Chapter 4: Evolutionary Principles and Our Primate Cousins

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Learning Objectives

- Discover the ways that adaptation, genetics, and the environment intersect to shape life on earth.
- Recognize the rigorous, scientific evidence for evolutionary theory.
- Learn how humans and our close primate relatives are the result of evolution and adaptation.
- Consider examples of how scientists study non-human primates to understand human development.

What is Evolution?

The path to life on earth is a long and fascinating one. Several great thinkers along the way have contributed to our modern understanding of this journey, and to the theory of evolution. These early researchers, people like Charles Darwin, Gregor Mendel, and others, laid the groundwork for how we understand the development of our species and all the others with which we share the planet. The prevailing scientific perspective on these origins is **evolution**. The *theory* of evolution explains how our species and others developed. What is a theory, exactly? It's an explanatory framework for a complex process; in other words, it's an idea that explains how something occurs. The *fact* of evolution is demonstrated by a vast array of evidence, from fields as varied as archaeogenetics and epidemiology. In short, we humans originate from a long line of species that came before us. Over millennia, and via the processes of adaptation and natural selection outlined below, useful mutations found in extant species have been passed on to subsequent generations, which in turn has resulted in new species that are better suited to survive and thrive in particular environmental niches. This process results in one of the hallmarks of the theory of evolution: that there exists more species diversity today than in the past. Let's dive into the steps that comprise this theory.

Adaptation and Evolution

Adaptation is an important concept for considering how evolution occurs. For adaptation to transpire, a species must be able to survive long enough to produce the next generation, which in turn survives and reproduces, and so on. If something about the environment changes – for instance, if a key food item becomes less readily available – a species may need to adapt or else face extinction over a period of time. Usually, these changes are small and represent minor shifts in the frequency of traits; this is called **microevolution**. Adaptation does not always mean change, however; if a setting or environment is relatively stable, a species can remain the same and still experience adaptive success. A **species** is typically defined as a group of organisms that can reproduce to create viable offspring. If adaptation requires a lot of change over time, sometimes a group of organisms winds up so different from other communities of the same species that it can no longer interbreed successfully; this is called **speciation** – a new species has been formed – and is an example of **macroevolution**. Similarly, if a group is isolated for many generations, it may change to the extent that reproduction with members of the larger group is no longer possible.

Charles Darwin's work on finches in the Galápagos Islands was among the first scientific studies to carefully document the relationship between environment, adaptation, and speciation. But Darwin was working at a time when scientists did not yet understand where the raw material for variation came from. For that, we turn to the field of genetics.

Genetics and Variation

Genetics is a relatively new scientific field that has helped us understand some of the mechanisms of adaptation and variation via the basic building block of genes. **Genes** are a unit of inheritance and specify particular biological and physical traits; they are passed from parents to offspring. Most genes code for proteins that have varied functions in the body, and they comprise segments of DNA. There are two general foci in the study of genes: Mendelian genetics and population genetics.

Mendelian genetics is based on the work of a 19th century Augustinian friar named Gregor Mendel, who performed hundreds of experiments with pea plants. This work contributed to our understanding of genetic inheritance and of dominant versus recessive traits. Remember Punnett squares from biology class? Those are a great example of Mendelian genetics, since they illustrate how the **alleles**, or varieties of a gene, present in a parent generation are passed on via reproduction to the next generation. Depending on the parent alleles and how they recombine in offspring, Mendel discovered that some alleles can be considered **dominant** and others **recessive**. So, pea offspring only need one copy of the dominant allele that results in the green pod **phenotype**. These peas, with one copy of the green pod allele, would be considered to have a **heterozygous** dominant **genotype**. Other pea traits, like the yellow pod phenotype, turned out to be recessive; peas need two copies of the allele for a yellow pod and would be considered to have a **homozygous** recessive genotype. Why all this talk about peas in an anthropology text? Discovering some of these basic processes turned out to be key in developing scientific approaches to study our own species' development and can help us to understand how and why we inherit particular traits from our own biological parents. For instance, the **law of independent assortment** tells us that just because we inherited our mother's blond hair, we won't necessarily also inherit her big feet.

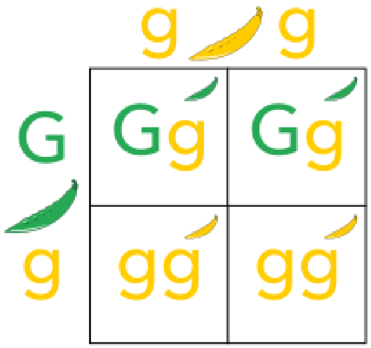

Figure 1. Punnett square showing the cross of a homozygous recessive paternal genotype (phenotype: yellow pod) with a heterozygous maternal genotype (phenotype: green pod) and the probability of their offspring's genotypes. By Wikimedia author Pbrks. Modified to indicate that green pod color is dominant in peas - File:Punnett_Square.svg., CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=94237067

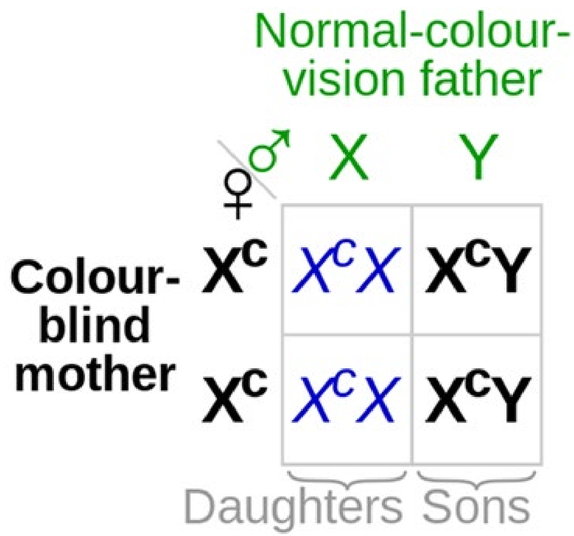

Figure 2. Punnett square showing the cross of a color-vision father with a color-blind mother and their predicted offspring. By Cmglee, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=106072201

Population genetics considers, well, populations of organisms. The basic unit of population genetics is the **gene pool**. This is essentially all the genetic material (e.g., genes, DNA) that exists in a breeding population or species. **Mutations**, or deviations in genes or DNA, present in the gene pool are a key source of variation and provide the raw material for biological adaptation. Mutation occurs much more commonly than you may think – humans accumulate trillions of new mutations daily as our bodies go about the work of keeping us alive. Sometimes mutation is simply a mistake that happens when DNA combines to make a subsequent generation, or it can have environmental causes. So why don't we find loads of humans walking around with a mutant third arm? Most mutations are irrelevant; they may never be passed on or their impact in a population may simply be neutral. The key thing to remember, though, is that *sometimes* the variation that mutation introduces can be really useful to a species. If that happens, the mutated genetic material may be passed on (through reproduction) more often than the non-mutated version. Over generations and generations, the mutated genetic information becomes the norm in a population if it continues to help a species adapt (remember: adapt = survive and reproduce) successfully. This process is often referred to as **natural selection**. We can look to the example of prehistoric primates' opposable thumbs and big toes as a great illustration of this. Opposable digits show up in the paleoarchaeological record about 55 million years ago, as the result of a series of random mutations. These opposable digits helped some lucky individuals to better grasp tree branches, which means those primates who had the capability could access more food and were more successful using trees to escape predators. Since they had more food and survived more often, they also tended to produce more offspring than their non-opposable-thumbed neighbors. Over thousands of generations, this trait's continued adaptive benefits mean that it not only spread throughout that initial prehistoric primate population, but it shows up in many modern primate species as well. Even humans retained the opposable thumb from our ancestors, which has been instrumental in our development of tools.

In addition to natural selection, processes like gene flow and genetic drift can impact the incidence of particular alleles –and therefore the traits (or phenotypes) those alleles may code for—to shape the way a population interacts with their environment. **Gene flow**, also called *gene migration*, is the process of genes spreading through reproduction from one population to another population of the same species. This usually occurs via migration, when a few individuals make their way into a new population and breed. If the incidence of gene flow is very high, the frequency of alleles in both populations is relatively the same. Gene flow keeps our huge human population connected and prevents speciation, even though individuals are spread over a great geographical distance. In contrast, a random reduction in allelic variation might be chalked up to **genetic drift**. This can occur when individuals in a small population do not reproduce to pass along their genetic material. Then the next generation is markedly less diverse – and genetic diversity is a good thing! Diversity can help keep a population or a species resilient, or better able to withstand change. Genetic drift in a population of spider monkeys might happen if, say, several do not survive a hurricane – essentially, their genetic information is wiped from that gene pool, and the remaining genetic material in their surviving group-mates reflects a slightly different proportion of alleles than before.

Genetic **clines** are the result of a wide array of processes, including natural selection, gene flow, and genetic drift, and they often appear as a geographical concentration of a particular allele or trait. Clinal variety is the reason that populations of humans in or from some parts of the world experience higher rates of lactose tolerance or sickle cell disease. Lactose intolerance occurs when humans (and other mammals) lose their ability to produce lactase in the small intestine, usually as they enter adolescence; lactase is an enzyme that breaks down lactose, a sugar found in most fresh dairy products. This loss of lactase production was the norm for virtually ALL humans until around 10,000 years ago, when a mutation appeared, likely first in modern-day Turkey, that enabled lactase production into adulthood. This mutation meant that humans could digest and obtain nutrients from non-fermented dairy products throughout their lives (fermentation reduces lactose), and the mutation spread throughout the region over the course of just a few thousand years. Additional similar mutations popped up in other places, too. Scientists aren't precisely sure why these lifetime-lactase-production mutations were so successful, perhaps lactose tolerance was adaptive amidst the stressors of disease and hunger that were common during early sedentary life in villages (Evershed, et al. 2022). Lactose persistence remains far more common today in humans with European ancestry, as well as some groups with African, Middle Eastern, or south Asian ancestry.

Sickle cell disease is a condition in which the red blood cells of an afflicted person take the shape of a sickle, or a half-moon. This shape does not flow through the body smoothly like normal rounded blood cells, and thus may cause pain, internal blood clots, anemia, and premature death. This condition appears on the surface to be **maladaptive**, or *not* well suited to survival and reproduction. Yet in fact, the sickle cell allele is maintained in some human populations because it can be quite adaptive under specific environmental conditions. It's important to understand that sickle cell disease is a recessive condition – it develops only in individuals who have two copies of the recessive allele that codes for sickle cell. In heterozygous individuals that inherit just one copy of the sickle cell allele, their dominant normal cell allele means they have normal red blood cells PLUS an advantage: being a carrier of just one copy of the sickle cell allele provides significant protection against malaria, a mosquito-borne disease that is often fatal. Because of the protection it can provide, the sickle cell allele continues to be passed from one generation to the next in some geographical areas of sub-Saharan Africa with a high rate of malaria transmission, and among human populations with ancestry in those regions.

Now that we're well-versed in some key mechanisms of evolution, let's apply them to consider our relationship to our closest living relatives, the Primates.

Our Primate Cousins

Non-human primates are a fascinating and diverse set of species as the result of evolution and adaptation to a wide range of geographic and environmental niches. Anthropologists are particularly interested in non-human primates because of our shared ancestry that dates back about 65 million years. We can look to extant and primitive non-human primate species to help us understand human evolution and development. After all, we share almost 99% of our DNA with a couple of our closest living non-human primate relatives, the chimpanzee and bonobo. It should come as little surprise then that taxonomically, humans are categorized as primates. All primates, including humans, have a number of traits in common that set them apart from other categories of mammals – more on that in the sections that follow. There are about 250 living non-human primate species, depending on the scientist you ask. There is some discrepancy in this number due to genetic variability and debates around classification. Plus, occasionally a new primate is still discovered. For example, the Popa langur was newly described as a unique species in Myanmar in 2020. For better readability of this chapter, your author will refer to non-human primates as simply *primates* from here on out; just take care to remember that humans are also classified as primates!

Primatology

By now you likely have read about and recognize how inherently interdisciplinary and collaborative the field of anthropology is, and anthropological investigations into primate biology, behavior, and evolution are no exception. **Primatology** is the field of science focused on studying non-human primates. Biological anthropologists in particular, alongside other specialists like psychologists, evolutionary biologists, zoologists, ecologists, paleontologists and paleoanthropologists, geneticists, and more, often work in cooperation with primatologists to consider primates, both in captivity and in the wild and in the past and present. Their goals may differ slightly, depending on their training and the focus of their research. But taken all together, the work of this diverse pool of scientists tells us a lot about our primate "cousins" thereby shedding light on our own species' development as well. Two especially influential contemporary primatology researchers include Jane Goodall and Frans de Waal. Goodall is an English anthropologist, who in the 1960s established herself as an expert on chimpanzees via long periods of close observation of wild chimps at Gombe Stream National Park in Tanzania. She was among the first researchers to report that chimps make and use tools, a trait previously thought to have been limited to humans. She is still active today in promoting global environmental justice to promote the wellbeing of all species. de Waal is a Dutch primatologist who studies chimps and bonobos mostly in captivity; he works at Emory University's Yerkes National Primate Research Center and has written extensively about the psychology of primates. de Waal's work often challenges preconceptions about human exceptionalism, arguing, for instance, that primates and other mammals have complex emotional lives. (For more on what primatology can and cannot tell us about humans,
see Chimpanzees Can't Tell Us Much About Being Human by Agustín Fuentes.)

Primate Traits & Classification

Primates comprise an order of species with some shared key characteristics. These shared characteristics are grouped together via **taxonomy**, a hierarchical classification system that helps to categorize items, including living things, based on their traits. In living things, those traits come from a long and often complex process of adaptation and evolution; **phylogeny** shows the evolutionary relationship between living things – it may be helpful to think of phylogeny like a family tree. You can see a simple example of this below and access a more exhaustive set –including prehistoric species and information about phylogenetic analysis—here.

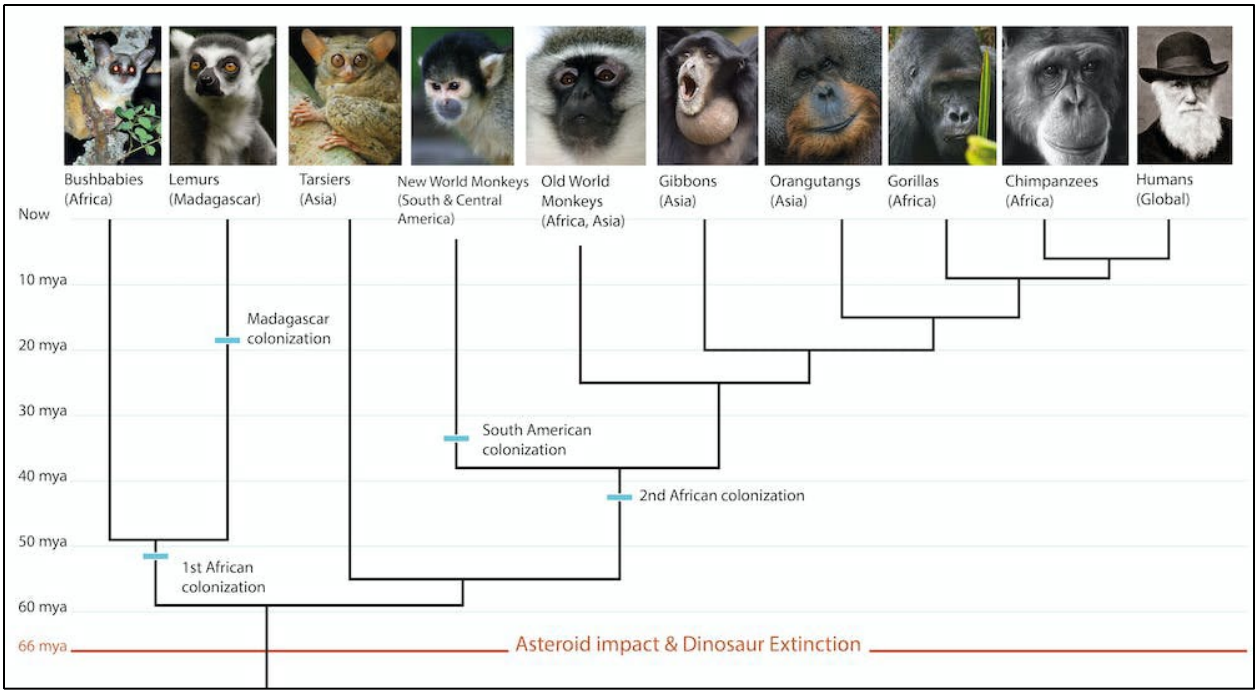

Figure 3. Primate phylogeny, showing a selection of living primates with dates and geographical origins. Nicholas R. Longrich/Wikimedia.

The figure below shows the shared characteristics of primates –including us humans— that link these species into one order and indicate a common ancestor. These characteristics can also be used to differentiate primates from other kinds of mammals. Primate traits have developed via the evolutionary mechanisms outlined in the first part of this chapter, and they have remained hallmarks of the group because they proved adaptive in a wide range of environments, from leafy rainforests that favored arboreal lifestyles to arid, rocky landscapes in which terrestrial dwelling is required. As you read through the list, consider *why* these traits may have been so adaptive.

Primate Evolutionary Trends

- Generalized, unspecialized skeleton:
  - No loss of limb bones from the ancestral condition;
  - Presence of a clavicle that allows greater mobility;
  - Capable of varied movement and locomotion, including ***brachiation*** or a swinging arm to arm locomotion.
- Large, complex brain (relative to body size), especially cerebral cortex.
- Decreased reliance on olfaction (sense of smell):
  - Reduction of snout and olfactory bulb in frontal cortex.
- Increased reliance on vision:
  - Enlarged visual cortex, greater visual acuity, and color vision;
  - ***Stereoscopic vision*** (forward-oriented, overlapping fields of vision, with excellent depth perception).
- ***Prehensile*** (grasping) hands and feet and ***opposable*** thumb and big toe.
  - Nails instead of claws.
- Long pre- and post-natal life periods with greater reliance on learning.
- Complex social organization; tendency toward cooperation in some species.
- Tendency toward diurnality.

Figure 4. Primate evolutionary trends. Adapted from The History of Our Tribe: Hominini by Barbara Helm Welker.

The primates are divided into two major taxonomic groups: **Strepsirrhines**, which retain primitive characteristics, such as the lemurs of Madagascar and the bush babies of Africa; and the more derived **Haplorrhines**, which include all other primate species. The strepsirrhine primates have more typical mammalian noses that are moist and more complex. We haplorrhines have simpler, dry noses and do not smell as well (Helm Welker). Check out https://en.wikipedia.org/wiki/List_of_primates for a great open access collection of information about non-human primates, plus loads of images, all organized taxonomically. Which one is your favorite?

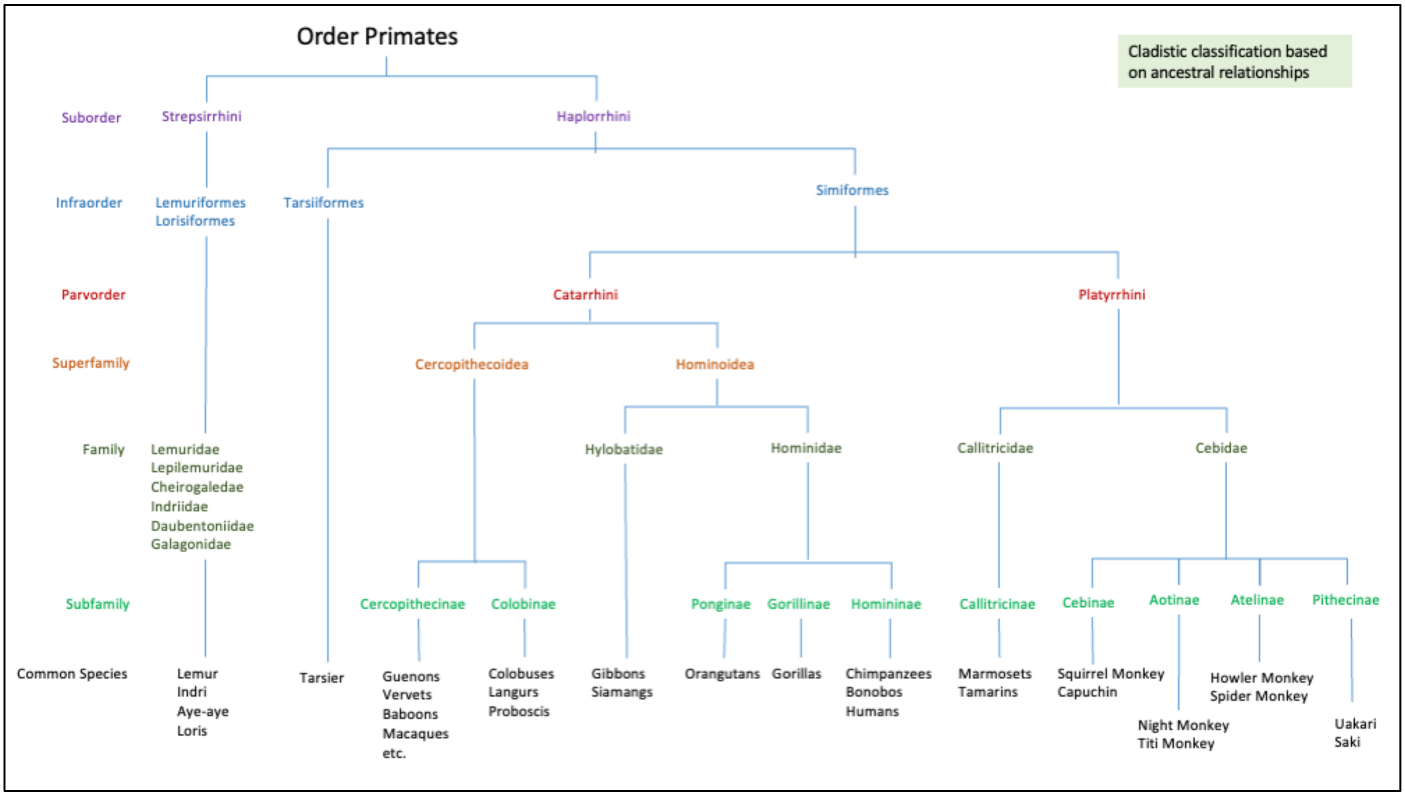

Figure 5. Modern primate taxonomy, showing hierarchical classification. By Tori Saneda ([CC BY-NC 4.0](CC BY-NC 4.0)).

Until recently, humans were separated from the other great apes at the “family” level. All great apes are too closely related to be separated into different families. The lesser apes, like the gibbons and siamangs of Southeast Asia, are still separated into their own family, the Hylobatidae. All of the great apes are now in the family Hominidae or hominids, formerly our exclusive domain. The orangutans come out at the subfamily level, leaving the African great apes in the subfamily Homininae or hominins. Some experts suggest that chimps and humans should be included in the same genus (Helm Welker).

Apes have a set of unique characteristics that differentiate us from the smaller primates like monkeys, tarsiers, and lemurs. For one, apes lack tails. We also have relatively large brains, and a more upright trunk posture with a short, shallow, wide rib cage. Apes have a variable degree of **sexual dimorphism** (that is, differences between male and female morphology) in body size such that sexual dimorphism is low in humans and bonobos, moderate in chimps, and high in gorillas and orangutans. Males have more pronounced prognathism (jutting jaws or muzzle) as well. Ape life stages are longer than that of other primates, especially the juvenile dependency period. And finally, us apes are capable of learning and using symbols and using tools with some modification (Helm walker).

Primates and Culture

Until recently, researchers believed that humans were completely unique and wholly separate from other kinds of living things, owing to cultural perceptions and a dearth of scientific information (and perhaps more than a little egocentrism). But we now know that several of our closest living relatives possess skills and intelligence –even emotions—that are remarkably similar to those of humans. These discoveries are fascinating in and of themselves, but they are also anthropologically important because they can help us more accurately hypothesize about the behaviors and capabilities of our long-extinct ancestors, the hominins (more on them in another chapter).

You've read above about Jane Goodall's discovery that chimps use tools; other primate species do, too. Along with stones for breaking open hard foods like nuts, chimps have been observed using thin sticks to fish ants or termites out of the ground and making spears to hunt smaller primates. A recent study details how chimps also use insects medicinally – a group in Gabon were observed placing crushed insects on their own and on groupmates' wounds (Mascaro, et al. 2022). Something even more interesting? The use of particular tools or "medicine" like this tends to be specialized and limited to one group, rather than commonly used widely across all members of a given species. This indicates to some researchers that these practices are learned and passed from one generation to the next, and thus represent a rudimentary form of local culture (e.g., Sanz, Call, & Morgan 2009).

This complexity in behavior is not limited to apes. As you can see in the following excerpt, capuchins, who have a large brain relative to their body size, appear to value fairness and react negatively when they perceive inequity. And apes seem to consider the risk of future retribution and thus value fairness even if it doesn't help them directly. (Please pardon the multiple bracketed ellipses -- they indicate that some of de Waal's original text has been omitted here for brevity.)

> *"Back in the lab, Sarah [Brosnan] and I were baffled that our capuchins, instead of just consuming their own rewards, also kept an eye on those of others. This hadn't been noticed before because of how animals are typically tested. […] Thanks to my interest in social behavior, however, […] monkeys were rarely alone during tests. That was how we noticed that they closely eyed every morsel of food that went to others. It was as if they valued their own reward relative to what others got.*
> *[…]*
> *This led to a relatively simple experiment that exploited the talent of capuchins to barter, which they do spontaneously. […] For our experiment, we placed two monkeys in a test chamber sitting side by side with mesh between them. We'd drop a small rock in the area of one of them, then hold up an open hand to ask for the rock back. We'd do this with both monkeys in alternation twenty-five times in a row. If both of them got cucumber slices in return for the rocks, they'd make the exchanges all the time […]. But if we gave one monkey grapes for the exchange while keeping the other one on cucumber, we'd*

> *trigger some real drama. […] Upon noticing their partner's raise, the monkeys who'd been perfectly happy to work for cucumber all of a sudden went on strike.*
> *[…]*
>
> *Sensitivity to reward distribution helps insure payoffs for both parties, which is essential for continued cooperation. It is probably no accident that the animals most sensitive to inequity –chimps, capuchins, and canids—hunt in groups and share meat.*
> *[…]*
>
> *Fairness can be seen in the natural behavior of apes […]. I once saw two juveniles quarreling over a leafy branch. An adolescent female chimp interrupted the quarrel, took the branch from them, broke it in two, then handed each a part. […] High-ranking males, too, often break up fights over food without claiming any of it for themselves. They just settle the dispute, which allows all parties to share. Panbanisha, a bonobo, being tested in a cognition laboratory, earned large amounts of milk and raisins in exchange for a task she performed. But her friends and family were following everything from a distance, and she felt their envious eyes on her. After a while, Panbanisha began to refuse rewards, as if worried about being privileged. Looking at the experimenter, she kept gesturing to the others until they, too, got some of the goodies. Only when they got some did she eat hers.*
>
> *Apes can think ahead. Had Panbanisha publicly eaten her fill, there might have been unpleasant consequences when she rejoined the others later on (de Waal 2019: 208-215)."*

Eye-opening, right?! Discoveries like this can help us to feel some kinship with apes and monkeys, which in turn can encourage greater protections of primates in the face of a range of anthropogenic threats to their existence, like deforestation, hunting, the pet trade, development, war and conflict, and climate change.

Another curious new discovery that may shed some light on our ancestors' abilities is that of ape "language." Researchers at the Max Planck Institutes for Evolutionary Anthropology and for Cognitive and Brain Sciences in Leipzig recorded thousands of wild chimp vocalizations from chimps at Taï National Park in Ivory Coast. Upon analysis, they found that these vocalizations followed some rules – there were twelve different call types that were routinely combined in specific ways to create vocal sequences (Girard-Buttotz, et. al. 2022). In her work with bonobos in captivity, researcher Sue Savage-Rumbaugh developed a set of 300 symbols, or "lexigrams," corresponding to English words to enable the bonobos to communicate with human beings. Her relationship with a male bonobo named Kanzi proved legendary: Kanzi's impressive aptitude for understanding spoken English and for communicating with humans using the lexigrams showed that our primate relatives were far more sophisticated than most people had dared to imagine. Many linguists (and linguistic anthropologists) would argue that these examples surely indicate forms of complex communication but fall short of true language – more on that in another chapter.

As you finish up this reading with the following Case Study, consider how various kinds of primate observations in the wild and experiments in captivity are different – and what that may mean for our understanding of the ways our closest living relatives, our extinct ancestors, and our own species evolved.

Case Study: "The Left Bank Ape"

This Case Study is a summary of a great article called "The Left Bank Ape," written by David Quamman for *National Geographic*.

Wamba is a primatology research camp in the Democratic Republic of the Congo. Takayoshi Kano founded Wamba in 1974 to study wild members of the bonobo species (Pan paniscus). Scientists sometimes refer to bonobos as left-bank apes, given their native location on the south side (left bank) of the Congo River. Due to their slightly smaller size, they were also referred to as pygmy chimpanzees, but modern scientists avoid this label as it is (for lack of a better term) reductive.

David Quammen worked with Tetsya Sakamaki to chronicle the uncommon aspects of the bonobo that set them apart from the chimpanzee. The most commonplace ways that the bonobo differs from the chimpanzee are in their behavior, especially the unique ways they create social power structures, practice specific dominance patterns, and their rather infamous penchant for sexual activity. The bonobo is matriarchal and prioritizes sexuality and bonding, while the chimpanzee is patriarchal and engages in dominance battles and ingroup fighting. However, Quammen notes that bonobos do fight with each other, hunt, and sometimes go extended periods without engaging in sex.

Most bonobo sexual activity is sociosexual; that is, sexual activities are not strictly between adult males and females for reproduction. Rather, the purpose of these activities ranges from communication to reconciliation or from pleasure to instructional play and beyond. Bonobos utilize sex to avoid or resolve infighting and power struggles, whereas chimpanzees do the opposite. While male chimpanzees maintain their status through alliances and fighting, female bonobos hold high social ranks by prioritizing amicable relationships and using sex to resolve conflicts.

Usually, it is the status of a male's mother that settles any conflict that may arise between male bonobos; this is one of the reasons why researchers Gottfried Hohmann and Barbara Fruth consider mother-son bonding as crucial to bonobo social structure as female bonding. However, there is evidence of heightened cortisol in some male bonobos. Cortisol is a stress hormone, and this evidence indicates that high-ranking male bonobos suffer a unique kind of social stress: balancing the aggression that earns his status with males and the deference that keeps his place with females. This balancing act ultimately determines the mating opportunities of any male bonobo and his place in society. The way that bonobos deal with conflict and stress (for example, utilizing sociosexual behavior) is what makes their dynamics so unique.

Given their uniquely stable power structure, bonobos often forage during the day in large parties, up to 15 or 20 individuals, without engaging with neighboring bonobo communities. Their diet consists mainly of fruit, herbaceous vegetation that grows year-round, and little animal protein (similar to what chimpanzees eat). Though it is much more likely for animal protein to come from insects and millipedes, hunting behavior does occur. It is more common for bonobos to hunt anomalures or duikers, but sometimes they prey upon other primates.

This lack of competition in obtaining food is crucial to Richard Wrangham's hypothesis on the differences between chimp and bonobo behavior. On the right bank of the Congo River, gorillas and chimpanzees coexist – the gorilla eating herby vegetation and the chimpanzee eating whatever was left. On the left bank, there were not (and still aren't) any gorillas, meaning the bonobos are free to eat whatever and whenever they need to. With more abundant natural resources and less reason for social competition than chimpanzees, the bonobos thus live in more stable, egalitarian communities.

Bonobos and chimpanzees are the two closest living relatives of *Homo sapiens*. Our lineage diverged from theirs about seven million years ago, and the bonobos and chimpanzee lineages diverged from each other about nine hundred thousand years ago. Modern bonobos are classified as endangered (with only 15,000-20,000 remaining in the wild) and are protected by Congolese law. The protected areas, however, are not all effectively secured as the Congo recovers from over a century of institutional dysfunction. In the wake of human activity, the bonobos are left with fewer and fewer wild spaces in which to survive.

Chapter Summary

In this chapter, we explored the mechanisms of evolution and how they impact every species we see today, including ourselves. Evolution has brought diversity to the world as organisms adapted to survive and thrive in many different types of environments. This adaptation happens over many generations and bolsters reproduction while lessening the likelihood of extinction. Diversity in this context presents itself as variations—whether it is physically observable or genetically encoded. Useful or neutral traits get passed down from parents to their offspring at a higher rate.

Sometimes the gene pool is impacted in a unique way through mutations that alter DNA. Like the origin stories of fictional superhero characters, mutations can sometimes be beneficial to the survival and longevity of a species. Just as opposable digits were introduced as a mutation to prehistoric primates that gave them an edge in survival, natural selection means they are better fit to navigate their environment and produce offspring. The process of natural selection favors useful traits, but it is not to say that all species should be identical. In fact, it's the opposite! Processes like mutation, gene flow, and recombination give rise to genetic diversity that increase a species' resilience. In contrast, genetic drifts may cause the genetic diversity a species needs to thrive to actually decrease.

Using a wide variety of evidence from genetics and the fossil record, anthropologists have learned a great deal about our closest living relatives, the non-human primates. Apes like bonobos and chimpanzees share 99% of their DNA with us, so it's clear that humans and primates descend from a common ancestor, which is why we are grouped within the same phylogenetic category. The great apes and humans share some specific characteristics in common as well, such as larger brains, wide rib cages, and an upright posture that differentiates us from smaller primates like lemurs and monkeys. Not only do we share genetic and physical similarities, but we also exhibit similar behaviors, emotions, and intelligence to apes – to some degree. This example of evolution provides us with a framework through which we can understand adaptative processes that tell a story leading up to the present day, and perhaps motivate us to work to save our primate relatives!

Key Terms

adaptation
allele
arboreal
cline
dominant
evolution
gene
gene flow
gene pool
genetic drift
genotype
Haplorrhines
heterozygous
homozygous
law of independent assortment
macroevolution
maladaptive
maladaptive
Mendelian genetics
microevolution
mutation
natural selection
phenotype
phylogeny
population genetics
primatology
recessive
sexual dimorphism
speciation
species
Strepsirrhines
taxonomy

Comprehension Questions

The following questions are intended to help you check your understanding of the reading above. It may be helpful to review these even before you begin reading so you know what information to focus on.

1. How would you explain the theory of evolution to a kindergartener? Use a clear, specific example to illustrate the steps in this process.
2. How and why do anthropologists and other specialists study primates?
3. What evidence supports the idea that some non-human primates exhibit behaviors and capabilities similar to that of humans? What traits do humans have that set us apart?

Critical Thinking and Engagement Questions

Once you've completed the reading, answer the following questions to practice applying and thinking critically about the material. You may want to reference other resources like those linked below, too.

1. You're conversing with a friend about your anthropology class, and they blurt out, "I don't believe in evolution – I don't come from a monkey!". Using appropriate terminology from our class materials, explain why their statement is problematic.
2. Many non-human primates are classified as endangered species. What are the threats they face? And what efforts are underway to try and protect them globally?
3. Explain why it is highly unlikely that earth will ever turn into a *Planet of the Apes*-type situation, with non-human primates taking over and displacing humans.

Resource Links

Consider the following resources for more information about the topics in this chapter:

- *Ape Genius*. 2008. WGBH/NOVA, National Geographic Television, John Rubin Productions, Inc.
- Darwin, Charles. 1859. On the Origin of Species (eBook version).
- Gregor Mendel Institute of Molecular Plant Biology at the Austrian Academy of Sciences.
- Emory National Primate Research Center
- the Jane Goodall Institute
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