evolutionary premise. That premise is that humans (and all economic “agents”) act in such a way as to maximize self-interest. Virtually all economic theories (except Marxism) are based on this premise, but the paradox of economics is that by pursuing only self-interest, humans act (in the words of Adam Smith) as if guided by an “invisible hand” to promote the general welfare. Hence, the theories of human behavior based on evolutionary biology have been adopted and expanded by economists much more easily than in the other social sciences.

Another exception was linguistics, in which the work of Noam Chomsky is perhaps best known. Chomsky argued that the acquisition of human language is essentially innate, based on observations of the “deep grammar” of all known human languages. Later work by Eric Lenneberg and others strongly suggested that human language acquisition is essentially a form of imprinting, a behavior first described by ethologist and Nobel prize winner Konrad Lorenz:

- Like imprinting, human language acquisition occurs during a well-defined critical period.
- If language is not acquired during this critical period, it cannot be acquired at a later age.
- Once acquired, the ability to speak and understand spoken language is never forgotten or lost (except as the result of brain damage), although the specific language one learns may change over time.
- Unlike conditioned behaviors, reinforcement is not necessary for language acquisition; indeed, negative reinforcement does not stop it.
- Specific brain regions are “wired” for language; damage to such areas can cause the complete loss of the ability to speak or understand spoken language.
- Finally, although the capacity to acquire and use spoken language is clearly innate, the actual language one learns during the critical period depends entirely on what language you hear during that time; in other words, we inherit the capacity to learn language.

Perhaps no one has generated more controversy and been accused of more vile intentions than E.O. Wilson, both for *Sociobiology: The New Synthesis* and for

his follow-up book, *On Human Nature*. In *Sociobiology*, Wilson provided the groundwork for theories of evolutionary psychology.

In *On Human Nature*, Wilson argued that humans have several evolved behavioral tendencies, including the aforementioned ability to acquire and use language, personal and social aggression (including a tendency toward warfare), the establishment and maintenance of dominance hierarchies, role differentiation on the basis of gender, mating systems that include considerable non-reproductive sexual behavior, altruistic behavior and social cooperation, and a tendency toward religious behavior and belief.

Wilson also did not directly attack the Standard Social Science Model, concentrating instead on presenting an alternative explanation for the origin and evolution of human behavioral tendencies and mental abilities. He was also careful to point out the same caveat that ethologists point out when explaining animal behavior: that all behaviors are the result of a blend of innate and learned components.

More recently, Stephen Pinker has mounted a direct frontal assault on the Standard Social Science Model in his book *The Blank Slate*, published in 2002. In it, he ties the blank slate concept at the heart of the Standard Social Science Model to two other ideas: the Noble Savage and the Ghost in the Machine.

The idea behind the Noble Savage (most closely associated with French philosopher and writer Jean-Jacques Rousseau) is that humans are born as essentially “innocent” beings and are later corrupted through contact with society. The implication of this idea is that all that should be necessary to change “human nature” is to change society so that it reproduces the “state of nature” enjoyed by the “Noble Savage.”

The idea behind the Ghost in the Machine is that humans have a “soul” that is not reducible to evolved biological nature. Paradoxically, this idea is derived from the innatist philosophy of Plato, but unlike his philosophy, the modern Ghost in the Machine has no essential nature beyond human “free will.”

Pinker systematically disposes of these three assumptions underlying the Standard Social Science Model, using arguments derived primarily from cognitive psychology and artificial intelligence, linguistics, and evolutionary psychology. Pinker’s argument from cognitive psychology is based on the observation that the algorithms developed by cognitive psychologists and computer programmers can do precisely what both the innatists and the social constructivists said couldn’t be done; that is, they can generate behavior (and motivations, and even “thoughts”) from living neurons.

Furthermore, Pinker points out that a “blank slate” can’t do anything by itself. Just like a computer, the human mind requires a program by which it can link inputs to outputs. Where do these decision rules come from? They evolved by means of natural selection in our evolutionary past.

Using an argument derived from Chomsky's theory of "universal grammar," Pinker also points out that "an infinite range of behavior can be generated by finite combinatorial programs in the mind." Just as an infinite number of English sentences can be composed to express the full range of human experience, an infinite number of human behaviors (and "thoughts") can be composed using a relatively small set of simple "combination rules." What are these? They are the evolved psychological mechanisms that evolutionary psychologists propose as the "fundamental units" of the human mind.

This, in turn, implies that "universal mental mechanisms underlie superficial variation between cultures." Just as a "deep grammar" underlies the immense variation between human languages, a "deep logic" underlies the immense variation between human cultural practices.

Out of the foregoing, Pinker then distills a final principle: "The mind is a complex system composed of many interacting parts." Once again, this is simply a restatement of the "massive modularity" hypothesis upon which evolutionary psychology is based. Rather than having to learn absolutely everything "from scratch," we apply an inherited set of "decision rules" that make it possible to react quickly and effectively to a rapidly changing environment.

The massive modularity hypothesis also parallels what we now know about the structure of the brain and how it influences the mind. A half-century of brain studies have shown that the brain is not a "single-purpose machine" supporting the actions of a "single-minded person." Rather, the brain is a loose confederacy of semi-independent "modules," most of them specialized to perform fairly specific tasks. One of these modules produces the sensation we call our "self." Far from being the author of our actions, the "self" is mostly an observer of the outcomes of the activity of the other modules that make up the confederacy we think of as our "self."

Furthermore, neither the tasks nor the programs that function to produce them are necessarily all working toward the same coordinated end. Extensive research has shown that modules can "think for themselves" and even produce conflicting actions in the same "self." These findings strongly support the "massive modularity" hypothesis.

They also explain why we often feel "of two minds" about our actions and their motivations, and may find ourselves doing things that we don't want to do, but can't seem to stop ourselves from doing. Once again, the processing modules that make up our brains, like the evolved psychological mechanisms that make up our minds, aren't *supposed* to do anything; they exist because in the past those individuals that had them survived and reproduced more often than those who didn't.

# FOR GREATER UNDERSTANDING

## Questions

1. Why is it unlikely that humans begin life as a “blank slate”?
2. If humans are born with specific “innate capacities,” what does this imply about the structures of human societies and how easily they may be changed?
3. How does the approach to human behavior taken by evolutionary psychologists differ from that of “innatists” and “social constructivists”?

## Suggested Reading

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## Other Books of Interest

Buller, David J. *Adapting Minds: Evolutionary Psychology and the Persistent Quest for Human Nature*. Cambridge, MA: MIT Press, 2005.

Gazzaniga, Michael S., ed. *The Cognitive Neurosciences*. 4th ed. Cambridge, MA: MIT Press, 2009.

## Websites of Interest

1. *TED Conferences* website provides a video by Professor Steven Pinker about the theories contained in his book *The Blank Slate: The Modern Denial of Human Nature*. —  
[http://www.ted.com/index.php/talks/steven\\_pinker\\_chalks\\_it\\_up\\_to\\_the\\_blank\\_slate.html](http://www.ted.com/index.php/talks/steven_pinker_chalks_it_up_to_the_blank_slate.html)
2. A video interview with Professor Steven Pinker (Massachusetts Institute of Technology) by journalist Robert Wright discussing evolutionary psychology. —  
<http://video.google.com/videoplay?docid=3554279466299738997#>
3. A video interview with Professor Edward O. Wilson (Harvard University) by journalist Robert Wright that contextualizes evolutionary psychology within science, politics, academics, and philosophy. —  
<http://video.google.com/videoplay?docid=-4975549474851602314#>

## Lecture 6

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### Food, Clothing, Shelter, and Health

**The Suggested Reading for this lecture is David M. Buss's *Evolutionary Psychology: The New Science of the Mind*, chapter 3: "Combating the Hostile Forces of Nature: Human Survival Problems."**

**E**volution by natural selection ultimately depends on differential survival and reproduction. Herbert Spencer's phrase "survival of the fittest" therefore captures only half of the requirements for natural selection. Reproduction is equally important. Indeed, if an organism survives (that is, it doesn't die and it isn't killed) but does not reproduce, then whatever heritable characteristics it may have will disappear when it eventually dies. For this reason, evolutionary biologists often say that an organism that doesn't reproduce is "invisible" to evolution by natural selection. However, there are some exceptions to this rule (for example, the non-reproductive members of a eusocial insect colony nevertheless contribute to the survival and reproduction of one or more of their siblings, with whom they share the majority of their genes).

We will spend several lectures discussing the "reproduction" half of the "survival and reproduction" equation. For now, I would like to concentrate on those behavioral traits that, despite being less "sexy," are nonetheless important aspects of evolution by natural selection: finding and consuming nutritious food, accommodating to (and in some cases resisting) the effects of climate and weather, and avoiding or surviving predators and diseases.

Animals have many anatomical, physiological, and behavioral adaptations for accomplishing these activities. Indeed, one thing that separates humans (and some of the great apes) from the other animals is that most of our adaptations for carrying out these activities are behavioral. Predators—animals that kill and eat other animals—usually have anatomical adaptations for finding, killing, and consuming their prey.

Humans have equally effective behavioral traits that allow them to find, subdue, and kill even larger prey. Furthermore, most of these behavioral adaptations are clearly learned, passed down as part of the knowledge and skills that make up the cultures of such people.

And not only passed "down"—human information transfer via learning is "horizontal" as well as "vertical." Humans can as easily pass on information and skills to their contemporaries as their offspring, which greatly increases the volume of information that can be transferred, the speed with which this happens, and the breadth over which the information can be disseminated.

Once again, what is inherited in a Darwinian sense is not the specific forms of behaviors, but rather a tendency to learn certain types of behaviors more easily than others, despite significant differences in cultural environments. That said, there is strong evidence that we inherit innate tendencies to prefer certain types of foods, based on their nutritional content.

For example, given the opportunity to freely choose from a large variety of foods, most people (and especially children) prefer foods with relatively large amounts of sugars, fats, and salt.

Why do we prefer high-sugar, high-fat, high-salt foods? Because, in our evolutionary past, our ancestors who preferred these foods survived and reproduced more often than others who did not, or did not as much.

Sugars are primary sources of metabolic energy for animals, especially during the developmental stages leading up to puberty. Fats contain almost twice as much metabolic energy as sugars, and so consuming fats to fuel the rest of the body is also more efficient than consuming foods high in plant fiber.

Finally, sodium is essential to the normal function of animal cells (especially muscle cells and the cells of the nervous system). However, sodium is relatively rare in most terrestrial environments. Also, plants do not take up sodium, so a diet high in plant material will necessarily be low in sodium. Therefore, eating animals and consuming salt whenever and wherever possible would have been adaptive in environments in which sodium is rare and difficult to obtain.

To sum up, those who limited their intake of sugars, fats, and salt when they were available would not have survived and reproduced as often as those who had no such limitation. In an environment where such materials were rare (that is, our Pleistocene past), such behavior would have been strongly adaptive. In our current environment, such behavior leads eventually to serious health problems, such as diabetes, obesity, and high blood pressure. However, since these diseases typically strike us down when we are older, natural selection cannot eliminate them, as anything that happens after we reproduce is generally “invisible” to selection.

There is even a strong suggestion that natural selection in our primate past can explain the human preference for alcohol. Alcohol is toxic, and many animals will not consume foods that have any amount of alcohol in them. However, primates (and especially humans) tend to prefer foods that have small amounts of alcohol in them, especially fermented fruits.

Ripe fruits contain large amounts of sugar, which when it is fermented by yeasts on and in the tissues of the fruit is converted into alcohol. Alcohol is also volatile and an excellent vehicle for disseminating volatile odorants into the air. Indeed, since fruits ripen as a way of attracting animals, who eat the fruits and disseminate the seeds, the plants that produce such fruits and the animals that seek them out and eat them constitute a “coevolutionary spiral,” in which each increase in adaptiveness of one partner stimulates a corresponding increase in the other partner.



All of these combine to make alcohol a “marker” for primates, who have a higher than usual requirement for high-energy, sugar-containing foods. Once again, primates who limited their intake of fermented fruit would have been selected against, compared with primates who had no such limitation.

So intense is selection on the basis of nutrition that the nutritional environment inside the womb can have profound effects on our behavior and nutritional status later in life (and even in our children’s lives). There is experimental evidence that mammals in general, and humans in particular, can have more than one metabolic “set point,” depending on our nutritional environment before birth. Individuals that develop inside mothers who are consistently starved of calories tend to have what is now known as a thrifty/hungry metabolism. That is, they have lower metabolic rates and higher hunger “set points” (especially for sugars and fats) than individuals whose mothers were well-fed. As a result, children of “hungry” mothers tend to be “hungry” themselves, and show a significant tendency toward obesity in environments in which food is plentiful.

Not all foods are tasty and nutritious. Plants and fungi (such as mushrooms) can’t run away from animals that might eat them. Therefore, plants and fungi that have materials in their tissues that are toxic or distasteful to animals would not have been eaten as often as those that did not. Natural selection, in other words, tends to select for plants and fungi that contain toxic or distasteful materials.

Because such materials are often present in non-animal foods, animals that eat plants are adapted to being able to identify potentially toxic or dangerous food sources.

Humans and other primates (and rats) all exhibit a food preference behavior known as neophobia; that is, they avoid eating foods with which they are not familiar. This is particularly true among younger individuals, who will only sample new foods in small amounts, unmixed with other foods. That way, if they are sickened by the new food, they can quickly learn to identify and avoid it.

Cooking accomplishes three things: it makes foods (especially animal foods) more easily digestible, it kills bacteria and fungi, and it preserves food (at least until the food cools off). Cooking, of course, requires the ability to use fire, and therefore if cooking food is adaptive, then this adds to the adaptive value of the ability to make and use fire.

Indeed, humans are rare among animals in that we are not terrified and repelled by fire. On the contrary, humans tend to be fascinated by fire. There is archaeological evidence that humans have used fire for at least three hundred thousand years, and perhaps as long as 1.5 million years. Given this immense span of time, it is quite possible that this behavior is itself the result of natural selection. Of course, a few of our domesticated animals—dogs and cats—share our proclivity for fire, but that is probably the result of selection as well; since our ancestors lived with fire, the animals they domesticated would have been selected for their tolerance for fire.

Is there some adaptive reason for the fact that we use spices in cooking? Extensive research has shown that spices are bacteriocides: They kill bacteria, or at least inhibit their growth. Indeed, there is a correlation between average ambient temperature and "spiciness" of foods, with spicier foods preferred in warmer climates. This is probably because warmer ambient temperatures encourage more rapid spoilage of foods.

However, spices are also used to hide the fact that foods have already spoiled. This would in turn imply that spicy foods could be potentially dangerous. Who would be most susceptible? Children. Every parent can attest that children are much less likely to prefer spicy foods, and that this is particularly true for spicy foods composed of a mixture of different materials (especially cooked cream sauces, vegetables, and meats, which are most likely to contain toxins derived from plants and bacterial spoilage).

Food preferences are strongly influenced by our evolutionary past. This is also the case for the steps in finding, procuring, processing, and consuming food.

Both hunting and gathering are usually done in groups, rather than alone. Hunting in particular is a social activity among both apes and humans. As is the case in other social carnivores, groups of hunting humans can use techniques that increase the probability of success.

Even gathering, especially in the context of agriculture, can often be enhanced by group cooperation. Ethnographic evidence also points to group gathering as a social milieu within which females (the primary gatherers) can simultaneously assist each other in finding choice foods, while at the same time sorting out and strengthening their social relationships through conversation and reciprocal altruism. The same is also the case for group agriculture, in which whole communities participate in food production in ways that would not be possible for individuals.

Food distribution also occurs primarily in the context of group activity. This is especially true for meat, the product of hunting and of cooperative animal husbandry. Plant food sources are usually less concentrated and of lower nutritional value than meats, and can often be preserved, whereas meats cannot be as efficiently preserved and stored. Therefore, when hunters obtain large prey, there are usually elaborate rules for the distribution of such foods, often tied to the dominance structure of human groups. Once again, the ultimate reason for the existence of such rules and rituals is that they enhance the survival and reproduction of both the individuals that have them and the groups of which they are members.

In nearly all climates, clothing provides protection against the vagaries of climate and weather. Clothing also simultaneously conceals and reveals secondary sexual characteristics. Clothing also serves as an indirect indication of social status, which is particularly noticeable and important in large social groups with intense dominance hierarchies.

Humans generally need clothing because unlike almost all other mammals (except cetaceans) we lack sufficient fur and hair to provide insulation and protection. Even in environments in which insulation and protection are generally unnecessary, humans still wear some form of clothing. Clothing, therefore, has both a purely functional aspect and a social aspect.

In both cases, natural selection has resulted in the evolution of learned abilities to fashion and use clothing. That such abilities are innate is testified to by the fact that they are pan-specific (that is, all human societies learn to do these things) and conform to general rules that are related to the biological functions of clothing.

Consider shoulder pads. Shoulder pads in male clothing serve two functions: they provide protection from blows aimed at the upper body and they enhance the shoulder-to-hip ratio, making their wearer appear more masculine. That the tendency to fashion and wear shoulder pads is probably the result of an evolved tendency is indicated by the fact that they have been reinvented multiple times in multiple cultures, and almost always in the same general context.

This even explains why shoulder pads have sometimes appeared in women's clothing: Such appearances have generally coincided with shifts in women's roles from "domesticity" to competition in social milieus dominated by men.

Shelter, like food and clothing, has significant evolutionary implications in humans. The tendency to occupy, and especially to build, shelters is a relatively uncommon trait among most animals. Once again, this is generally because most animals have anatomical and physiological adaptations that make the occupation and/or building of shelters unnecessary. Humans, by contrast, all either occupy natural shelters or build shelters that protect us from the extremes of our environment.

Our ancient Pleistocene ancestors are often caricatured as "cave-men," occupying shelters that they have not themselves constructed. While this may have been true for some of our ancestors, it is probably the case that our perception of how prevalent such behavior was among our ancestors is strongly biased by the fact that only in caves are such ancient remains preserved well enough for us to find and study them. In other words, the vast majority of our evolutionary ancestors probably lived in shelters constructed of the same perishable materials of which ours are constructed: wood and piles of stones, which eventually rot and are dispersed by natural forces.

And, like clothing, our shelters also communicate our social status as well as protect us from the elements. Cultural anthropology is filled with examples of houses and other buildings that both provide shelter to their inhabitants and provide strong signals as to the social position of their owners.

Height is a crucial cue indicating social status among humans. Numerous studies have shown that taller people are more likely to rank higher in social groupings than shorter people. This tendency is also reflected in the details of

buildings. People of higher social status tend to build and live in taller buildings, and especially in buildings in which the architectural details tend to indicate that their inhabitants are unusually tall. And it is not accidental that social revolutions often involve “leveling”; that is, literally “cutting people down to size” in a way that decreases the status distinctions between individuals in society.

All of these common correlations between status and architecture are the result of an underlying adaptive algorithm that correlates perception of social status with differential survival and reproduction: Taller people live in taller shelters, command more resources, and therefore have relatively higher survival and reproductive rates than smaller people. This, in turn, is correlated with a noticeable trend in human physical evolution: People today are more than twice as tall as our distant evolutionary ancestors, and average human height continues to increase, probably as a result of selection for height.

For most of our evolutionary history, our ancestors were as likely to be prey to larger predators as to be predators on other animals. Consequently, we have inherited a suite of behaviors that minimize our potential exposure to predation, behavior that we retain even though most of those predators are now either rare or extinct.

Primates in general, and humans in particular, have relatively poor night vision. In essence, we have traded visual sensitivity (especially in low light) for visual acuity, a distinct advantage for animals that live in trees and depend on ripe (that is, brightly colored) fruit for food. This makes us particularly vulnerable to predation at night, when our visual acuity is almost worthless. Hence, there is a strong tendency for humans to be generally fearful in low-light environments, in which our “agency detectors” tend to be working on overdrive.

We also have a tendency to “see” predators and other dangers where they don’t actually exist, especially in low light and in unfamiliar environments. That is, our ancestors who were frightened of the dark (and therefore more alert) and who saw lions and tigers and bears lurking in every shadow and dark place survived and reproduced more often than those who didn’t, because sometimes there really were predators lurking about.

Predators weren’t the only animals that threatened our ancestors; poisonous spiders and snakes also provided an evolutionary force that has shaped our behavioral responses. Poisonous spiders and snakes do not have poisons to injure or kill people; they have them to kill smaller prey and to defend themselves against larger predators. Furthermore, most species of poisonous spiders and snakes live in the same habitats in which our evolutionary ancestors lived: Those individuals that had an innate, unreasoning fear of spiders and snakes would have been less likely to be bitten by them, and would therefore pass on their innate, unreasoning fears to their descendants. Such spider and snake phobias are so intense that we can “see” spiders and snakes in other

things: crawling insects and wavy power cables on the floor, especially in darkened rooms or outdoors in low light.

Diseases and parasites are inescapably associated with sociality; they are spread from host to host by contact, especially in dense social aggregations. This especially applies to diseases and parasites that are spread through physical contact, and especially to those spread via food and sex. Adults have evolved tendencies to avoid certain kinds of physical contact. For example, people have strong negative reactions to both feces and vomit. Both can be vectors for the spread of disease. In other words, those of our ancestors that “instinctively” avoided contact with such things survived and reproduced more often than those who did not.

In some cultures, the behavioral tendency to avoid “contamination” has led to the evolution of extraordinarily complex social adaptations. For example, there are extremely detailed prohibitions on contact with most bodily fluids in Japanese and other east Asian cultures. In India, the caste system is intimately tied to the social segregation of contact with potential pathogens, with “untouchables” relegated to the cleaning and processing of materials contaminated with human feces.

Human phobias, especially those involved with exposure to potential predators, poisonous animals, and contamination by pathogens are widespread and show correlations with particular environments. And, by contrast, although many people today are injured or killed by knives, guns, cars, and warfare in general, natural selection has not yet had sufficient time to shape our tendency to learn to avoid such potential threats.

# FOR GREATER UNDERSTANDING

## Questions

1. Why is the tendency to prefer sweet, salty, fatty foods (which were once scarce and valuable commodities) now potentially maladaptive?
2. Why can we so easily infer people's social status from their clothing or where they live?
3. How does the approach to human behavior taken by evolutionary psychologists differ from that of "innatists" and "social constructivists"?

## Suggested Reading

Buss, David M. *Evolutionary Psychology: The New Science of the Mind*. 2nd ed. Boston: Allyn & Bacon, 2004.

## Other Books of Interest

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## Websites of Interest

1. The PBS website provides "The Botany of Desire" based on the book of the same name by Michael Pollan. — <http://www.pbs.org/thebotanyofdesire>
2. The *New York Times* "Sunday Book Review" features a review of Michael Pollan's book *The Omnivore's Dilemma*. — <http://www.nytimes.com/2006/04/23/books/review/23kamp.html>
3. Dr. Randolph M. Nesse (professor of psychiatry, professor of psychology, research professor for the Research Center for Group Dynamics, Institute for Social Research, and director of the Evolution and Human Adaptation Program at the University of Michigan) provides articles, links, and new Web media on his personal website. — <http://www-personal.umich.edu/~nesse>

## Lecture 7

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### Cooperation and the Paradox of Altruism

**The Suggested Reading for this lecture is David M. Buss's *Evolutionary Psychology: The New Science of the Mind*, chapter 9: "Cooperative Alliances."**

**D**arwin's theory of evolution is based on the assumption that natural selection takes place at the level of *individuals*. According to his theory, the heritable characteristics of *individuals* that survive and reproduce more often than others become more common over time. That is, those characteristics become what we refer to as *adaptations*.

Darwin realized that the evolution of the kind of cooperation that exists among the social insects—ants, bees, termites, and wasps—could not evolve by natural selection at the level of individuals. The reason for this is that the members of the worker and warrior castes of most of the species of social insects are sterile and cannot pass on their anatomical, physiological, or behavioral characteristics to their offspring. Instead, they assist one (or, in some species, a small number) of their siblings to reproduce, usually producing many more offspring than any single individual could successfully produce alone. Sterile workers in ant colonies, bee hives, termite mounds, and wasp nests also sacrifice their lives in defense of the group, a behavior that appears to be a very extreme form of altruism.

Darwin's solution was surprisingly simple. He pointed out that animal breeders do the same thing when they breed cattle, sheep, and pigs for meat. These animals are usually killed while very young, typically before reproductive age. In most cases, male cattle, sheep, or pigs are castrated soon after birth, a treatment that makes them grow larger, taste better, and be less aggressive. To obtain more cattle, sheep, or pigs for meat, close relatives (parents or full siblings) of the slaughtered animals are bred and their offspring castrated and slaughtered for meat. Because these relatives have similar heritable characteristics, the characteristics of the slaughtered animals persist.

Darwin considered this to be selection at the level of the "family" rather than the individual. His use of "family" rather than "group" was not accidental. In the sense that Darwin used it, "family" means a group of closely related individuals, presumably sharing a closely related set of heritable characteristics.

Later, and especially in his book *The Descent of Man and Selection in Relation to Sex*, Darwin extended this idea to selection at the level of groups, especially groups of humans. Darwin described groups of humans (usually referred to as "tribes") competing with each other in various ways. He proposed that a group composed of cooperative (that is, "altruistic") people would usually succeed more often than groups composed of selfish individuals. Although he didn't

formally propose the term, Darwin was describing what has since been called “group selection.”

In the decades following the publication of the *Origin of Species*, the concept of group selection came to be the standard explanation for the evolution of cooperative behavior, and this idea was explicit in Darwin’s discussions of social insects. As a result, most biologists simply accepted the idea that “group selection” was the explanation for the evolution of insect sociality and, perhaps, social behavior of all kinds. Consequently, no systematic attempt was made to test this idea until the 1960s.

In 1962, Vero C. Wynne-Edwards published a monumental work entitled *Animal Dispersion in Relation to Social Behavior*. The book was immediately popular with ethologists both for its encyclopedic coverage of animal social behavior and the theory of group selection that Wynne-Edwards proposed for much of this behavior. Wynne-Edwards proposed that many different forms of social behavior had one underlying function: to restrict the full reproductive potential of the members of social groups of animals.

He based this assertion on the observation that such behaviors do indeed have the effect of lowering the average reproductive output of the members of a social group of animals, considered as a unit. This is because, as a result of such behaviors, some individuals do not have as many offspring as they could, and a sizeable number have no offspring at all (those who cannot attract a mate, defend a territory, or rise to a dominant position in a hierarchy). Such social behaviors were therefore adaptive at the level of groups because, as a result of restricting reproduction, such groups did not exhaust the resources available to them, thereby avoiding eventual extinction.

In 1966, George C. Williams, in *Adaptation and Natural Selection: A Critique of Some Current Evolutionary Thought*, directly attacked Wynne-Edwards’s theory, and by extension all theories of group selection. Using logical arguments (backed up with only a few well-chosen examples), Williams showed that each of Wynne-Edwards’s group selection explanations could be replaced by a parallel explanation at the level of individual selection. In particular, Williams pointed out that any population of animals composed of individuals that restricted their reproduction could be “invaded” by a selfish individual that maximized it. The idea that selfishness inevitably trumps altruism became a paradox as difficult to solve and as potentially fatal as Darwin’s paradox of the evolution of sterile castes by natural selection.

Yet the living world is filled with amazing examples of cooperation and altruism. Worker honeybees will attack anything that they perceive to be threatening their hive, despite the fact that such an attack is almost invariably fatal to the defending worker. The paradox is plain: Either the worker’s suicide somehow results in the production of more workers like herself (the workers are all female), or her behavior is not the result of an evolved tendency (an extremely unlikely possibility, as this behavior is clearly innate).



Williams himself had mentioned that a solution to this paradox existed, but most evolutionary biologists were unfamiliar with it (this solution had been suggested only two years earlier by William D. Hamilton).

Hamilton has often been called the “Darwin” of the twentieth century, but while he is credited with founding a huge and growing discipline within the biological sciences, he was almost completely unknown at the time of the publication of his most important work and is still not well known outside of the field of evolutionary biology.

Hamilton’s most important contribution to evolutionary biology was the formulation of what is now known as Hamilton’s Rule:

- Altruism can evolve (that is, is selected for) when the cost of an altruistic act is less than the benefit to its recipient, multiplied by the degree to which the altruist is related to the recipient.

In other words, altruism can evolve by natural selection as long as the altruists are closely related to each other and their actions benefit their altruistic kin. Stated another way, the probability of altruism evolving in a population increases directly with genetic relatedness.

Because it ties the evolution of cooperation to genetic relatedness, Hamilton’s Rule is often referred to as kin selection:

- Altruism can evolve by natural selection if it benefits closely related kin.

Hamilton’s theory of kin selection is strongly supported by observations of social insects. Societies in which there is one or more sterile caste and extraordinarily high degrees of cooperation (“altruism”) are referred to as eusocial societies. Hamilton pointed out that eusociality has evolved independently in nature several times, presumably meaning that the same mechanisms contributed to its evolution in each case. Hamilton also pointed out that nearly all of these independently evolved lines of eusocial animals are found in the order *Hymenoptera* of the class *Insecta*.

The order *Hymenoptera* includes the ants, bees, and wasps, many of which are highly eusocial, plus other species that are nearly solitary. All species of *Hymenoptera* use a peculiar genetic system to determine sex. In this system, called haplodiploidy, females develop from fertilized eggs (eggs containing genes from both mother and father), while males develop from unfertilized eggs (eggs containing genes only from the mother). This means that female ants, bees, and wasps are related to their siblings by an average of three fourths, while they are related to their own offspring by only one half. Therefore, a female ant, bee, or wasp who helps her sister (that is, the “queen”) produce offspring will, on the average, cause more copies of her genes to be passed to the next generation. Haplodiploidy therefore predisposes the *Hymenoptera* toward the evolution of eusociality, but does not absolutely require it.

Notice that, according to Hamilton's Rule, natural selection happens at the level of genes, rather than at the level of individuals. This means that, according to Hamilton's Rule, altruism does not exist at the level of genes. This is because an animal that performs an apparently altruistic act that causes the frequency of its genes to increase in the next generation is acting "selfishly" on behalf of its genes.

But what about apparently altruistic behaviors that do not appear to benefit the altruist's close kin? Do they exist, and if so how can they be explained? The answer to the first question is yes, and there are numerous examples.

- One example is alarm calls among mixed species of foraging birds. Like the alarm calls of the prairie dogs, these are given when a predator is spotted. However, because such flocks often consist of several species, it is unlikely that the bird giving the warning is closely related to them all.
- Another example is the widespread phenomenon of "cleaners" that rid other animals of parasites. On tropical reefs there are species of fish that have specialized in removing parasites from the scales (and even the lining of the mouth) of other fish. The fish that they are cleaning generally do not eat the cleaners, and the cleaners do not nibble on their hosts, despite numerous opportunities for both to do so.
- In an even more extreme example, there are acacia trees in subtropical Africa that provide ants with both food and hollow thorns as nesting space. In return, the ants aggressively repel animals that attempt to graze on the leaves or branches of the acacias. But the question remains, how can such apparent altruism evolve between members of different species?

The answer to this conundrum was suggested by Robert L. Trivers, sometimes referred to as the "Einstein of sociobiology," in 1971. According to Trivers's theory:

- Reciprocally altruistic exchanges must be repeated, with no definite endpoint (that is, it generally requires long-lived individuals that live in the same place).
- Such exchanges must involve only small units of value per exchange (that is, so that neither player is tempted to cheat).
- The individuals involved must be able to unambiguously identify each other as individuals, and remember what exchanges have occurred and what units of value have been involved (and which individuals are "cheaters").
- Cheaters must be identified and punished for cheating at a level of retribution that exceeds the benefit derived from cheating.

Notice several important implications of Trivers's theory:

- For reciprocal altruism to evolve does not require either love or even trust on the part of either player, only that the exchanges be repeated.

- The longer the players interact with each other, the greater the potential cumulative benefit from reciprocally altruistic exchanges.
- Trivers's requirements strongly imply that animals that are long-lived can identify each other as individuals, have a good memory, and can predict the behavior of other animals with fairly high accuracy are most likely to evolve cooperation as the result of reciprocal altruism.
- These conditions fit humans better than almost any other animals.

In 1981, William D. Hamilton coauthored a paper with Robert Axelrod in which they refined and extended Trivers's theory of reciprocal altruism. Axelrod and Hamilton hosted a computer tournament in which they invited scientists from around the world to submit computer programs to solve a mathematical paradox called "the Prisoner's Dilemma." The Prisoner's Dilemma is a mathematical game in which two prisoners are given the choice to either keep silent or turn state's evidence. Because of the way these two choices are rewarded (or punished), both prisoners rationally choose to turn state's evidence, despite the fact that they would both go free if they both kept silent.

Programs were submitted from all over the world. Axelrod and Hamilton pitted the programs against each other in a tournament in which the "house strategy" was complete selfishness (no cooperation in any round of the game). Importantly, the games were repeated, because complete selfishness always wins if the game is only played once. The result of the tournament was striking: The winner was the simplest program submitted, consisting of only four lines of code in the computer language BASIC.

The winning program (submitted by mathematical game theorist Anatol Rapoport) was called "Tit for Tat," and had the following rules:

- On the first round of the game, cooperate with the opposing player.
- On the second round of the game, do exactly what the opposing player did in response to the initial cooperative move.
- If the opposing player is selfish (a strategy technically referred to as "defection"), Tit for Tat immediately retaliates by defecting as well.
- However, if the opposing player cooperates, Tit for Tat responds by cooperating.
- If the opposing player first defects, but then cooperates later, Tit for Tat does not punish it for past behavior, but simply cooperates as long as its opponent does so.

Note several characteristics of Tit for Tat that contributed to its success:

- It's "nice"; that is, it starts off by cooperating on its first round.
- It's also retaliatory, immediately punishing an opponent for defection.
- It's also forgiving, immediately rewarding a defector for cooperating.
- It's simple.

- It's robust; it consistently won repeated rounds of the game and versions of the tournament, and is still the reigning champion two decades (and many tournaments) later.

After publishing their findings in *Science*, Axelrod and Hamilton went on to expand on their discoveries in a landmark book, *The Evolution of Cooperation* (1984). In it, they applied the basic principles of Tit for Tat to the evolution of cooperation in many different species, including humans. They pointed out what Trivers had mentioned earlier: that the evolution of cooperation doesn't require either love or trust. All that is necessary for cooperation to evolve between two players is duration of relationship; the game must be repeated with no identifiable ending point.

They also pointed out that this means that symbioses in which two or more unrelated groups of organisms live in constant, intimate contact with each other are most likely to evolve the kinds of cooperative strategies exemplified by Tit for Tat. The converse of this finding is that short-term (and especially single-time) exchanges are much more likely to result in pure selfishness.

Does the apparent success of Tit for Tat mean that genuine altruism is impossible? Not necessarily: An entirely new mathematical theory for the evolution of altruism via group selection was proposed in the early 1970s by George R. Price. Central to Price's new analysis was what has come to be known as the Price Equation: a mathematical formula that ties the fate of a specific gene to its effects on a population of individuals that have that gene. Using a mathematical concept called covariance, Price showed that changes in the frequency of a gene in a population were tied to the expression of that gene among the descendants of individuals possessing it. Price also showed that the ultimate evolutionary effect of any given gene could best be measured by determining its effects on populations of individuals with the gene, compared with other populations in which different genes were present.

George R. Price was an extraordinarily talented amateur whose unorthodox approach to the problem of the simultaneous evolution of related traits has revolutionized evolutionary theory. While studying evolutionary biology on his own, Price happened to read William D. Hamilton's 1964 paper on the evolution of altruism via kin selection. Price wrote to Hamilton with his own analysis of the idea, but Hamilton was on a nine-month research trip to Brazil. While Hamilton was gone, Price worked on his own mathematical analysis of the problem of the evolution of altruism by natural selection. While Hamilton was still in Brazil, Price sent him a manuscript containing his mathematical analysis of the problem.

Central to Price's new analysis was what has come to be known as the Price Equation: a mathematical formula that ties the fate of a specific gene to its effects on a population of individuals that have that gene. In essence, Price showed that the ultimate evolutionary effect of any given gene could best be measured by determining its effects on populations of individuals with the gene,

compared with other populations in which different genes were present. In other words, specific genes (especially for altruism) have their greatest effects on groups, which in turn affect the continued survival and either increase or decrease in frequency of those genes.

Price also showed that Hamilton's concept of kin selection was subsumed by his equation. In a small population (that is, "group") individuals can be negatively related as well as positively related; that is, an individual can share fewer genes with certain other individuals (especially non-group members) than with their group as a whole. Price showed mathematically that this means that such individuals can benefit their group (and therefore those individuals to whom they are more closely genetically related) by lowering the fitness of individuals to whom they are not closely related. Spite, in other words—harming another individual at some cost to oneself—can be positively selected if one's closer relations benefit.

Another striking implication of Price's model is that, while it can incorporate kin selection, it does not require it for altruism to evolve. This is because the actions of altruists can have positive effects on the average fitness of groups, even if they are not closely related to the members of the group. Selection, in other words, can operate at the level of groups as well as individuals.

Hamilton was initially skeptical, but eventually revised his own theory of kin selection to incorporate Price's insights. In 1975, Hamilton published a paper on "innate social aptitudes of man" in which he argued for what has come to be called multi-level selection:

- Simultaneous natural selection at the level of genes (that is, kin selection), individuals (that is, classical Darwinian selection), and groups (that is, group selection).

Hamilton's analysis was essentially a concession that group selection was not only possible, it also amplified the effects of individual and kin selection.

In 1998, Elliott Sober and David Sloan Wilson published *Unto Others: The Evolution and Psychology of Unselfish Behavior*, in which they argued for the importance of multi-level selection, especially as an explanation for the evolution of cooperation. Sober and Wilson pointed out that the Price equation and related mathematical analyses provide a strong foundation for a new theory of group selection, one that explains the evolution of cooperation at all levels. They also proposed that this idea, which they call multi-level selection, provided an empirically testable model for the evolution of cooperation, and provide experimental results to support it.

# FOR GREATER UNDERSTANDING

## Questions

1. J.B.S. Haldane, one of the founders of modern evolutionary theory, once quipped that he would risk his life to save two brothers or eight cousins. What did he mean by this?
2. Is reciprocal altruism genuinely unselfish?
3. According to George R. Price's theory of group selection, neither genetic relatedness nor reciprocal altruism is necessary for the evolution of cooperation. What are the implications of this idea for the relationships within human groups and between human groups?

## Suggested Reading

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## Websites of Interest

The *Internet Encyclopedia of Philosophy: A Peer-Reviewed Academic Resource* website provides a lengthy entry by Ayelet Shavit (Tel Hai Academic College, Israel) entitled "The Evolution of Altruism by Group Selection." — <http://www.iep.utm.edu/group-se>

## Lecture 8

### Gender and Sex Differences

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**The Suggested Readings for this lecture are Martin Daly and Margo Wilson's *Sex, Evolution, and Behavior* and John Gray's *Men Are from Mars, Women Are from Venus: A Practical Guide for Improving Communication and Getting What You Want in Your Relationships*.**

One of the main reasons behind the growing acceptance of George Price's model of group selection is the observation that role specialization always accompanies group selection. As Price first pointed out, this is a direct outcome of his model: The fate of the members of a group is directly tied to the fate of the group as a whole, and vice versa. Or in evolutionary terms:

- The fitness of the individual members of a group is directly tied to the fitness of the group, considered as a single functional unit.

This is why altruists can increase in frequency overall, even when they decrease in frequency relative to the other members of their group. The actions of the altruists enhance the fitness of the group as a whole. This means that cells that have become so specialized that they can no longer reproduce on their own can still become more common over time if the group of which they are members increases in size. This requires that there be a mechanism by which the non-reproductive cells can continue to be reproduced, even though they themselves no longer reproduce. The non-reproductive members of a group continue to be produced by the reproductive members of the group that benefits from their altruism, just as Darwin originally suggested.

Which brings us back to the importance of role specialization in social evolution:

- Increasing role specialization at the level of individuals is autocatalytic as group selection proceeds.

That is, when selection operates at the level of groups, it has the effect of selecting for increasing degrees of role specialization among the individuals that make up the group. This enhances survival and reproduction of the group, which in turn sets the stage for further role specialization. In other words, group selection appears to cause role specialization when selection operates on the group rather than exclusively on individuals:

- Role specialization is both a cause and an effect of social evolution, and therefore increases as social evolution proceeds.

Animals today are multicellular eukaryotes, composed of many specialized cells that cooperate to form the tissues, organs, and organ systems that together make up an individual multicellular organism. However, animals are

the evolutionary descendants of unicellular animal-like protozoa that lived in the oceans around a billion years ago.

All eukaryotes share several structural and functional characteristics, including a true cell nucleus, mitochondria and cell division by mitosis. However, only animals show distinct structural and functional differences between females and males.

At the very beginning of the evolution of animals, single-cell ancestors did everything they had to do to survive and also reproduced as single cells. The mechanism by which they reproduced is the same one that eukaryotic cells still use to divide: mitosis.

In addition to dividing into two identical cells by mitosis, our unicellular protist ancestors also sometimes did the opposite: Two cells would occasionally fuse together to form a single cell containing two complete sets of chromosomes. Lynn Margulis has proposed that this process—cell fusion—originally evolved because it allows cells to counteract the negative effects of genetic mutations.

Cells that have two complete sets of chromosomes are called diploid cells, whereas cells that have only one set of chromosomes are called haploid cells. We ourselves are diploid, having received one complete set of genetic material from Mom and one from Dad. This was also true for our unicellular ancestors, except that “Mom” was a single haploid cell and “Dad” was another haploid cell, which fused together to make a diploid cell.

How do we get from fused diploid cells to the haploid cells that can fuse together to form them? A second cell division process evolved, called meiosis, which has the effect of dividing diploid cells into haploid cells with only one set of chromosomes each. Once again, Lynn Margulis proposed that meiosis evolved originally as a means of separating the two sets of chromosomes in a fused diploid cell following the comparison and repair of their two sets of genetic material.

Furthermore, the two sets of chromosomes are randomly shuffled during meiosis, producing new combinations of the genetic material from the two parents. Following DNA repair and chromosome shuffling, a diploid cell could then divide by meiosis to form the “normal” haploid forms.

In other words, our protist ancestors alternated between a unicellular diploid form and a unicellular haploid form. Further, these two forms reproduced themselves via two different kinds of cell division: mitosis and meiosis.

The specialization of sex cells into female (large and immobile) forms and male (small and mobile) forms was the first and most important consequence of group selection in the origin of animals. When our distant ancestors were still unicellular protists, the haploid cells that were produced by mitosis and meiosis separated from each other, producing free-living unicellular haploid protozoa. When some of these unicellular haploid cells fused together to form a diploid cell, it was also still unicellular.



What made them into true animals was that the founders of the kingdom Animalia didn't separate following cell division; they stayed attached to each other, forming a multicellular "confederacy"—a body, in other words.

At this point, a crucial branch point in evolution occurred: Among the ancestors of animals, the diploid form was the one in which multicellularity evolved as the result of mitosis and cell adhesion. This branch point tied the diploid form to multicellularity and therefore the production of haploid reproductive cells by meiosis.

Animals, by chance, stumbled on a mechanism that had two complementary outcomes: the alternation of a large multicellular diploid form with a small unicellular haploid form, and a process of cell division going from the former to the latter that tremendously increased the genetic variability between offspring. At first, the cells of the large multicellular diploid forms were virtually identical in structure and function. The confederacies ("bodies") of which such cells were members increased in size, as this allowed them to store more resources in their tissues, made predation on other animals easier while at the same time reducing their vulnerability to predation, and allowed the confederacy to survive the deaths of some of its members. And, as they evolved by group selection, the individual cells became more specialized.

A crucial thing to notice about these multicellular confederacies is that not all of their cells retain the ability to reproduce. The cells that can do this—usually called sex cells—started out as nearly identical haploid cells, but very quickly differentiated into two types: large cells that do not move under their own power ("egg cells" or "ova") and small cells that swim around using long whip-like tails called flagella (called "sperm cells" or "spermatozoa").

On a functional level, what distinguishes females from males is that females have large, non-mobile reproductive cells, whereas males have smaller, mobile reproductive cells. This specialization of function between female and male sex cells evolved from an ancestral form in which there were no such differences. This strongly implies that the specialization into female and male forms is adaptive. So why have almost all animals separated into distinct female and male forms, whereas plants, fungi, and other living organisms have not? What evolutionary advantage does this distinction confer on the two different forms?

The answer is a direct implication of Price's theory of group selection: The specialization of mating cell types into female and male forms conferred an adaptive advantage on the groups of which they were a part, rather than each individual form. And what were these "groups"? They were the multicellular "confederacies" from which the sex cells were derived. Price pointed out that cells stand in the same relationship with the bodies from which they are derived as individual organisms stand with the groups of which they are a member. In both cases, the fates of the groups and the individuals that make them up are tied together.

Having one type of haploid sex cell that is large and immobile and another that is small and mobile increases the efficiency of reproduction. The large, relatively immobile form (egg cells) can store large amounts of food for the developing embryo, but can't move very well (which limits distribution in space, but also limits exposure to potential predators and other dangers). By contrast, the small, relatively mobile form (sperm cells) can disperse widely in space (increasing the probability of encountering other egg cells), but can't store much food to stay alive long or to fuel development following cell fusion (and exposes them to potential predators and other dangers).

Logically, a "confederacy" of cells (an animal) could either produce egg cells, or sperm cells, or both. Once again, the specialization argument explains why the "either-or, but not both" option is the one that evolved in most animals. Producing egg cells requires different cell-division processes and makes different demands on the "confederacy" than producing sperm cells. Since egg cells are larger and contain more materials, they can only be produced in small numbers, whereas sperm cells can be made in huge numbers.

Once animals had differentiated into structurally and functionally different mating types (females and males), the differences between these two mating types affected the evolution of animals in many important ways. An important effect of this role specialization is sexual selection, which can only exist if there are separate and functionally distinct sexes.

It is not too far-fetched to assert that the anatomical and physiological differences between females and males (which date back almost a billion years), combined with the more recent effects of sexual selection among our primate ancestors, has resulted in the evolution of structurally and functionally different female and male bodies and minds. Furthermore, there are both theoretical and empirical reasons to infer that this distinction is firmly grounded in the biology of animal reproduction.

In the context of evolutionary psychology:

- Gender describes a behavioral role, whereas sex describes a biological role.

Gender and sex are related, but not necessarily identical nor directly "mappable" onto each other. Gender behaviors are not necessarily tied to biological sex. For example, transvestites and transgendered people exhibit behaviors that are more often associated with members of the opposite sex. Nor are these distinctions limited to humans; there are many examples of "transgendered" behavior among other animals.

Evolutionary psychologists begin with the assumption that gender differences are partly innate and partly learned. To be more precise, gender roles are learned, but such learning is both facilitated and constrained by innate tendencies arising from the different evolutionary histories of females and males.

This viewpoint directly contradicts the Standard Social Science Model, whose supporters assert that there are no significant differences between female and male humans that are not learned via cultural conditioning. Recent empirical research has shown otherwise: Females and males differ in a number of characteristics, and these differences can be correlated with selective pressures arising from the biology and ecology of our evolutionary ancestors.

Almost no one would argue that there aren't any significant anatomical or physiological differences between females and males. But whether there are behavioral and cognitive differences between females and males is considerably more controversial. However, it should be clear by now that even if gender-specific behaviors are learned, the basic mechanism of imprinted learning—that is, an inherited tendency to learn certain types of behavior more easily and in specific ways in specific contexts—can still produce learned behaviors that have evolutionary significance.

Locating and procuring food is an essential activity in humans. Detailed analysis of the food procurement behaviors of living hunter-gatherers indicates that there is a significant gender-related difference in these behaviors. In general, females gather food resources, especially plants, by foraging in the near environment. By contrast, males hunt animals for food, often traveling long distances as they do so.

This implies that females should have different perceptual and orientation abilities than males, differences that can be empirically tested. Several different teams of researchers have tested the ability of females and males to recall the identity and location of objects in the near environment. In nearly all cases, females have demonstrated a significantly greater ability to find and remember the locations of such scattered and hidden objects.

Other tests have investigated whether there are differences between females and males in their ability to navigate and orient over long distances. In these tests, males have consistently demonstrated a significantly greater ability to navigate over long distances, and to orient themselves relative to “home.”

Living in social groups requires social skills, especially in communication. Investigations and psychological tests have generally indicated that females report feeling a greater intensity of emotion and express their emotions more easily and more often than males. Females also score higher than males in “agreeableness,” and also in feeling anxiety, anger, and depression.

Females tend to talk more at home and in one-on-one conversations, whereas males tend to talk more in larger social groups. Ethological studies of human conversations have also shown that females tend to converse face-to-face with more eye contact and closer physical adjustments of distance between speakers.

Females also tend to stick to single topics of conversation for longer periods of time, while males change subjects more often, and with fewer “warnings” of

topic change. Finally, females tend more often to express agreement, especially with group decisions and positions, whereas males are prone to debate over disagreements, and to remain obdurate longer in the face of social pressure.

There are also observable differences between females and males in types of cognition, and in overall patterns of social behavior. Females and males generally do not exhibit significant differences on intelligence tests. However, females on the average score higher on measures of verbal fluency and ability to empathize with others. Males tend to score higher on tests of mathematical ability and on ability to organize and categorize objects and ideas (often referred to as “systematizing”). Overall, females are generally happier than males, and express greater concern for family and personal values, whereas males on average express greater concern for political and wider social issues.

Males in most cultures also tend to have more social rights and corresponding responsibilities than females. This is particularly true in the context of religion, in which males are almost always found in dominant roles. However, this pattern of gender differentiation is also quite sensitive to cultural and subsistence patterns, a sensitivity that has evolutionary implications as well.

Males are generally more physically aggressive, and are more prone to taking risks (especially during and after puberty, but before they have fathered children). Although both females and males commit crimes, males commit the overwhelming majority of violent crimes, especially murder, and are much more likely to die violently than females. Females are somewhat more likely to attempt suicide, but males are much more likely to succeed in killing themselves.

Finally, and perhaps most importantly, males almost exclusively engage in group violence and organized warfare. Indeed, females play at most a supportive role in organized violence and warfare, while involuntarily suffering equal or even greater negative consequences from it. One last difference: When rape happens, it is males that forcibly rape females, both singly and in groups; females virtually never forcibly rape males.

## FOR GREATER UNDERSTANDING

### Questions

1. How does differential parental investment affect the evolution of female and male reproductive behavior?
2. In what ways are the reproductive strategies of females and males complementary and in what ways are they not?
3. What are the differences between female and male behavior and are these differences innate or learned or some combination of the two?

### Suggested Reading

Daly, Martin, and Margo Wilson. *Sex, Evolution, and Behavior*. 2nd ed. Belmont, CA: Belmont Publishing Company, 1983.

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The *New York Times* website provides an article from its Science section by Nicholas Wade from June 26, 2007, entitled "Humans Have Spread Globally, and Evolved Locally." —

<http://www.nytimes.com/2007/06/26/science/26human.html?pagewanted=1>

## Lecture 9

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### Sex Lives of the Vertebrates

The Suggested Reading for this lecture is Olivia Judson's *Dr. Tatiana's Sex Advice to All Creation: The Definitive Guide to the Evolutionary Biology of Sex*.

**E**volution by natural selection is all about love (or, more properly, sex) and death.

- Natural selection is the result of unequal, non-random survival and reproduction.
- Adaptations evolve because individuals who survive and reproduce more often than others pass on the traits that made such survival and reproduction possible, thereby becoming more common in populations over time.

The sum total of all of the heritable characteristics of a living organism is known as that organism's *phenotype*. Traditionally, the phenotype of an organism is usually considered to be its physical appearance: things like height and seed shape and eye color. However, the founders of the science of ethology also included behaviors.

The idea that behaviors are part of an animal's phenotype is central to the sciences of ethology and evolutionary psychology. According to this viewpoint, behaviors can be adaptations that have evolved by means of natural selection. Or, to be more precise, natural selection can result in the *capacity* for certain behaviors, which can therefore be considered part of the evolved phenotype.

To an evolutionary biologist:

- Sex is the exchange of genetic material between two (or more) organisms.

Defined this way, it should be clear that sex is not necessarily tied to reproduction, nor is it absolutely necessary.

- Bacteria generally do not have sex (that is, they don't exchange genetic material), and when they do, it isn't necessarily tied to reproduction.
- Among the more complex eukaryotes, especially animals, sex can be tied to reproduction, but just because two individuals exchange genetic material doesn't mean that they will successfully reproduce.

As anybody who has studied bacteria (or fungi, or plants) knows,

- It is possible to reproduce without having sex.

And, as anybody who has spent any time observing humans can tell you,

- It is also possible to have sex without reproducing.

Most people, when they think about sex, usually don't think about exchanging genetic material. They think about behaviors. Specifically, they think about those behaviors whereby genetic material from one individual is combined with the genetic material of another individual to produce another, genetically different individual. To a biologist, this process is known as *mating*.

If an organism pays absolutely no attention with whom it is mating, then such mating is random. However, mating is almost never random, especially among animals. This is because some individuals have a lot to lose if they do not discriminate between potential mates.

Which individuals have a lot to lose? *Females*, because, in general, females invest more energy, resources, and time in the production of offspring than do males. This asymmetry of parental investment is the basis for what evolutionary biologists call "female choice," and female choice is an essential part (perhaps the most essential part) of what Darwin called sexual selection.

- Females who discriminate between potential male mates are more likely to successfully produce and raise offspring.
- This is particularly true when females cannot successfully raise offspring without male assistance.

If females discriminate between potential male mates, then whatever characteristics females use to discriminate between males will become more common among their male offspring. The result of this process is sexual selection:

- Sexual selection is the increase in frequency of any characteristic (and its underlying genetic cause) as the result of non-random, unequal mating and reproduction.

This is the basis for what biologists call sexual dimorphism.

- Sexual dimorphism is a difference in the phenotypes (including behaviors) of females and males.

This is why, if there is a phenotypic difference between females and males in a species, it is generally the males that have the more exaggerated features (bright colors, big antlers, larger muscles, elaborate courtship displays).

- The greater the degree of sexual dimorphism in a species, the greater the amount of sexual selection (and usually female choice) that has shaped those differences.
- As the result of female choice, females shape the reproductive adaptations of males, including their anatomical and behavioral phenotypes, and especially their courtship and mating behavior.

Many evolutionary biologists, including Charles Darwin, believe that sexual selection differs in important ways from natural selection:

- Natural selection is the result of two demographic processes—non-random, unequal survival *and* reproduction—operating on heritable variations within populations.

- Sexual selection is the result of only *one* demographic process—non-random, unequal reproduction *alone* (usually as the result of non-random, unequal mating)—operating on heritable variations within populations.

Several significant milestones in the analysis of sexual selection:

- In 1882, Charles Darwin pointed out, in *The Descent of Man, and Selection in Relation to Sex*, that unequal reproduction is usually the result of female choice and provided numerous examples of adaptations resulting from sexual selection, particularly in males.
- In 1948, Angus Bateman analyzed the behavior of female and male fruit flies and traced the genetic effects of sexual selection using genetic markers. He found “an indiscriminatory eagerness in the males and a discriminatory passivity in females.”
- And in 1972, Robert Trivers defined sexual selection as “an investment by the parent in an individual offspring that increases the offspring’s chance of surviving (and hence reproductive success) at the cost of the parent’s ability to invest in other offspring.”

In his groundbreaking theory of parental investment and sexual selection, Trivers pointed out that females typically invest more energy, resources, and time in their offspring than most males do.

- Females who are discriminating in their choice of males will be selected *for*, but males who are discriminating in their choice of females will be selected *against*.
- Females can only successfully raise a relatively few offspring per lifetime, whereas the number of offspring that males can father is virtually unlimited.
- The result of this asymmetry is that males are more likely to successfully mate with more than one female than females are to successfully mate with more than one male.

Now we need to distinguish between two basic life-cycle adaptations: semelparity and iteroparity:

- *Semelparity* is a life-cycle adaptation in which an animal reproduces only once, usually dying shortly after mating.

Most semelparous animals produce very large numbers of offspring, for which they provide little or no parental care.

- *Iteroparity* is a life-cycle adaptation in which an animal reproduces several times during its life cycle, often (although not always) annually.

Most iteroparous animals produce relatively small numbers of offspring per reproductive cycle. Some iteroparous animals provide parental care, while others do not.



Theoretically, there are three basic mating systems—promiscuity, monogamy, and polygamy:

- *Promiscuity* is completely indiscriminate mating.

Darwin pointed out that promiscuity would usually be selected against, except in cases of “broadcast mating” (as in oysters).

- *Monogamy* is one female mating with one male.

There are several kinds of monogamy:

- *Lifelong monogamy* is mating with only one individual during an entire lifetime.
- *Serial monogamy* is mating with only one individual during a single reproductive cycle (often, although not always, a year).
- *Polygamy* is mating with more than one mate during a lifetime.

This definition of polygamy does not specify which sex is doing the multiple mating, unlike the more common use of this term among the general public, which usually refers to a man having more than one wife. Polygamy is *not* limited to males, and there are at least three distinct kinds of polygamy.

From a purely biological standpoint, serial monogamy is a form of polygamy, more correctly referred to as “vertical polygamy.” By the same logic, mating with more than one individual during *one* reproductive cycle is more correctly referred to as horizontal polygamy.

There are at least three types of polygamy—polygyny, polyandry, and polygynandry:

- *Polygyny* is having more than one *female* mate per male.
- *Polyandry* is having more than one *male* mate per female.
- *Polygynandry* is more than one female mating with more than one male.

This picture is complicated by several covert forms of mating, but we must first distinguish between reproductive versus social monogamy:

- *Reproductive monogamy* is a mating pattern in which a single female is the *genetic* parent of all the offspring from a single male.

In reproductive monogamy, females or males may provide their mates with food and reproductive sites, anti-predator defense, and so forth, but do not necessarily have to do so. However, they do contribute their genetic material to all of their mate’s offspring.

- *Social monogamy* is a mating pattern in which a female or male spends much or all of his or her time with a single mate (providing food, protecting against predators, and defending against rival mates), but does not necessarily mate exclusively with them.

It is important to point out that the individuals with which socially monogamous mates are paired do not necessarily mate exclusively with their apparent mates. In social monogamy, both females and males can (and often do) perform what are known as

- *Extra-pair copulations*: Copulation with individuals with which they are not necessarily socially monogamously mated.

In most cases, such extra-pair copulations are covert:

- Females, in particular, are very good at concealing their extra-pair copulations from their socially monogamous male mates.

It is also important to note here that:

- Examples of social monogamy with significant frequencies of both female and male extra-pair copulations are found in many birds and mammals, including humans.

Remember that female choice shapes the mating behaviors of males. Most people who think about it at all think that polygamy (or, more properly, *polygyny*) is shaped by the behaviors of males, not females. However, this is clearly not the case:

- Females make males polygynous by allowing them to mate with them.

Why do they do this? To paraphrase an aphorism of George Bernard Shaw,

- “It is better to have part of a successful male than all of an unsuccessful one.”

It is necessary to keep in mind the difference between mating and child rearing. Mating includes all behaviors associated with conception of offspring. Child rearing starts with conception and includes all behaviors associated with successfully raising offspring until they are capable of reproducing themselves.

This distinction is not always obvious, but it is extremely significant when analyzing reproductive behaviors.

The same distinction can be made between mating and child rearing. What we refer to as “love” really has two biologically different forms: the emotional motivations that result in mating behavior and the emotional motivations that result in child rearing. The first kind of “love” can be thought of as something like *infatuation*: the obsessive and sometimes painful desire to mate with someone. The second kind of “love” can be thought of as a kind of *attachment*: the long-term and sometimes addictive desire to be with someone and to participate with them in the successful raising of offspring. These two kinds of “love” are not as simple as they appear, and involve surprisingly different sets of behavioral adaptations, which may or may not be complementary.

## FOR GREATER UNDERSTANDING

### Questions

1. Are natural selection and sexual selection fundamentally different processes, or two different aspects of the same process?
2. Why is it that, according to the theory of sexual selection, female choices of potential mates shape the phenotypes (including the mating behaviors) of males?
3. Why are both females and males usually motivated to have more than one mate?

### Suggested Reading

Judson, Olivia. *Dr. Tatiana's Sex Advice to All Creation: The Definitive Guide to the Evolutionary Biology of Sex*. New York: Holt Paperbacks, 2003.

### Other Books of Interest

Darwin, Charles. *On the Expression of Emotions in Men and Animals*. Penguin Classics. New York: Penguin, 2009.

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### Articles of Interest

Bateman, A.J. "Intra-sexual Selection in *Drosophila*." New York: *Heredity*, vol. 2, pp. 349–368, 1948.

Sillén-Tullberg, Birgitta, and Anders P. Møller. "The Relationship Between Concealed Ovulation and Mating Systems in Anthropoid Primates: A Phylogenetic Analysis." Chicago: *The American Naturalist*, vol. 141, pp. 1–25, January 1993.

### Websites of Interest

1. *Science* magazine and the American Association for the Advancement of Science provide a presentation by Professors Stephen F. Schaffner and Pardis C. Sabeti (Broad Institute of MIT and Harvard) entitled "Examining Natural Selection in Humans." — <http://science.cnpq.com/lasca/webinar/sabetischaffner/20060626>
2. *The Complete Work of Charles Darwin Online* website provides first edition versions of his writing. — <http://darwin-online.org.uk>

## Lecture 10

### The Evolution of Human Sexuality

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The Suggested Readings for this lecture are David P. Barash and Judith Eve Lipton's *Myth of Monogamy: Fidelity and Infidelity in Animals and People*, Sarah Blaffer Hrdy's *Woman That Never Evolved*, and Donald Symons's *Evolution of Human Sexuality*.

**S**exual selection based on female choice drives the evolution of polygyny in most vertebrates.

And so, the burning question becomes, "What are humans: monogamous or polygamous?" In Western culture, the answer provided by both society and the overwhelming majority of individuals was, until very recently, "Monogamous, of course!" This was true despite clear historical evidence that this was not always the case.

Monogamy as a social rule in Western culture seems to have coincided with the rise of urban culture in the city-states surrounding the Mediterranean about three millennia ago. Today, this is what most people in the West say they are, but what are most people *doing*, and *why* are they doing it?

Until recently, the prevailing opinion was that humans were either "naturally" monogamous (at least, most were) or that they were "socially programmed" to be monogamous. Either way, the general assumption was that "humans *are* monogamous" (despite obvious exceptions). Furthermore, humans *ought* to be monogamous as well, either because their religion or society (or laws) said so, or because that was obviously the "best" way to be.

The first serious challenge to the assumption that humans *are* monogamous "naturally" was made by Donald Symons in *The Evolution of Human Sexuality* (1979). Symons based his analysis of the evolution of human sexuality on Trivers's theory of parental investment and sexual selection. Central to Symons's theoretical analysis was the idea that

... with respect to sexuality, there is a female human nature and a male human nature, and these natures are extraordinarily different ...

[because] the sexual desires and dispositions that were adaptive for either sex were for the other tickets to reproductive oblivion.

This is because males are in constant competition with other males for access to females, and females are in constant competition with other females to produce optimal numbers of offspring. While it is possible for females and males to have aligned interests, it is certainly not guaranteed. If it is possible for females to successfully raise their offspring with little or no help from a male, then there is no selective pressure for males to provide such help, and those males who father the most offspring with the largest number of females

will have higher reproductive success. Furthermore, this will happen even if the females and males in question do not know that their behavior affects their reproductive success.

A basic principle in evolutionary biology, and especially in evolutionary psychology, is that there are both *proximate* and *ultimate* causes for most adaptations, including behavioral adaptations.

- The *proximate cause* of a behavior is the specific sensory, nervous, motor, and hormonal activities that produce the behavior.

For example, in most animals (and certainly in humans) the reason that both females and males court and eventually copulate is because it generally feels good. That is, the sensory, nervous, motor, and hormonal systems of females and males produce physical sensations during courtship and copulation that are strongly positively reinforcing. Each step in the chain of behaviors encourages the participants to perform the next step, with the outcome that copulation is successful, the female becomes pregnant (or “gravid”), and in the fullness of time the female produces offspring. Once the offspring are produced, they generally perform behaviors (and have physical and chemical characteristics) that encourage their parent (or parents) to provide them with sufficient resources to develop into sexually mature adults themselves.

Nowhere in this entire chain of events is it necessary for any of the participants to know or understand that their actions, if performed correctly, will have the effect of producing fertile offspring that will develop to sexual maturity and produce fertile offspring themselves.

- The *ultimate cause* of a behavior is the particular evolutionary process by which the behavior came to be, including (but not necessarily limited to) natural and sexual selection.

For example, in all animals (and certainly in humans) the reason that females and males court and eventually copulate is that in the past those individuals that did so, and did so well, survived and reproduced more often.

To make an analogy, the proximate cause for arriving at Grandma’s house for dinner is the chemical and mechanical processes that cause the family car to move on down the highway. In biological terms, these are the sensory, nervous, motor, and hormonal processes that cause the behaviors to happen.

By contrast, the ultimate cause for arriving at Grandma’s house for dinner is the driver of the car. In biological terms, this is natural and sexual selection working over many generations of organisms, preserving those proximate mechanisms that have the effect of maximizing reproductive success.

In long-lived animals such as humans, gestation takes a long time, and therefore fertilization and birth are separated by long periods of time, during which quite a lot can happen. Therefore, it is probably just as well that the proximate causes of behavior, including sexual behavior, work as well as they do. Natural selection, although it has the long-term effect of producing evolutionary adaptations,

can only work directly on organisms through proximate mechanisms. Indeed, there are reasons to believe that in humans, knowledge of the evolutionary implications of one's actions can inhibit behaviors that are encouraged by proximate mechanisms. Therefore, it is likely that the various behaviors that women and men perform in the course of courtship and copulation are driven by proximate processes, and neither require the conscious intent of producing offspring, nor even produce any awareness of that ultimate effect at all.

Keeping this in mind, let's now look at Donald Symons's findings and conclusions vis-à-vis the evolution of human sexuality.

- First, Symons asserted that *evolutionary explanations of human sexuality are "value free."* It is important to keep in mind this basic principle of evolutionary psychology: Just because a behavior is a certain way, doesn't not necessarily mean that it *ought* to be that way.
- *Humans, like virtually all other animals, do not mate promiscuously.* Both males and females are harmed by indiscriminate mating, especially females.
- *Intrasexual competition is generally much more intense among males than females.* In pre-agricultural societies, male-male competition over females is the most common cause of male-male violence.
- *Males are more likely to be polygynous than monogamous, whereas females can accommodate to monogamous, polygynous, polyandrous, and polygynandrous circumstances.* These refer to mating behavior, but not necessarily to the production of offspring. In other words, males seek to have multiple sex partners, regardless of whether this results in more children. By contrast, so long as they can be successfully raised, females are relatively indifferent to how many fathers they have for their children.
- *Males almost universally experience sexual jealousy of their mates, whereas females can generally accommodate to their mate(s) having other mates.* This is because males who tolerate their mates copulating with other males father fewer offspring, whereas if females can successfully raise their offspring, it doesn't matter who else their mates are mating with.
- *Males are more likely to be sexually aroused by visual stimuli, especially the sight of female sex characteristics (and especially genitals), whereas females are more likely to be sexually aroused by sexual fantasies and stories.* This conclusion is strongly supported by observations of the kind of pornography preferred by males (visual, with minimal narrative) versus females (narrative, even if not visual).
- *Physical features of females, especially those indicating youth and health, are most sexually arousing for males, whereas characteristics indicating influence and power (but also care and nurturance, especially for children) are more attractive to females.* Males who mate with young, healthy women father more children, whereas females who mate with males that can provide resources for their children have more success doing so.

- *Males are more likely to seek and to be gratified by sexual variety than females.* The more females a male mates with, the more children he will have, whereas multiple mates do not generally mean more children for females because of their relatively limited reproductive capacity.
- *Orgasms are an adaptation in males, but probably an accidental side-effect in females.* The inability to orgasm is sterilizing in males, but unless orgasm increases fertility in females, it is neither selected for nor against.
- *Unlike most other mammals, human females do not show outward signs of ovulation.* Notably, Symons does not present a strong evolutionary explanation as to why this might be the case.
- *In virtually all human societies, copulation is viewed as a service that females provide to males, rather than vice-versa.* This is both an observed pattern in human societies, and a consequence of the other effects already enumerated.

Like many other evolutionary psychologists, Symons also asserted that *the foregoing behavioral adaptations for sexual behavior in humans probably evolved during the Pleistocene, and have not changed significantly since then.* This is because the Pleistocene lasted a very long time (millions of years), long enough for natural and sexual selection to adapt our ancestors' sensory, nervous, and motor systems, whereas there has not been sufficient time (less than forty thousand years) since then for this to happen. An important implication of this view is that our behavior today may not "make sense" under current conditions, especially in the context of the recent development and use of artificial contraceptives and the development of human societies characterized by large, relatively mobile populations and resulting anonymity.

Symons concluded that *the human mind is largely a product of evolution by natural and (especially) sexual selection, rather than pure learning as asserted in the Standard Social Science Model.*

- *In particular, the mind (and the behaviors it produces and guides) is driven and guided by emotions, rather than the other way around.*

Symons's pioneering work was both widely praised and just as widely condemned. Symons's book was primarily theoretical, providing a coherent set of testable hypotheses for the evolution of human sexuality, supported by empirical information if it was available. By and large, such empirical support was not available, since this kind of frank examination of human sexuality had not been done up until then. Furthermore, most scientists assumed (as did most of Western society) that monogamy was both "natural" and "universal," and polygamy was "abnormal."

Symons's book stimulated an avalanche of new studies into animal and human mating systems. In 1981, Sarah Blaffer Hrdy published *The Woman That Never Evolved*. Hrdy began her book with an analysis of the asymmetry between female and male parental investment. Although she seemed intent

on challenging the views of Symons and other male sociobiologists, in this chapter, at least, she came to essentially the same conclusion as Trivers: that the asymmetry between female and male parental investment selects for different sexual behaviors in females and males.

Much of Hrdy's book is a catalog of female behavior in non-human primates. Much of this section of the book is taken up with providing examples of monogamy among primates, in contrast apparently with Symons's emphasis on polygamy, and especially male polygyny. Hrdy also pointed out that female primates seem not to compete with each other anywhere near as often or as intensely as primate males do.

The centerpiece of her book is an in-depth discussion of a behavior pattern that Hrdy herself is credited with discovering and analyzing: infanticide by males in polygynous primates. During field work studying Hanuman langurs in northwest India, Hrdy observed a consistent pattern of infanticide among the polygynous groups of langurs living in and around a school for the blind. Groups of langurs, usually referred to as troupes, consist primarily of females and their young, with usually a single dominant male that mates with most or all of the sexually mature females in the troupe.

Males often compete with other males, especially young males from outside a troupe challenging older males for dominance. If a usurping male manages to displace the dominant male, he then kills all the nursing and immature infants. This causes the females to stop nursing and to begin reproductive cycling, at which point the new male impregnates them.

Although it seems quite ghoulish, such infanticide has a straightforward evolutionary explanation: The males that do this have more offspring than males that do not. Indeed, *a male that kills the offspring of the former master of a troupe lowers his rival's fitness while simultaneously raising his own.* Hrdy also points out that females rarely intervene in this behavior, as their own sons by the dominant troupe leaders also benefit from this same behavior pattern.

Hrdy's discovery was once controversial, but the evidence from extensive natural history data collected since the 1970s has confirmed her hypothesis. This pattern has now been found in many species of primates, and in many other mammals. So common is infanticide by newly established dominant males, that behaviors once thought odd or perverse are now subsumed under the general phenomenon of "non-paternal male infanticide."

Hrdy concluded her book with an argument against Symons's suggestion that the female orgasm is not adaptive. However, a close reading reveals that Symons doesn't actually claim that female orgasm is non-adaptive, only that there is little evidence either way. Hrdy herself points out that not all women orgasm—statistically between 30 and 50 percent do not, or do not consistently. However, she does not present evidence to indicate how female orgasm could function as an adaptation, for example, by increasing the probability of fertilization by altering sperm uptake.



Hrdy's point in writing *The Woman That Never Evolved* appears to have been threefold:

1. To point out that monogamy does exist, at least among some primates.
2. To show that polygyny has what we would consider negative consequences, especially a tendency toward non-paternal male infanticide.
3. To suggest that female human orgasm may not be entirely non-adaptive (although it is not clear what alternative she has argued for).

The title of her book refers to her assertion that, since there is little evidence that females in other primate species have either competed for dominance, formed strong cooperative groups, defended their offspring against the depredations of dominant males, or evolved a consistent ability to orgasm, if human females want to accomplish these things they will need to do it . . . well, “unnaturally,” I guess.

While this conclusion resonates with the idea that our evolved “nature” does not and cannot give us our ethics, on retrospect Hrdy's only lasting contribution to the understanding of the evolution of human sexual behavior is the suggestion that non-paternal male infanticide may be adaptive—a suggestion followed up by evolutionary psychologists, with predictably controversial results.

Her other apparent aim—to show that monogamy is not entirely unknown among primates (and, by implication, may not be “unnatural” for humans)—has not fared well at all. Indeed, subsequent natural history studies have so undermined the Victorian view of “natural monogamy” that sociobiologists David P. Barash and Judith Eve Lipton could with considerable justification title their 2001 book *The Myth of Monogamy: Fidelity and Infidelity in Animals and People*.

Extensive study of the mating patterns of many animals has shown that monogamy is by far the *least* common mating behavior in the kingdom Animalia. The overwhelming weight of the natural history data collected since 1980 tends to support the idea that multiple mating is the rule among both sexes in the vast majority of animals, especially vertebrates.

Barash and Lipton emphasized the mating behavior called “extra-pair copulation,” in which females and males copulate with another individual besides the one with whom they are “mated.” Using a wealth of examples, they showed that both females and males can increase their reproductive success by pursuing what is essentially a “mixed” mating strategy. Using an updated interpretation of Trivers's original theory of parental investment, Barash and Lipton showed that the observations of myriad extra-pair copulations among animals formerly thought to be monogamous can be explained in both females and males, but for different evolutionary reasons:

- For males, extra-pair copulations are strictly a “numbers game”; the more females a male can copulate with, the more offspring he will father. Therefore, males who inherit whatever behavioral tendency led

to their conception as the result of extra-pair copulation will pass this tendency on to their sons.

- For females, extra-pair copulations are part of a complex calculus of costs and benefits, all of which ultimately reduce to maximizing fitness among a limited number of offspring. Since females can only have a limited number of offspring, then for the tendency to seek extra-pair copulations to evolve would require that doing so would increase the probability that those offspring would have a better chance of survival. Barash and Lipton point out two ways this can happen: Mating with multiple males can increase the genetic variation between a female's offspring, and it can also result in obtaining resources from more than one male.

Two further benefits to females have since been suggested:

1. Mating with multiple males might confuse the males as to which male is the father, thereby forestalling non-paternal male infanticide.
2. Mating with multiple males can also set up the conditions necessary for sperm competition; if multiple mating is the rule, then those males who produce the largest quantity of the most viable sperm will father the most offspring, which will benefit the sons of females who encourage such competition.

For centuries, people in Western culture assumed that they, along with most other animals, were "naturally monogamous." This assumption was clearly not based on observation, but rather on what could be called "wishful ethicizing." Because the dominant moral code in Western culture prescribed monogamy, the "fact" that it was "natural" reinforced the moral code. Selectively noticing examples of apparent monogamy among non-human animals, while dismissing examples of polygamy as "perverse," or "unnatural," or (at best) "rare," was essentially reifying, rather than verifying that humans were also "naturally monogamous."

## FOR GREATER UNDERSTANDING

### Questions

1. Why did Donald Symons assert that “the sexual desires and dispositions that were adaptive for either sex were for the other tickets to reproductive oblivion”?
2. Under what circumstances does it make evolutionary sense for males to commit infanticide?
3. Why are “is” statements and “ought” statements logically separate, and what implications does this separation have for the science of evolutionary psychology?

### Suggested Reading

Barash, David P., and Judith Eve Lipton. *The Myth of Monogamy: Fidelity and Infidelity in Animals and People*. New York: Holt Paperbacks, 2002.

Hrdy, Sarah Blaffer. *The Woman That Never Evolved*. Rev. ed. Cambridge, MA: Harvard University Press, 1999 (1981).

Symons, Donald. *The Evolution of Human Sexuality*. New York: Oxford University Press, USA, 1981.

### Other Books of Interest

Trivers, Robert L., *Natural Selection and Social Theory: Selected Papers of Robert Trivers*. New York: Oxford University Press, USA, 2002.

Wright, Robert. *The Moral Animal: Why We Are the Way We Are: The New Science of Evolutionary Psychology*. New York: Vintage, 1995.

### Websites of Interest

1. The *Salon* magazine website provides an article by David P. Barash from January 23, 2001, entitled “The Myth of Monogamy.” —  
<http://www.salon.com/sex/feature/2001/01/23/monogamy>
2. The *New York Times* website features articles about polygamy in its “Times Topics” section. —  
<http://topics.nytimes.com/topics/reference/timestopics/subjects/p/polygamy/index.html>

## Lecture 11

### Monogamy and Polygamy

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**The Suggested Reading for this lecture is David P. Barash and Judith Eve Lipton's *Myth of Monogamy: Fidelity and Infidelity in Animals and People*.**



Are humans monogamous or polygamous?

Before answering this question we need to ask another question: How would one go about finding an answer to this question? And what do we mean by “humans”? One way to answer both of these questions is to ask people what they are doing. However, this depends on people telling the truth, and this is a problem when it comes to sexual behavior; not only because there are strict codes of what kinds of sexual behavior are right and wrong, but also because self-disclosure on questions like this can be used by others to categorize people.

One way to get answers is to use anthropological data collected by field anthropologists who have asked people what they are doing and carefully observed what they are doing to see if it conforms to what they say they are doing. Data like this has been collected from many different cultures over the past century. However, not all of it has been collected and analyzed for cross-cultural patterns such as the one we are interested in here.

The largest cross-cultural database of anthropological information is the Human Relations Area Files, established in 1949 and maintained at Yale University. According to these files, out of the human cultures studied, the percentages of “socially acceptable” and/or “encouraged” mating patterns are as follows:

*Polygyny* (one male with multiple female mates) comprises 83 percent of all independently described human cultures. These specifically include cultures and societies in which having more than one wife is either encouraged or at least socially allowed. A significant fraction (about 20 percent) of such societies practice sororal polygyny, in which a male mates with two or more sisters.

Polygyny is (or was, until recently) common in most of sub-Saharan Africa, southeast Asia, pre-colonial Australia, pre-Columbian North and South America, Polynesia and other Pacific islands, and most of the Middle East. Only a minority of males in such societies were/are polygynous, with the degree of polygyny usually being directly correlated with socioeconomic status and political influence.

*Monogamy* (one male with one female mate) comprises only 16 percent of all independently described human cultures. These specifically include cultures and societies in which monogamy is either serial or life-long.

Monogamy has been common only in Europe and its colonies (colonial and post-colonial North and South America and Australia), and parts of the Middle East (post-exilic Israel). The majority of males and females in these societies are monogamous, but there are significant frequencies of covert extra-pair copulations. Given that serial monogamy is actually vertical polygamy, only a small minority of human cultures are monogamous, and then not all of the members of those cultures practice it.

*Polyandry* (one female with more than one male mate) comprises less than 1 percent of all known human cultures, and even then it is sometimes problematic to determine if the actual mating system is indeed polyandrous. Polyandrous cultures include societies in which having more than one husband is either encouraged or at least allowed under special circumstances. Most known polyandrous societies practice fraternal polyandry, in which a female usually mates with two or more brothers.

Polyandry is currently and apparently has been very rare among humans. The only documented polyandrous human cultures are in Himalayan Nepal and Tibet, and isolated groups in southern India. Lewis Henry Morgan (and Frederick Engels, among others) suggested that polyandry was the “prehistoric” mating pattern in humans, but this idea has not been supported by historical or anthropological evidence.

Polygyny is not a category formally recognized by contributors to the Human Relations Area Files, as no known human society recognizes “group marriage” as a legitimate or socially acceptable (that is, overt) mating system.

However, *covert* polygyny is a phenomenon that has existed since prehistory. The question is not, “Do human females and males have multiple mates?” but rather, “How often and under what circumstances do human females and males have multiple mates?” This question is not easy to answer, because such behavior is almost always kept hidden.

Demographic studies have indicated that the frequency of covert female extra-pair copulations that result in offspring ranges from less than 2 percent to greater than 55 percent, depending on locality, economics, and social group.

In groups with “high paternity confidence,” the frequency of covert female extra-pair copulations that result in offspring ranges from less than 1 percent (among Sephardic Kohanim) to about 11 percent (among Mexicans). In general, groups with “high paternity confidence” are from higher socioeconomic levels.

In groups with “low paternity confidence,” the frequency of covert female extra-pair copulations that result in offspring ranges from less than 15 percent (among urban Russians) to greater than 55 percent (among Americans who have used medical clinics to determine paternity). In general, groups with “low paternity confidence” are from lower socioeconomic levels.

Overall, the frequency of covert female extra-pair copulations that result in offspring averages around 4 percent. While this number may seem low,

consider that this means that in the United States alone approximately twelve million people are *not* the genetic offspring of the person who thinks he is their father.

Since not all matings result in offspring, these frequencies are therefore *minimum* estimates. The actual rates of covert extra-pair copulations are clearly higher . . . probably much higher.

- Conclusion: A significant fraction of both female and male humans are polygamous.

That said, it is likely that females and males have different evolutionary reasons for favoring polygamy:

- *Females* are motivated to perform extra-pair copulations because the offspring of such matings exhibit more genetic variation than the offspring of a single male.

Increased genetic variation is positively selected in variable environments. This is especially true when the extra males with whom the females mate have heritable characteristics that increase the reproductive success of their offspring (especially the ability to get many females to mate with them).

- *Females* are also motivated to perform extra-pair copulations because they may obtain resources from males who are not their mates.

This is particularly the case when females can conceal the paternity of their offspring from their partners. Sillén-Tullberg and Møller (1993) have argued that concealed ovulation began as a female strategy to allow females to mate with several males and avoid the danger of retributive infanticide. Once established, a female could choose a caring male with good access to resources and use concealed ovulation to ensure his continued commitment. She could also seek matings with other males, confident that her partner would raise any subsequent offspring as his own. This may also explain why human females have permanently enlarged breasts, as it is then difficult for a male to assess when she has ceased lactation and is ovulating again, or when she is in the early stages of pregnancy.

With males it's much simpler:

*Males* are motivated to perform extra-pair copulations because doing so results in increased numbers of offspring.

As mentioned earlier, American mating patterns approximate what is often called "serial monogamy." But what exactly do we mean by this? A demographic study of human sexual behavior in America was carried out in the early 1990s. Although the authors of this "Sex in America study" claimed that their findings (primarily statistical) indicated that Americans are overwhelmingly monogamous, the data reveals just the opposite. If one considers "serial monogamy" as a socially acceptable form of vertical polygamy, then the following percentages of Americans are polygamous:

*Males* who have mated with more than one female = 77 percent.

*Females* who have mated with more than one male = 65 percent.

*Americans* who have mated with more than one person = 72 percent.

In other words, the most reliable demographic data (including census data) indicates that “serial monogamy” (in the form of serial divorce and remarriage) is now the statistical majority pattern of marriage in the United States and much of western Europe, Japan, and other developed nations.

Since the publication of the *Sex in America* study, more in-depth investigation has shown two trends:

The frequencies and trends described above are increasing, both in America and worldwide.

The frequencies listed above are probably underestimates, especially for females. Recent studies in England have shown that females are more likely to under-report the number of sexual partners they have had, whereas males overestimate the number of sexual partners they have had.

Although no single cause for these trends has yet been identified, there are clear correlations with economic and historical forces and events:

Dramatic increases in divorce rates in the twentieth century have been correlated with wars.

Increases in divorce rates have also been correlated with institution of social welfare policies, especially those under which unmarried females are provided with long-term child support indexed to the number of children.

To an evolutionary biologist, the term “serial monogamy” is an oxymoron. It makes no evolutionary difference whether one currently has several mates, or has had several mates in series. The outcomes are the same: offspring with more than one mate.

- It makes more sense to call what Americans, Europeans, and others are doing “vertical polygamy”: “vertical” meaning “separated by time” and “polygamy” meaning having more than one mate.

Beginning in 1990 and ending in 1995, I performed a pilot study into the dimensions of vertical polygamy in the United States. Data collected were almost entirely derived from questionnaire and interview results. Subjects were chosen using random sampling techniques. Unfortunately, difficulties in collecting data meant that the sample size was insufficient to draw conclusions applicable to the United States population as a whole. However, the correlations were sufficiently strong to suggest the following:

- Rates of vertically polygamous mating generally agreed with those derived from the *Sex in America* study and other studies.
- Both females and males are vertically polygamous, although at slightly different rates.

- Males divorce and remarry more often than females.
- Males remarry with younger females and have more children with each subsequent mate.
- Females remarry with older males and have fewer (often no) children with each subsequent mate.
- Reproductive rates of females and males approximate those of polygamous Mormons in nineteenth-century Utah, although with lower overall numbers of offspring.
- The degree of reproductive asymmetry (“skew”) is *greater* among twentieth-century Americans than among nineteenth-century Mormons. This is paradoxically because people have fewer children now than in the nineteenth century. Therefore, every child represents a larger percentage of the total today than in the nineteenth century.

These results have the following evolutionary implications:

- Female and male Americans are both motivated toward polygamy, although at different rates and probably for different underlying evolutionary reasons.
- These mating patterns are correlated with the disintegration of the nuclear family, the relative impoverishment of women (compared with men), and increased social pathology (especially in urban areas).

In addition, I was able to draw some correlations between divorce rates and socioeconomic level. These correlations are similar to those found in other studies, and shed light on the forces driving the demographic changes in divorce and remarriage in America and worldwide.

The first correlation was that the higher a man’s socioeconomic level, the more likely he was to divorce, to remarry, and to have children with his second and subsequent wives. Divorce and remarriage rates were also correlated with socioeconomic level in women, but significantly the rate of having children with second and subsequent husbands was not. In other words, the more resources a man controls, the more likely he is to have multiple wives and increased relative numbers of children. This pattern is the same as that for horizontal polygyny, as shown by multiple demographic studies of polygyny in west Africa, Polynesia, and other locations where polygyny is open and socially acceptable.

Wealthy and powerful men and women are also more likely to have public extra-marital affairs. This is not simply because their lives are more visible; there is an actual increased frequency of such behaviors among the wealthy and powerful.

Many historical figures, including British Admiral Horatio Nelson, artist Pablo Picasso, composer Richard Wagner, philosopher Friedrich Nietzsche, and poet Ezra Pound are known to have had long-term *ménage-a-trois*



relationships, and the theme of “threesomes” is widely used in advertising, fiction, movies, and television.

There is even a social movement, similar to the “gay pride” movement, whose supporters demonstrate publically for the widespread acceptance of polygamous relationships. Because of the negative connotations of the term “polygamy,” these activists call their preferred form of multiple relationships “polyamory.” Not only is polyamory a widespread phenomenon, it is also a political movement that aligns itself with the recognition of gay marriage and the removal of government from private relationships.

Polygamy exists today, and there are many indications that it is increasing in both frequency and acceptance worldwide. As long as the economic and social conditions that have resulted in the current trend toward vertical polygamy persist, polygamous mating patterns will also persist and almost certainly increase in the United States and the rest of Western culture. Therefore, I make the following predictions:

- The frequency of extra-pair copulations among Americans will continue to increase until it reaches a new equilibrium (parameters as yet undefined).
- As the trend intensifies, there will be increased political support for modifications to legal and social sanctions against polygamy, resulting in political efforts to legalize polygamy in one or more states within the next ten years (such proposals have already been made, but have so far been unsuccessful).
- If some form of polygamy is legalized in one or more states, polygamy in those locales will evolve in patterns similar to those in social monogamy.
- In particular, economically and socially preeminent individuals of either sex will become positively identified with polygamy and a stable polygamous lifestyle.

# FOR GREATER UNDERSTANDING

## Questions

1. Is polygamy increasing or decreasing worldwide?
2. What is the correlation between divorce, remarriage, and socioeconomic status?
3. How might polygamy become as socially acceptable as monogamy in Western society?

## Suggested Reading

Barash, David P., and Judith Eve Lipton. *The Myth of Monogamy: Fidelity and Infidelity in Animals and People*. New York: Holt Paperbacks, 2002.

## Other Books of Interest

Baker, Robin. *Sperm Wars: The Science of Sex*. New York: Basic Books, 1996.

Constantine, Larry L., and Joan M. Constantine. *Group Marriage: A Study of Contemporary Multilateral Marriage*. New York: Macmillan, 1973.

Fisher, Helen E. *Anatomy of Love: A Natural History of Monogamy, Adultery, and Divorce*. New York: Simon & Schuster, 1992.

Foster, Barbara, Michael Foster, and Letha Hadady. *Three in Love: Ménages à Trois from Ancient to Modern Times*. Bloomington, IN: iUniverse, 2000.

Goode, William Josiah. *World Changes in Divorce Patterns*. New Haven: Yale University Press, 1993.

Michael, Robert T., John H. Gagnon, Edward O. Laumann, and Gina Kolata. *Sex in America: A Definitive Survey*. New York: Little, Brown, 1994.

Riley, Glenda. *Divorce: An American Tradition*. Lincoln, NE: University of Nebraska Press, 1997.

## Articles of Interest

Anderson, K.G. "How Well Does Paternity Confidence Match Actual Paternity? Evidence from Worldwide Nonpaternity Rates." Chicago: *Current Anthropology*, vol. 48, no. 3, pp. 511–518, 2004.

## Websites of Interest

1. The Human Relations Area Files, Inc. (HRAF) is an internationally recognized organization in the field of cultural anthropology. The mission of HRAF is to encourage and facilitate worldwide comparative studies of human behavior, society, and culture. — <http://www.yale.edu/hraf>
2. The Home Box Office (HBO) television series *Big Love* "explores the evolving institution of marriage through this typically atypical family." — <http://www.hbo.com/big-love/index.html>

## Lecture 12

### Attraction, Courtship, and Mating

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**The Suggested Reading for this lecture is Helen E. Fisher's *Why We Love: The Nature and Chemistry of Romantic Love*.**

**S**exual reproduction in mammals can be divided into three stages: courtship and mating, attachment, and child rearing.

However, we haven't actually discussed how it is that humans manage to mate with each other: how we pick out a likely candidate for a mate, how we court such a candidate, how such courtship eventually leads to the underlying evolutionary focus of mating—copulation and fertilization—and how these then translate into making babies and raising them up to become sexually mature adults.

As Donald Symons pointed out in *The Evolution of Human Sexuality*, males should be attracted to younger females that have physical features that indicate that they are healthy, because these traits are indicators of higher potential female reproductive success. Females, on the other hand, should be attracted to older males that have behavioral and physical cues that suggest that they will be able to provide resources and, ideally, quality child care to the limited numbers of babies that the females can produce.

Notice that these predispositions on the part of males and females are complementary: Older males prefer younger females, and vice-versa. Notice also that this means that two classes of people—younger males and older females—are predicted to fare less well in the competition to produce viable offspring. Of these two categories, younger males have better prospects in general, as they will eventually mature and command more resources (and perhaps learn how to be more solicitous parents).

Older females, however, are not entirely out of options; if they have already successfully raised children, they can still assist their children in raising their grandchildren, thereby increasing their overall reproductive success. However, females that reach the age of menopause without reproducing in general become “invisible” to selection from an evolutionary standpoint. Therefore, those females that “hear the reproductive clock ticking,” and especially those for whom its ticking grows louder with age, are selected for over those who don't hear the clock ticking at all or who, for whatever reason, ignore it.

Over the past few decades, evolutionary psychologists have conducted considerable research to determine if these predictions are valid, and what kinds of sensory, cognitive, and behavioral patterns are correlated with increased relative reproductive success. In particular, considerable research has been conducted in precisely what characteristics males and females find most

attractive; that is, which cues provide the most reliable information about reproductive quality. Most of these studies have been specifically focused on attractiveness, that is, those anatomical and behavioral characteristics that result in the highest intensity courtship behaviors and, ideally, the highest relative reproductive success.

Donald Symons pointed out that “the sexual desires and dispositions that were adaptive for either sex were for the other tickets to reproductive oblivion.” This is particularly true for attractiveness: Females and males differ significantly in their primary and secondary sex characteristics. These differences are correlated with different behavioral and physiological adaptations. Since females and males are predicted to cue in on different qualities in a prospective mate, it is likely that the anatomical, behavioral, and physiological cues they consider to be most attractive will be different as well.

David Buss, one of the founders of the science of evolutionary psychology, has summarized the characteristics that females should find most attractive, given the predictions discussed earlier:

1. *Cues indicating a male's ability to invest in raising offspring.* These include age, ambition, control of resources, industriousness, social status, and strength.
2. *Cues indicating a male's willingness to invest in raising offspring.* These include behavioral cues indicating affection, commitment, dependability, stability, and positive interactions with children.
3. *Cues indicating a male's ability to protect his mate and offspring.* These include age, courage, dexterity, health, physical strength, and size (especially height).
4. *Cues indicating a male's ability to care for his offspring.* These include dependability, emotional stability, kindness, and positive interactions with children.
5. *Cues indicating a male's compatibility as a mate.* These include similar ages, similar personalities, and similar values.
6. *Cues indicating a male's overall health and longevity.* These include age and physical condition, clear skin, dexterity, gait (as an indicator of locomotor health), and symmetry (especially facial symmetry).

There is abundant evidence that females in other species choose their mates on the basis of these cues. This is particularly true for females in polygynous species, as they generally cannot rely as much on the undivided attention of a successful male mate. Female mate choice has long been known to be correlated with such exaggerated male characteristics as long tails and bright plumage in birds (indicators of better nutrition and lower parasite loads) and body size and strength in most vertebrates.

Although more complex for humans, the same general trends are noticeable:

1. Territory size and command of resources are correlated with polygyny in humans, indicating that more women are willing to mate with men who command such resources.
2. However, since men in polygynous societies must spread their attention and resources over more women and children, many women (including many in societies that allow polygyny) choose to invest in males who demonstrate an ability and willingness to invest exclusively in their offspring.
3. The flip side is that if men (especially men with single female mates) perceive that their children are not actually theirs, they are more likely to either abandon or ignore them, or even harm or kill them.

Some women pursue an alternative strategy: choosing men that don't necessarily invest much in their children, but show clear signs of being reproductively successful nevertheless. The assumption is that if she can successfully raise them, her sons from such a male could inherit his characteristics, sometimes called the "sexy son" hypothesis. Indeed, the ideal strategy for a woman is to convince a "good provider" to care for her children, while having them fathered by a producer of "sexy sons." This also means that men who demonstrate that multiple women have found them attractive are more likely to attract even more women (up to a point, of course).

More important than any other single cue for women, compared with men, is economic and financial status of men. In all studies in all cultures, women rate economic and financial status significantly higher than men do.

David Buss summarized the findings of the largest study conducted on the subject: Women worldwide desire financial resources in a marriage partner more than men. Women also consistently rate social status higher than men, and in general rate older men more attractive than men their own age or younger. This is because, on average, the older a man is the greater his wealth, prestige, and social status (not to mention experience and intelligence).

However, women generally do not find very old men attractive (as their probability of surviving long enough to raise their offspring is lower), unless the men are extremely wealthy and the women can be reasonably certain of inheriting their money if they die. Last, but not least, among the cues indicating ability to provide resources is ambition and industriousness; once again, women rate these characteristics significantly higher than men.

Although women rate the foregoing characteristics much higher than men, the traits they rate the highest are love, kindness, dependability, and emotional stability. Interestingly, women also rate the tendency for men to express sexual jealousy very low. These cues correlate with personal satisfaction on the part of females, and also with males' suitability as parents. Women also find men who are attentive and kind with children more attractive than men who are indifferent or hostile to children.

Finally, although women do not rate physical characteristics as high as men,

they do show a significant preference for men who are taller, physically fit, and athletic. This preference is suspected of being a partial holdover from our Pleistocene past, in which such men could provide protection to women and their children, as well as being better hunters and workers. It is also significant to note that these characteristics are also positively correlated with the other cues that women use to rate potential mates, combining to produce a mutually reinforcing suite of male characters that are strongly correlated with reproductive success.

There is indirect evidence from developmental medicine that facial and body symmetry are positively correlated with health. In particular, facial and body asymmetry are indirect indicators of genetic abnormalities.

Demographic and studies analyses have confirmed that the preferences shown by women for potential male mates do indeed translate to higher rates of marriage. For example, women's responses to personal ads correspond very closely to the cues identified in surveys of preferences described above. Sociological studies also indicate that physically attractive women more often marry men with higher financial and social status.

However, these are only indirect confirmations. It isn't clear from the foregoing that the preferences listed actually translate into higher relative reproductive success of women and men. To see if this is the case, let's look at the characteristics that men use to choose their female mates.

Female reproductive success means getting a male to impregnate you and then, if necessary, getting a male to provide enough resources for your offspring to survive until they reproduce. Getting a male to impregnate a female is usually not difficult. The second part depends primarily on how abundant resources are in the local environment. If they are abundant, then as a female reproductive success is not as dependent on the mate's behavior as it might be in a poorer environment. This means that females who base their choice of male mates on their ability to provide resources for their offspring have the highest relative reproductive success.

For a male, reproductive success means getting a female to let him impregnate her and then, if necessary, providing enough resources for offspring to survive until they reproduce.

But which females should a male be most interested in? Males who can get a young, healthy female to mate with them have higher reproductive success than males who either can't get such females to mate with them or who mate with older or less healthy females.

Males that fulfill the criteria that females use to choose mates will have higher reproductive success than males that do not, and vice-versa. Males that command sufficient resources to help a female successfully raise her offspring, and who demonstrate that they are willing and able to provide such resources, will be chosen most often by females. And females that demonstrate through their

behavior (and appearance) that they are fertile and have the potential of producing many offspring will be preferred most often by males.

When surveyed concerning the criteria that they use to rate a potential mate, men rate youth and physical appearance much higher than women. Both men and women rate attentiveness, affection, kindness, and love highest when seeking a mate. However, from an evolutionary standpoint we are most interested in those characteristics in which there are significant differences.

For men, youth and appearance are the most important such variables:

- In cultures in which monogamy is the social norm, there is a significant age difference between men and women at first marriage, with men averaging around three years older than their (first) wife.
- This age difference is significantly greater in polygynous cultures, with men averaging more than five years older than their wives.
- This pattern holds for cultures in which “serial monogamy” (vertical polygamy) is the rule: Men are three years older than their first wife, five years older than the second, eight years older than the third, and so forth.
- Men who marry younger women have significantly more children (that is, higher reproductive success) than men who marry older women. Finally, the situation is the opposite for women; those who marry older men have higher reproductive success than those who marry very young men (especially in cultures in which male assistance is a requirement for successful child rearing).

Another testable prediction is that men should prefer to mate with women who are not already mated with other men (especially those who do not already have children). Again, demographic data support this prediction; men are more likely to marry women who have not yet married or had children.

The high value placed on virginity in some cultures makes evolutionary sense. In cultures in which paternity is not easily determined, men strongly prefer to mate with women who have not yet had sex with any other man (and therefore cannot have yet had, or be carrying, children fathered by another man).

Conversely, this means that women should prefer to mate with men who have already demonstrated that they are both fertile and willing and able to father children.

Besides virginity, what other cues can a man use to maximize his reproductive success? If there are anatomical characteristics that are correlated with future fertility, males who cued into such characteristics when pursuing a mate would have a higher probability of success. Two such characteristics have been identified and studied: waist-to-hip ratio and “feminized” facial structure.

Before puberty, both boys and girls have approximately identical waist-to-hip ratios: about 0.85 to 0.95. However, during puberty, female sex hormones

(especially estrogen) cause more fat to be deposited on the hips, and also cause the bones underlying the hips to change shape, thereby reducing the female waist-to-hip ratio. Studies conducted on men in many cultures have shown that men find a waist-to-hip ratio of about 0.70 to be maximally attractive, with lower waist-to-hip ratios rated as less attractive. Epidemiological studies have shown that female reproductive success also correlates with reduced waist-to-hip ratio, peaking at around 0.70. An interesting discovery in this regard was that American women rate even lower waist-to-hip ratios as attractive than men do, indicating a tendency to “overshoot” the “ideal” waist-to-hip ratio.

Elevated estrogen levels in women are also correlated with characteristic changes in the shape of the face: the jaw line is less pronounced, the distance from nose to chin is slightly less, and the ratio of the size of the eyes to the overall size of the face is larger. All of these characteristics are also correlated with higher ratings of attractiveness by men. Using computer morphing techniques, female photographs can be manipulated to produce different “feminine” and “masculine” ratios in facial structure. Men rate the most “feminized” faces highest, indicating an indirect preference for higher estrogen levels, while females rate “masculinized” faces somewhat higher, indicating an indirect preference for higher testosterone levels. Elevated estrogen and testosterone levels are correlated with higher reproductive success, thereby supporting the hypothesis that males and females are using such cues as indirect measures of potential reproductive success.

But what happens after someone has picked out a potential mate? Consider the potential dangers of choosing the wrong mate: Not only might they have lower actual reproductive success, but the process of mating itself can expose one to real threats.

The possibility of wasting precious resources, of contracting a sexually transmitted disease, and of physical and/or emotional abuse are all potential dangers. Indeed, physical contact of any kind carries with it a non-zero possibility of such dangers. We observe, in fact, that all animals (including humans) generally maintain what is referred to as an “individual distance” from other animals, a “cushion” of space.

Mating, however, involves copulation, which requires elimination of this protective “cushion.” Is there something that can overcome our evolved reticence at being physically touched by others?

In 1979 Dorothy Tennov published *Love and Limerence*, in which she identified limerence, a specific behavioral pattern correlated with the early stages of courtship and mating. Limerence is a behavioral adaptation that results in the breakdown of behavioral inhibitions and individual distance, leading to mating and copulation. Limerence is correlated with profound neurochemical changes in the nervous system, producing physiological, cognitive, and behavioral changes that increase the probability of mating, and especially copulation.



Tennov, a psychotherapist, discovered limerence by accident, observing that a significant number of her patients showed a similar pattern of behavior and cognition while “falling in love.” Central to the concept is the limerent object (LO): the person upon whom one’s limerence is focused. Tennov cataloged the following primary symptoms of limerence:

1. Overall emotional and psychological arousal, with altered appetite, cognition, and sleep patterns.
2. Intrusive thinking about the limerent object, especially when such thinking overshadows other thoughts and activities.
3. Acute longing for reciprocation by the limerent object, combined with acute sensitivity to any hint of such reciprocation.
4. Acute anxiety when uncertain about the feelings of the limerent object, often accompanied by intense shyness and confusion in the presence of the limerent object.
5. An aching in the chest or stomach when uncertainty about the limerent object’s feelings is strong.
6. Buoyancy and intense joy if the limerent object is perceived as reciprocating.
7. A strong tendency to emphasize the positive qualities (and minimize the negative qualities) of the limerent object.
8. Overall, limerence is characterized by extreme emotional lability, with abrupt mood swings from high to low and back, depending on relatively minor changes in perceived reciprocation by one’s limerent object.

Tennov also noted that, if limerence is reciprocated it generally decays over time, eventually disappearing within two to four years.

1. If limerence is not reciprocated, this time course may be lengthened, and if a mutually limerent couple is prevented from consummating their relationship, the intensity of limerence typically increases as well.
2. Reciprocated limerence virtually always involves sexual behavior, and especially copulation.
3. In general, the higher the frequency of copulation, the more rapid the decay of limerence.

Tennov suggested that limerence is an evolutionary adaptation that has the effect of increasing the likelihood of mating between mutually limerent individuals; however, Tennov did not test this hypothesis herself.

Limerence is essentially a state of heightened physiological arousal. Does it matter what causes this heightened physiological arousal? In 1974, Donald Dutton and Arthur Aron set up a deceptively simple experiment: A female confederate presented a brief survey to male students in one of two locations: at the center of a narrow, rickety suspension bridge crossing a deep

ravine and at the center of a wide, solid concrete bridge over a shallow stream. They then asked the male students to write a brief passage describing the female who presented the survey. Despite the fact that it was the same female presenting the surveys, the males who had met the female on the rickety bridge used significantly more sexually charged imagery than the males who had met the female confederate on the concrete bridge. They concluded that the heightened physiological arousal caused by being on the rickety bridge was unconsciously interpreted by the men as a state of sexual arousal. This outcome suggested that physiological responses—specifically, activation of the sympathetic nervous and hormonal systems—play an important role in mediating sexual attractiveness and preparation for mating.

More recently, Helen Fisher and her colleagues have studied the neurochemistry of courtship and mating and have identified three different types of love: lust, romantic love, and attachment. In this model of attraction, courtship, and mating, lust is approximately equivalent to attraction, especially sexual.

- *Lust*, in other words, is a state of sexual arousal triggered by the cues discussed earlier and focused on a particular individual.
- *Romantic love* corresponds with limerence, as defined by Tennov.
- *Attachment* is generally unlike either lust or romantic love, in that attached individuals become calmer and happier when in each other's physical presence, rather than aroused and labile. However, attachment is highly correlated with anxiety following separation to a degree that is greater than in either lust or romantic love.

Fisher and her colleagues have used functional magnetic resonance imaging (often called fMRI) technology to determine if specific brain regions are associated with the three different types of love. They have also looked for correlations between these types of love and changes in the concentrations of brain chemicals, called neurotransmitters, that transmit and modify messages in the nervous system. In both cases, they have found clear associations between brain activity, neurochemistry, and the behaviors and emotions described earlier. Furthermore, there are distinct gender-related differences; females react with different parts of their brains than men do when “falling in love.”

All three kinds of love are associated with nervous pathways in the brain that use specific chemical messengers:

- Lust involves elevated levels of the male hormone testosterone; indeed, sex drive is almost entirely mediated by testosterone, in both males and females.
- Romantic love is associated with elevated levels of dopamine, a mood-altering neurotransmitter also associated with the “high” of cocaine use.
- Attachment is associated with elevated levels of two hormones, oxytocin and vasopressin, also secreted by brain cells.

Finding specific areas in the brain that are associated with the three different kinds of love, and especially correlating those brain centers with specific neurotransmitters, is strong evidence that these three behavioral and emotional states are evolutionary adaptations. The construction and operation of anatomical and physiological adaptations such as these is directed ultimately by genes, the existence of which is ultimately the result of natural and sexual selection. Like other behavioral adaptations, the context within which one expresses such genes varies from culture to culture. However, there are some characteristics that are found in virtually all cultures, which is a strong argument that they are evolutionary adaptations.

Since natural and sexual selection both ultimately depend on differential reproductive success, it should not be surprising that those human behaviors associated with courtship and mating are the result of the expression of evolved psychological mechanisms. However, successful reproduction doesn't end with mating. Most land vertebrates provide some form of parental care, which increases the probability of survival of offspring. This is particularly the case for mammals. And, among mammals, primates are noted for providing parental care for an unusually long percentage of the life span.

# FOR GREATER UNDERSTANDING

## Questions

1. Why is limerence a time-limited phenomenon and what role does it play in human mating?
2. What is the relationship between brain chemistry and love, and why does this relationship exist?
3. Why is there more than one kind of “love,” and what roles do the various kinds of love have in human mating, attachment, and child rearing?

## Suggested Reading

Fisher, Helen E. *Why We Love: The Nature and Chemistry of Romantic Love*. New York: Holt Paperbacks, 2004.

## Other Books of Interest

Buss, David M. *Evolutionary Psychology: The New Science of the Mind*. 2nd ed. Boston: Allyn & Bacon, 2004.

Daly, Martin, and Margo Wilson. *Sex, Evolution, and Behavior*. 2nd ed. Belmont, CA: Belmont Publishing Company, 1983.

Fisher, Helen E. *Anatomy of Love: The Natural History of Monogamy, Adultery, and Divorce*. New York: Simon & Schuster, 1992.

Tennov, Dorothy. *Love and Limerence: The Experience of Being in Love*. 2nd ed. Lanham, MD: Scarborough House, 1998 (1979).

## Articles of Interest

Dutton, Donald G., and Arthur P. Aron. “Some Evidence for Heightened Sexual Attraction Under Conditions of High Anxiety.” Washington, DC: *Journal of Personality and Social Psychology*, vol. 30, no. 4, pp 510–517, 1974. (A pdf of this article is available at the Web address below.) —  
<http://www.fpce.uc.pt/nucleos/niips/novoplano/ps1/documentos/dutton&aron1974.pdf>

## Websites of Interest

1. *Time* magazine article entitled “Sexes: Let’s Fall in Limerence” from January 21, 1980, provides a factual, but humorous, look at limerence. —  
<http://www.time.com/time/magazine/article/0,9171,952554,00.html>
2. The *Dorothy Tennov: Independent Scholar* website maintained by her family provides her collected works, essays, and information on limerence research. — <http://www.tennov.com>
3. The *National Geographic* magazine website features an article entitled “Love—The Chemical Reaction” from its February 2006 issue. —  
<http://ngm.nationalgeographic.com/static-legacy/ngm/0602/feature2>

## Lecture 13

### Love, Attachment, and Child Rearing

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**The Suggested Reading for this lecture is Robert Karen's *Becoming Attached: First Relationships and How They Shape Our Capacity to Love*.**

ourtship and mating is only the first stage of successful reproduction among species that provide extensive parental care, especially primates. Not all animals provide parental care, and parental care is almost entirely restricted to iteroparous animals (animals that reproduce more than once during their lives).

Robert Trivers's theory of parental investment and sexual selection can be used to explain the evolution of semelparity and iteroparity. Semelparity is an adaptation that increases offspring survival at the expense of parental survival.

For example, female Pacific salmon invest so much of their own material resources (that is, body tissues) in producing so many relatively large eggs that they essentially deplete their bodily reserves and die of starvation. Upon reaching their upstream breeding grounds, male Pacific salmon invest virtually all of their bodily resources in building nests, courting females, and defending their nesting territories against other males, and so they also die once the eggs laid by the females have hatched. Indeed, once they have begun this process, the bodies (and especially the jaws) of male Pacific salmon become so modified that they can no longer feed themselves, and so they literally die of starvation once mating is over.

In general, semelparous animals provide little or no parental care and are not generally large or long lived. This means that the behavior of the offspring of semelparous animals is mostly innate, as there is little or no opportunity for offspring to learn from their parents.

Iteroparous animals, by contrast, do not invest all of their resources in one massive reproductive effort. Instead, many iteroparous animals invest some of their time and energy in raising their offspring. On the average, iteroparous animals are larger than most semelparous animals and also generally live longer. This means that the behavior of the offspring of iteroparous animals includes more learned components, as there is more opportunity to learn from parents and from personal experience. Also, because more offspring survive as the result of increased parental care, iteroparous animals generally have fewer offspring than semelparous animals.

Overall, there is a correlation between iteroparity, body size, and longevity, and an inverse relationship between these factors and numbers of offspring produced.

- Semelparous animals (of which many insect species are prime examples) are often small, have very short life cycles, and produce very large numbers of offspring, very few of whom survive to adulthood.
- Iteroparous animals (of which mammals are prime examples) are usually larger, have longer life cycles, and produce relatively few offspring, most of whom survive to adulthood.

There is a general trend among animals: *Larger animals live longer and have fewer offspring, to whom they provide parental care.* There is also a correlation between this trend and sociality: *The more social a species is, the more likely it is to also follow the trend toward larger size, longevity, fewer offspring, and parental care.* This correlation isn't absolute; there are many exceptions to it, especially among insects and other invertebrates. However, among vertebrates there is at least a modest correlation between sociality and the other characteristics listed.

For example, among the felids (that is, cats), the smaller felids are generally solitary, whereas the most social felid (the African lion) is also one of the largest cats. This relationship also holds among the canids (that is, dogs); the smaller canids (foxes, for instance) are solitary, whereas the larger canids (coyotes and wolves) are the most social canids.

Primates, especially humans, have delayed maturation, an adaptation that results from increased survivorship of pre-pubescent offspring. Primate societies are the most complex vertebrate societies, surpassed only by the colonial invertebrates and the extraordinarily complex eusocial insect societies. Furthermore, the correlation between body size, longevity, parental care, and sociality generally holds among the primates. Indeed, the largest and most long-lived primate also provides the most parental care and is the most intensely social: us.

One of the most distinguishing characteristics of primates is delayed maturation:

- Primates take much longer to reach sexual maturity (that is, adulthood) than most other animals, especially when body size is taken into consideration.

Very large mammals, such as elephants and whales, take many years to reach sexual maturity. However, this is at least partly due to the length of time required to reach the very large size at which sexual maturity takes place. Primates, especially humans, take longer to reach maturity than any other mammals of their size.

Animals that develop relatively quickly are called precocial, whereas animals that develop slowly are called altricial:

- *Precocial* offspring are able to feed themselves and move about under their own power within a relatively short time, often as soon as twenty-four hours after hatching or birth.
- *Altricial* offspring are unable to feed themselves and generally cannot move by themselves for a relatively long time.

Precocial development allows young animals to feed themselves and escape predators, but also exposes them to predators and other dangers at the same time. Altricial development prevents young animals from being exposed to dangers until they have grown and developed the ability to learn how to cope. Many social carnivores and virtually all primates have offspring that are altricial. By far the most altricial of all primates, indeed of all animals, are humans.

Parental care makes delayed maturation adaptive, as predicted by Trivers. Humans and other primates provide an extraordinary amount of parental care to their offspring. According to Trivers's model, parental care qualifies as a form of parental investment.

In primates, it is not uncommon for both males and females to provide parental care, which has the effects of reducing differences between the sexes as a result of sexual selection. For example, many of the smaller primates, such as marmosets and tamarins, exhibit relatively little sexual dimorphism and tend to be monogamous. However, there is an increase in sexual dimorphism and polygamy (especially polygyny) among the larger primates, reaching its greatest degree of differentiation between females and males in the great apes . . . and humans, of course.

Delayed maturation is adaptive among the primates because it allows for a longer period of time during which developing primates can adjust to their environment via learning. Indeed, delayed maturation and increased opportunities for social learning appear to be autocatalytic in primates; that is, increases in one tend to cause increases in the other. Primates live in an extraordinarily complex ecological and social environment, made more complex by the fact that primates live a long time. Longevity has the side-effect of selecting for adaptability during an organism's lifetime, rather than over the generations. *Again, longevity, delayed maturation, and increased reliance on learning (as opposed to innate behavior) are all tied together in the evolution of primates, reaching their apex in us.*

Attachment is a crucial mechanism in parental care, both during early childhood and following mating in adulthood. *Why* do primates provide so much parental care? and what is the underlying neurobiology?

The answer is that primates become "attached"; neurobiology and learning combine to make primates spend most of their time with each other.

- Attachment, therefore, is the tendency for two or more individuals to spend most of their time in very close proximity to each other, and to behave in highly cooperative and mutually supportive ways.

Attachment happens in three contexts in the lives of social animals: individuals become attached during the formation of social groups, females and males become attached during mating, and parents and offspring become attached during development. Of these, it is likely that parent-offspring attachment evolved first among animals. The other two forms evolved later, using the same neurobiological machinery, but adapting it to different circumstances.

Attachment is different from attraction and limerence.

- *Attraction* (what Helen Fisher calls lust) is a strong biological drive that causes individuals to approach each other and perform behaviors of “courtship,” behaviors that allow females and males to assess each other’s qualities as potential mates.
- *Limerence* (what Helen Fisher calls romantic love) is a strong biological drive that causes individuals to ignore their innate avoidance of physical contact long enough to mate and produce offspring.
- *Attachment* is a more variable biological drive that causes mated individuals to remain together long enough to raise their offspring, and causes parents and offspring to remain together until offspring have reached sexual maturity.

All three processes are mediated by specific neurochemicals, which modify physiology and behavior in such a way as to bring about the behaviors described. To be specific, the neurochemicals produce emotional and motivational states that make the specific behaviors more likely.

- Lust is mediated primarily by testosterone, in both males and females, which has the effect of increasing sexual attraction and arousal.
- Romantic love (“limerence”) is mediated primarily by the neurotransmitter dopamine (along with norepinephrine), which has the effect of causing the increased arousal, focused attention, obsessive thoughts, and other sensations associated with infatuation.
- Attachment is mediated primarily by the hormones oxytocin and vasopressin, both of which produce sensations of calm and satisfaction.

There is also experimental evidence that endorphins—morphine-like compounds produced in the brain—also participate in the formation of attachment bonds. In both romantic love and attachment there is an important implication of these effects: separation distress, a “withdrawal symptom” caused by separation from one’s limerent object or attached partner.

Beginning in the 1940s, John Bowlby (an English clinical psychiatrist) studied attachment in infants, showing that infant attachment was strongly adaptive, especially when considered in the context of the evolutionary environment of adaptation. Bowlby eventually published a trilogy of books, *Attachment*, *Separation*, and *Loss*, in which he laid out a comprehensive theory of infant attachment.

Central to Bowlby’s theory was the idea that infants and toddlers become attached to their mothers (or other primary caregivers) during a specific critical period: the age at which the child becomes independently mobile and begins exploring the world. Bowlby hypothesized that the capacity for attachment (and the corresponding capacity for separation distress) was adaptive at this age because it caused newly mobile young children to remain close to their primary caregivers, rather than wandering away into potential dangers.



Bowlby invented the concept of the *evolutionary environment of adaptation* (usually abbreviated EEA), which is the particular ecological environment in which an adaptation has evolved by means of natural selection. An important corollary of the concept of an EEA is that the environmental conditions that resulted in the evolution of an adaptation may no longer exist at the present time. Under such conditions, the adaptation may persist if it has no negative consequences, or it may disappear as the result of selection against it.

Bowlby proposed that attachment evolved during our prehistory, when a young child who wanders away from its mother (or is otherwise separated from her) was exposed to significant dangers. Separation anxiety caused young children to search for and seek physical contact with their mothers whenever they became separated, and especially if they perceived a threat.

The underlying neurochemical/behavioral adaptation evolved by natural selection. Bowlby argued that attachment as an adaptation persists today, despite the fact that most of the dangers that caused its evolution by natural selection have since been minimized or eliminated.

Mary Ainsworth and her research team conducted extensive empirical research into infant attachment. Ainsworth was a student and later colleague of Bowlby's, assisting in his research and eventually developing an experimental method to test Bowlby's hypotheses.

- Ainsworth developed the *Strange Situation Protocol*, an experimental design in which infants and toddlers were exposed to a stranger in unfamiliar surroundings as a way to gauge their reactions.

During a test, a mother and young child were separated and united a total of eight times, during which the child was exposed to a stranger twice (once with her mother and once alone).

Ainsworth identified three different behavioral patterns exhibited by infants in response to the "strange situation":

- The majority of children (and mothers) exhibited what Ainsworth called *secure attachment*. When separated, they expressed anxiety and distress; when reunited, they expressed relief and happiness; and when with a stranger, the infants expressed more distress when alone. This response was considered to be adaptive, as it has the effect of "attaching" young children to their mothers (and vice-versa), a behavior that would clearly have been adaptive in the EEA.
- A minority of children exhibited what Ainsworth called *ambivalent attachment* (sometimes called *anxious attachment*). When separated, they expressed anxiety and distress; however, when reunited, the children continued to express distress, often increasing it and refusing to be comforted. This reaction was correlated with inconsistent attention on the part of the mother (or other primary caregiver); essentially, the child demanded more reassurance when distressed, as it could not be reasonably certain of getting attention and comfort otherwise.

- A smaller minority of children exhibited what Ainsworth called *avoidant attachment*. When separated, they expressed relatively little anxiety and distress; when reunited, the children often avoided their mothers or approached them with caution (and usually without soliciting attention or comforting). This reaction was correlated with consistent rejection of the child on the part of the mother (or other primary caregiver); essentially, the child avoided negative emotions by avoiding attachment and its distressing side effects.

These different types of attachment persisted into adulthood, significantly affecting the ability of parents to become attached to their own children. Although it is possible for individuals who are avoidantly attached to their mothers as children to become securely attached as adults, this requires much more positive attention and reinforcement. This pattern of attachment formation is consistent with a model of learned behavior very similar to imprinting; the sensory, nervous, and motor systems of infants and toddlers are “primed” by natural selection to learn one of the three patterns of attachment, but they learn through experience which of the three patterns is most rewarding and/or least painful.

Helen Fisher and her colleagues have recently identified the underlying physiological and neurochemical correlates of romantic love and attachment, and shown that this adaptation is also present among adults during mating and child rearing. What is interesting is that Fisher’s research points to the existence of three separate but related phenomena, all of which often get lumped together under the heading of “love.”

- Some people mistake sexual attraction for love, but Fisher’s term—“lust”—is much more descriptive, in that it focuses on a specific adapted outcome: becoming attracted to a potential mate (that is, someone with whom to copulate and make babies).
- Many people refer to romantic love when they use the term “love,” but this kind of love is not permanent, nor does it cause people to form long-term relationships. On the contrary, romantic love (limerence) is self-limiting and has one specific focus: getting two people who are attracted to each other to copulate and make babies. Once they have done so, this kind of love wears off, and it does so at right around the age at which most children were weaned in our Pleistocene EEA.

Cynthia Hazan and Phillip Shaver have shown that there is a physiological component to adult attachment and suggested that the same biological mechanisms underlie both infant and adult attachment. A basic principle of evolutionary biology is that nature often reuses adaptations that evolved under one set of circumstances in new situations, rather than evolving a whole new adaptation. Adaptations become modified into new adaptations as the result of natural selection operating under different conditions. Accordingly, we should

expect to find related behavioral adaptations using the same underlying neuro-biological machinery, and even some of the same genetic code.

In the late 1980s, Cynthia Hazan and Phillip Shaver proposed that adult attachment functioned in much the same way as infant attachment. Central to their hypothesis was that, like infant attachment, adult attachment resulted from a calming effect of physical closeness between attached individuals, which was replaced with distress during separation. This is very different from what happens during romantic love, which is characterized by increased irritability, obsessive thoughts and actions, and simultaneously heightened excitement and anxiety.

Hazan has gone on to show experimentally that attached adults, like attached infants and their caregivers, exhibit physiological co-regulation. That is, attached individuals tend to develop the ability to emulate and regulate each other's level of arousal, anxiety, comfort, and satisfaction. Hazan has shown that members of securely attached couples can regulate each other's responses to stress. Specifically, when a person is subjected to a painful stress, they react with increased heart rate, breathing rate, blood pressure, and other physiological measures. However, if they are subjected to the same stress in the presence of their securely attached partner, they show significantly less physiological stress. At the same time, their attached partner shows increased stress in reaction to their partner's stress.

The effects shown by Hazan's experimental subjects are characteristic of the effects of endorphins, and so it has been hypothesized that endorphins play a role in attachment. This has been shown to be the case in baby guinea pigs, and this separation distress can be relieved by injection of morphine, an artificial form of endorphin, and brought on by injection of naloxone, an antagonist of morphine. However, the role of endorphins in attachment in humans has yet to be experimentally confirmed.

# FOR GREATER UNDERSTANDING

## Questions

1. How is adult attachment like infant attachment, and how are they different?
2. What is “separation anxiety,” and how is it related to attachment and to jealousy?
3. What are the ecological and ethological contexts for the evolution of attachment?

## Suggested Reading

Karen, Robert. *Becoming Attached: First Relationships and How They Shape Our Capacity to Love*. New York: Oxford University Press, USA, 1998.

## Other Books of Interest

Bowlby, John. *Attachment and Loss, Volume I: Attachment*. 2nd ed. New York: Basic Books, 1983 (1969).

———. *Attachment and Loss, Volume II: Separation*. New York: Basic Books, 1973.

———. *Attachment and Loss, Volume III: Loss*. New York: Basic Books, 1982.

Fisher, Helen E. *Why We Love: The Nature and Chemistry of Romantic Love*. New York: Holt Paperbacks, 2004.

## Articles of Interest

Hazan, Cindy, and Phillip R. Shaver. “Attachment as an Organizational Framework for Research on Close Relationships.” London: *Psychological Inquiry*, vol. 5, no. 1, pp. 1–22, 1994. (A pdf of this article is available at the Web address below.) —  
[http://www.psy.miami.edu/faculty/dmessenger/c\\_c/rsrsrcs/rdgs/attach/hazanandshaver.pdf](http://www.psy.miami.edu/faculty/dmessenger/c_c/rsrsrcs/rdgs/attach/hazanandshaver.pdf).

Karen, Robert. “Becoming Attached.” *The Atlantic Monthly*. February 1990. (A pdf of this article is available at the Web address below.) —  
<http://www.psychology.sunysb.edu/attachment/online/karen.pdf>

## Websites of Interest

1. ATWS: *The Attachment Theory Website* by Richard J. Atkins features lists of authors, books, journals, and articles on attachment theory. —  
<http://www.richardatkins.co.uk/atws>
2. An article by R. Chris Fraley (University of Illinois) entitled “A Brief Overview of Adult Attachment Theory and Research.” —  
<http://www.psych.illinois.edu/~rcfraley/attachment.htm>
3. The *British Society for Neuroendocrinology* website provides an article by Keith M. Kendrick (The Babraham Institute, Cambridge) entitled “The Neuro Biology of Social Bonds.” —  
<http://www.neuroendo.org.uk/content/view/34/11>

## Lecture 14

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### Parents, Offspring, and Families

**The Suggested Reading for this lecture is Martin Daly and Margo Wilson's *Truth About Cinderella: A Darwinian View of Parental Love*.**

**I**t is clear that parental care is a key factor in our evolutionary success. But just how much parental care is enough, and who says so?

In 1974, Robert Trivers published a landmark paper on parent-offspring conflict in which he argued that parents and offspring can have opposed evolutionary interests.

Parents invest resources in their offspring because such investment increases the chances that those offspring will survive and eventually reproduce as a result of such investment. Trivers showed that asymmetries in parental investment could explain many of the anatomical, physiological, and behavioral differences between females and males. Donald Symons went on to show that this meant that mating behaviors that were advantageous for females were disadvantageous for males, and vice-versa.

Trivers argued that parents and offspring could also disagree on the amount of energy and materials invested in the offspring by the parents. From an individual offspring's point of view, the ideal circumstance would be if both parents invested all their resources in it alone, even if this led to the weakening (or even death) of its siblings (if any); indeed, even weakening or killing the parents as a result of consumption of their resources would not be too much, if in so doing the offspring has a higher probability of surviving until reproduction. In other words, semelparity combined with production of a single offspring is the ideal circumstance from the perspective of an individual offspring.

From the parents' point of view, however, the ideal circumstance would be to produce the largest number of offspring possible, while providing the minimum amount of resources necessary to ensure their survival and reproduction; indeed, even an occasional death of an offspring would not be disadvantageous, if this resulted in higher fitness for the remaining offspring. In other words, iteroparity combined with the production of multiple offspring is the ideal circumstance from the perspective of the parents.

The resulting competition cannot be carried to either extreme without lowering the fitness of all participants. This is because offspring eventually become parents, and so maximization of the fitness at one stage in the life cycle is incompatible with maximization over the entire life cycle. Therefore, selection as a result of parent-offspring conflict necessarily leads to an equilibrium.

Trivers suggested that the most obvious manifestations of parent-offspring conflicts would be behavioral, involving conflict during the cessation of

parental care in those species in which such care is provided. For example, female mammals nurse their offspring until the beginning of their next reproductive cycle. The milk provided by a nursing mother comes directly from her tissues, and so constitutes a drain on her ability to begin a new reproductive cycle. Therefore, nursing mothers must at some point wean their offspring from the breast before they can reproduce again. Weaning often becomes a competition between nursing mothers and their suckling offspring.

Some parent-offspring conflict is now known to occur in utero, as developing fetuses manipulate their mother's physiology in such a way as to provide more resources, sometimes to the mother's detriment. David Haig has shown that human fetuses produce hormone-like molecules that alter their mother's physiology in such a way as to force her to provide more nutrients to the fetus. For example, the placenta secretes hormones that compete with the mother's insulin, a hormone that reduces blood sugar (that is, glucose) concentration. This has the effect of elevating the mother's blood glucose concentration, which provides the developing fetus with increased glucose, an essential nutrient. However, in some women this process has the effect of inducing gestational diabetes, which in some cases continues after the birth of the infant.

Sarah Hrdy's discovery of infanticide in Hanuman langurs has led to the recognition that parent-offspring conflicts can have damaging or fatal effects when males raise offspring to which they are not genetically related. Stepfather infanticide is now known to be a common phenomenon among many species of mammals.

Beginning in the late 1980s, Martin Daly and Margo Wilson studied the rates of child battering and infanticide. They published data, taken primarily from crime, hospital, and social services statistics, indicating that children are significantly more likely to be injured or killed by stepparents, especially stepfathers, than by their biological parents, especially their mothers. This data was strikingly similar to that found among polygynous primates.

These patterns of child abuse and infanticide are identical to those predicted by the data from other primates. Again, the evolutionary explanation for this behavior pattern is that, in our evolutionary past, males who killed the unrelated dependent offspring of their new mates had a higher reproductive success than males who did not, resulting in an innate (and largely unconscious) tendency to neglect, abuse, or even kill unrelated offspring by their descendants: us. Despite attempts to refute such findings by social scientists, the overwhelming preponderance of the evidence collected to date supports Daly and Wilson's theory.

The conflicts that happen during human adolescence have also been explained as a form of parent-offspring conflict. That conflict between parents and their children virtually always accompanies adolescence has been a controversial idea in the social sciences. In 1928, the famous American anthropologist, Margaret Mead, published *Coming of Age in Samoa*, in which she asserted

that adolescence in Samoa was fundamentally unlike adolescence in the United States and other Western countries. She asserted that Samoan adolescents did not have the same conflicts with each other and with their parents as are common in Western culture, particularly over sexual behavior. Mead also stated that adolescent girls in Samoa reported that they often solicited sexual behavior from different adolescent boys, and that this behavior rarely if ever resulted in sexual jealousy. Mead's conclusions strongly supported the Standard Social Science Model of human behavior, which once again stated that human behavior has no innate limits, but rather depends entirely on learning in the context of culture.

However, Mead's work came under intense criticism in 1983, when Derek Freeman, a New Zealand anthropologist, published *Margaret Mead and Samoa: The Making and Unmaking of an Anthropological Myth*. In it, Freeman presented a strong case that Mead's conclusions were largely unsupported by data, and that in reality both parent-offspring conflict during adolescence and intense sexual jealousy were as characteristic of Samoan culture as they are of virtually all other human cultures. Freeman reinterviewed Mead's informants on Samoa and determined that they had systematically misled Mead as to their behaviors and beliefs as part of an elaborate "joke."

Freeman's book generated a firestorm of controversy in the social sciences, with Freeman being accused of the same calumnies as Stephen Pinker and other sociobiologists: racism, sexism, fascism, crypto-Naziism . . . the whole list of nefarious isms. However, close examination of Mead's field work and more detailed examination of Samoan culture has largely supported Freeman's conclusions.

Parent-offspring conflict is not the only such conflict that occurs during animal development; sibling-sibling conflict can be even more intense, resulting in some cases in siblicide. Among some species of birds, siblings routinely injure and kill each other in the nest.

That human siblings compete with each other for the attention of their parents is a universally recognized phenomenon. Indeed, it is the basis for the biblical story of Cain and Abel. That the biblical story is used as a mythological explanation for human violence is not far from the biological explanation for sibling rivalry: Such rivalry is adaptive in the context of limited resources, as the "winners" in such contests have increased survival and reproductive success, thereby passing on to their offspring the tendency to initiate and participate in such contests. In some cultures, parents attempt to minimize such rivalry; in others, they tend to exacerbate it. An intriguing hypothesis is that such differences are related to ecological circumstances; intense sibling rivalry would be more likely to evolve under conditions of ecological scarcity than abundance, as the fitness consequences of such rivalry would be intensified under such conditions.

Sibling-sibling conflict has also been invoked as the explanation of the *Westermarck effect*, a behavioral adaptation that minimizes incest in humans. The Westermarck effect is named for Finnish anthropologist Edvard Westermarck, who noticed that children who are raised together at an early age (that is, prior to puberty) generally do not become sexually attracted to each other, regardless of their genetic relatedness.

The Westermarck effect is significant because it has the effect of minimizing the occurrence of incest between genetically related siblings. For genetic reasons, mating between full siblings tends to result in greatly decreased fertility and greatly increased incidence of genetic abnormalities, especially homozygous lethal conditions such as cystic fibrosis and sickle cell anemia. Therefore, any mechanism that minimizes the probability of incestuous mating would be selected for at the level of individuals.

Incest is rare in natural populations of wild animals, who avoid incestuous mating using a variety of mechanisms. Among insects, close inbreeding is prevented by chemical recognition signals, which cause individuals to avoid mating with other individuals having the same or very similar chemical recognition signals. Among vertebrates, close inbreeding is more often minimized by forced outbreeding, in which parents (usually mothers) force their sons to leave the family groups prior to the onset of puberty.

Once again, in humans the mechanism that has the effect of producing a behavioral adaptation is based on an innate tendency to learn something, in this case who one's genetic siblings are. In the Westermarck effect, children learn who their full siblings are simply via repeated contact during early childhood. In the generally closed societies that existed throughout most of human evolutionary history (the Pleistocene and before), the individuals with whom one was raised as children were virtually always one's siblings; depending on the mating system involved, they would be anywhere from half siblings to full siblings (depending on whether the mating system was polygamous or monogamous).

Evidence supporting the Westermarck effect and the theory of incest avoidance comes from studies of Israeli *kibbutzim* and Chinese *shimpua* mating systems. During the first half of the twentieth century, members of the kibbutz movement in Israel established communal societies throughout Palestine. One of the social reforms practiced by the kibbutz movement was the elimination of private property, including children, who were raised in Children's Societies separate from their parents. Young children were grouped together by age, rather than by genetic relationship. Upon reaching puberty, such children almost never formed sexual relationships with each other, and almost none eventually married, preferring instead to court and marry children from another kibbutz. This pattern of "outbreeding" happened despite the stated preference by the founders of the Children's Societies that group members marry within their groups to enhance group solidarity.



When interviewed, most children who married outside their kibbutz stated that the main reason was because they were not attracted to the other members of their age group in the Children's Society. This directly contradicts a finding of specialists in human bonding that "familiarity breeds attraction"; however, this is only the case if such unfamiliarity results from being raised apart as children. Indeed, full siblings raised apart as children are actually more likely to be attracted to each other at sexual maturity than non-relatives, as they have more physical and behavioral traits in common.

The *shimpua* marriage custom in China (and especially Taiwan) began as a means by which poor families could "sell" a young daughter to a richer family, in exchange for which the richer family would betroth a son to marry the daughter. The daughter-in-law to-be (*shimpua* literally means "little daughter-in-law") provided free labor to the family of her betrothed husband-to-be, making the exchange essentially one of free labor for a younger son (older sons inherited the property of their parents).

It was well-known among the Chinese that marriages contracted via the *shimpua* custom were rarely successful, due primarily to a lack of sexual attraction between the betrothed couple, who were raised together as children. With the increase of general wealth and the decline of traditional customs in Taiwan, and the elimination of most traditional customs in mainland China under Communist rule, the *shimpua* system has mostly disappeared, not least because very few of its practitioners found the marriages that resulted from it very satisfying.

An important observation is that sibling-sibling conflict is most intense between siblings of the same age, but opposite sex. Such conflict, arising out of mostly unconscious motivations, are what eventually produce the antipathy that rules out sexual interest upon reaching puberty.

The flip side of parent-offspring and sibling-sibling conflict is cooperative breeding, in which parents are assisted in raising their offspring, most often by the older siblings of their offspring. This phenomenon is most often observed among birds, in which it is known as "helpers at the nest."

An interesting correlation to note in this regard is that in birds such helpers are more often male, whereas in mammals such helpers are more often female. This was predicted by a corollary of William D. Hamilton's theory of kin selection, in which Hamilton suggested that the homogametic sex (that is, the sex that resulted from the pairing of two identical sex chromosomes, such as two XXs) would be more likely to be altruistic than the heterogametic sex (that is, the sex that resulted from the pairing of two non-identical sex chromosomes, such as an X and a Y chromosome). In birds the homogametic sex is male (males have two Z chromosomes, whereas females are ZW), whereas in mammals the homogametic sex is female (females have two X chromosomes, whereas males are XY).

Although in most animals, breeding assistance is mostly provided by other parents, older siblings, aunts, or (rarely) unrelated individuals, in humans cooperation during breeding is again a culturally defined affair. Babysitting and child care are essentially cooperative forms of child rearing, and are virtually universal in human societies. The benefits to parents, and especially to mothers, of babysitting and child care are obvious; mothers can devote more time to finding and procuring food and other resources, which in modern industrial societies means having independent employment.

However, as with the case for stepfather child abuse, there are patterns in babysitting and child care that indicate that, even in these culturally defined systems of cooperative child rearing, there are underlying motivations that can affect survival and reproduction. One pattern is so obvious that it is virtually always overlooked: Babysitting and child care by close relatives (especially older siblings and grandparents) is almost always free (that is, no resources are exchanged), whereas babysitting and child care by non-relatives usually requires payment of some kind (that is, resources are exchanged for such care). There is also demographic data that indicate that children are more likely to be abused and even killed when under the care of unrelated individuals.

Another phenomenon that supports the evolutionary interpretation of cooperative child rearing is often referred to as the “grandmother effect.” In many societies in which free child care is provided, the most common provider is the mother of the mother of the children cared for. In some societies, this kind of child care is highly institutionalized, with grandmothers who don’t provide such care being socially ostracized.

Evolutionary psychologists have even suggested that the phenomenon of menopause, in which older women stop reproductively cycling and become effectively sterile, is part of an adaptation in which grandmothers, by assisting their granddaughters in raising their offspring, increase their overall fitness. Part of this argument is that the probability of genetic and developmental abnormalities rises exponentially with age. Therefore, a woman who helps her daughter raise her offspring may actually promote the survival and reproduction of more copies of her genetic material than if she attempted to produce more offspring at a relatively advanced age.

Returning once again to the distinction between individual selection, kin selection, and group selection, families provide a test case for the predictions that flow from the various theories we have already discussed.

- G.C. Williams and others argued that group selection could only happen under very limited conditions, in which groups were generally closed and in which the fitness of group members was very closely tied to the survival of the group as a whole.
- William D. Hamilton’s theory of kin selection suggested that cooperation could most easily evolve among closely related individuals, as cooperation would thereby promote the inclusive fitness of the individuals doing the cooperating.

- And George Price's theory of group selection via covariance also required that the fitness of altruistic individuals be tied directly to the groups of which they were members.

Cooperative breeding and child rearing meets all three sets of requirements, and so it is not surprising that natural selection would result in behavioral adaptations that would promote it. Indeed, the interesting question is, Why isn't cooperative breeding and child rearing more common?

One answer is that it is very common, but has only been recognized as such fairly recently. There appears to be a tendency toward increased sociality in many groups of organisms. In particular, this tendency is most notable among the eusocial animals. As ethologists have become more aware of the predictive power of the underlying theories, and consequently looked more carefully at the various behavioral adaptations of animals, we have discovered more and more examples that fit the predictions that flow from the theories.

And so, as we come now to the end of this lecture series, let me emphasize the trends that we have observed in the evolution of social behavior within groups:

- The theoretical models formulated by Hamilton, Trivers, and Price have been applied to wider and wider examples of cooperative animal behavior.
- As this expansion of application of theory has taken place, it has stimulated the gathering of natural history data that has, in the main, supported the theories and suggested new patterns that can be tested by further investigations.
- The basic assumption of ethologists—that all important animal behaviors are the result of a combination of innate and learned dispositions—can be applied to human behavior and motivation.
- The result of such application is the science of evolutionary psychology, which as we have seen has both provided a theoretical underpinning for understanding the behavior of humans in cooperative groups, and also stimulated new avenues of research that have yielded surprising and highly suggestive correlations between theory and observations.

The application of Darwin's theory of evolution by natural selection to the analysis of human behavior and psychology has generated controversy and stimulated new research into the origins of the human condition. Some of this research has reinforced ideas about human behavior and motivations that have been prevalent for centuries. However, much of this research has revealed some very surprising insights into the origins and dynamics of our behavior and the emotions and ideas that motivate it.

# FOR GREATER UNDERSTANDING

## Questions

1. When are parental interests aligned with those of their offspring, when are they in conflict, and how are such conflicts usually resolved?
2. What is the Cinderella effect and how is it related to the evolution of infanticide in primates?
3. What is the Westermarck effect and how is related to the evolution of incest avoidance?

## Suggested Reading

Daly, Martin, and Margo Wilson. *The Truth About Cinderella: A Darwinian View of Parental Love*. New Haven: Yale University Press, 1998.

## Other Books of Interest

Freeman, Derek. *Margaret Mead and Samoa: The Making and Unmaking of an Anthropological Myth*. New York: Penguin, 1986.

Mead, Margaret. *Coming of Age in Samoa*. New York: Harper Perennial Modern Classics, 2001 (1928).

## Articles of Interest

Haig, David. "Genetic Conflicts in Human Pregnancy." Chicago: *Quarterly Review of Biology*, vol. 68, pp. 495–532, 1993.

Trivers, Robert L., "Parent-Offspring Conflict." McLean, VA: *American Zoologist*, vol. 14, pp. 249–264, 1974.

## Websites of Interest

The *Brain & Mind* neuroscience magazine website provides an article by Brazilian researchers Silvia Helena Cardoso and Renato M.E. Sabbatini entitled "Learning Who Is Your Mother: The Behavior of Imprinting." —  
<http://www.cerebromente.org.br/n14/experimento/lorenz/index-lorenz.html>

## COURSE MATERIALS

### Suggested Readings

- Barash, David P., and Judith Eve Lipton. *The Myth of Monogamy: Fidelity and Infidelity in Animals and People*. New York: Holt Paperbacks, 2002. (A book that systematically demolishes the idea that monogamy is the rule for mating systems in animals, including people.)
- Barkow, Jerome H., Leda Cosmides, and John Tooby, eds. *The Adapted Mind: Evolutionary Psychology and the Generation of Culture*. New York: Oxford University Press, USA, 1992. (A collection of essays considered by many to be one of the founding documents of evolutionary psychology.)
- Buss, David M. *Evolutionary Psychology: The New Science of the Mind*. 2nd ed. Boston: Allyn & Bacon, 2004. (The best one-volume introductory textbook on evolutionary psychology.)
- Daly, Martin, and Margo Wilson. *Sex, Evolution, and Behavior*. 2nd ed. Belmont, CA: Belmont Publishing Company, 1983. (The most comprehensive book on the relationship between parental investment in offspring and the dynamics of child rearing.)
- . *The Truth About Cinderella: A Darwinian View of Parental Love*. New Haven: Yale University Press, 1998. (A book in which the authors apply Robert Trivers's theory of parental investment and sexual selection to human child rearing.)
- Darwin, Charles. *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life*. 1st ed. London: John Murray, 1859. (The first edition is the best; in later editions, Darwin watered down his arguments, especially for natural selection. This book is widely credited with founding the science of biology. All of Darwin's works [including much of his correspondence] are available in side-by-side facsimile/searchable [html] form free-of-charge online at: <http://darwin-online.org.uk>.)
- A recent printing of this work:
- Darwin, Charles. *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life*. New York: Nabu Press/Random House, 2010.
- Dawkins, Richard. *The Blind Watchmaker: Why the Evidence of Evolution Reveals a Universe without Design*. New York: W.W. Norton, 1986.
- Dunbar, Robin. *Grooming, Gossip, and the Evolution of Language*. Cambridge, MA: Harvard University Press, 1997. (A provocative hypothesis for the origin of language, by one of the founders of the science of evolutionary psychology.)
- Fisher, Helen E. *Why We Love: The Nature and Chemistry of Romantic Love*. New York: Holt Paperbacks, 2004. (A detailed exploration of the chemistry and physiology of love and romantic attraction.)

Gray, John. *Men Are from Mars, Women Are from Venus: A Practical Guide for Improving Communication and Getting What You Want in Your Relationships*. New York: HarperCollins Publishers, 1992. (A well-written book on the different communication strategies employed by males and females.)

Hrdy, Sarah Blaffer. *The Woman That Never Evolved*. Rev. ed. Cambridge, MA: Harvard University Press, 1999 (1981). (A book that revolutionized the evolutionary perspective on female mating strategies.)

Judson, Olivia. *Dr. Tatiana's Sex Advice to All Creation: The Definitive Guide to the Evolutionary Biology of Sex*. New York: Holt Paperbacks, 2003. (A non-technical [and often amusing] introduction to the evolutionary biology of sexual reproduction.)

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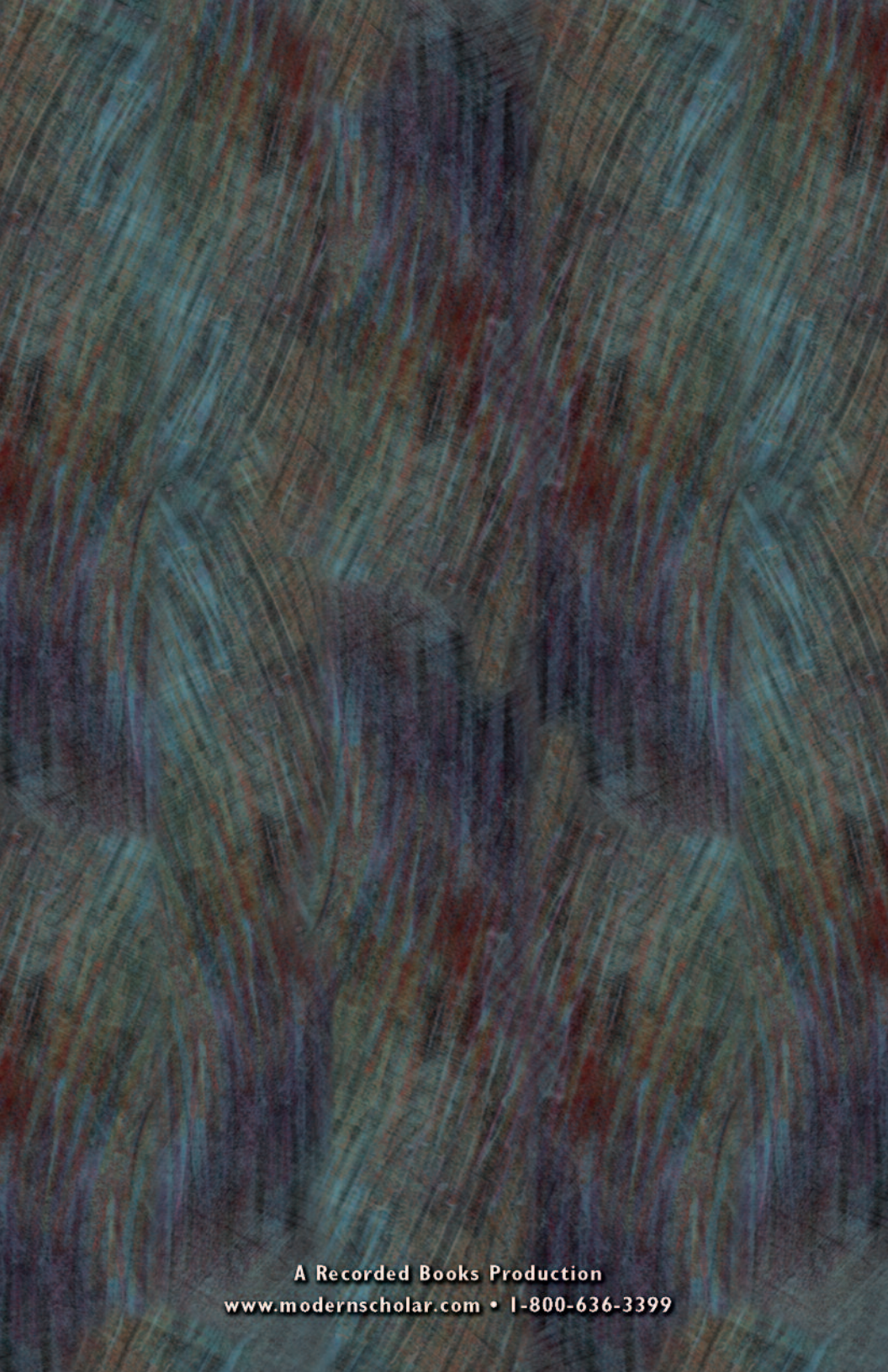
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