Introduction | Statistics | Biological
Learning | Perception | Memory | Thinking
Language | Trilogy of Mind | Cognition | Emotion
Motivation | Social/Personality | Development
Conclusion

Psychological Development

Lecture Supplement

So far in this course, we have focused our attention on mental processes in mature, adult humans. We have taken mind and personality as givens, and asked two basic questions:

- How does the mind work?
- How does the mind mediate the individual's interactions with the social environment?

Now we take up a new question: *Where do mind and personality come from?*

Views of Development

In psychology, there are two broad approaches to the question of the development of mind:

- The **phylogenetic** point of view is concerned with the development of mind across evolutionary time, and the question of mind in nonhuman animals. It includes *comparative psychology*, which (as its name implies) is concerning with studying learning and other cognitive abilities in different species (comparative psychology is sometimes known as *cognitive ethology*); and *evolutionary psychology* (an offshoot of *sociobiology*) which traces how human mental and behavioral functions evolved through natural selection and similar processes.
- The **ontogenetic** point of view is concerned with the development of mind in individual species members, particularly humans. This is developmental psychology as it is usually construed. Reflecting the idea that mental development, like physical development, ends with puberty, developmental psychologists have mostly focused on infancy and childhood.

More recently, it has acquired additional focus on development across the entire "life span" from birth to death, resulting in the development of new specialties in adolescence, middle age, and especially old age.

Although traditional comparative psychology is in decline, evolutionary psychology is increasingly popular. Developmental psychology is primarily concerned with the minds of infants and children. As such, it is dominated by the argument over nature and nurture, nativism and empiricism:

- Is the newborn child a "blank slate", which acquires knowledge and skills through direct experience and vicarious social learning?
- Or are some aspects of mental life innate, part of the child's genetic endowment, acquired through the course of evolution?

Nature and Nurture

The dichotomy between "nature" and "nurture" was first proposed in those terms by Sir Francis Galton (1822-1911), a cousin of Charles Darwin's who -- among other things -- expanded Darwin's theory of evolution by natural selection into a political program for *eugenics* -- the idea of strengthening the human species by *artificial* selection for, and against, certain traits.

Galton took the terms *nature* and *nurture* from Shakespeare's play *The Tempest*, in which Prospero described Caliban as:

> A devil, a born devil, on whose nature
>
> Nurture can never stick.

Galton's focus on nature, and biological determinism, was countered by Franz Boas (1858-1942), a pioneering anthropologist who sought to demonstrate, in his work and that of his students (who included Edward Sapir, Margaret Mead, Claude Levi-Strauss, and Zora Neale Hurston),

> the power of culture in shaping lives. It was nature versus nurture with the scales reset: against our sealed-off genes, there was our accumulation of collective knowledge; in place of inherited learning, there was the social transmission of that knowledge from generation to generation. "Culture" was experience raised to scientific status. And it combined with biology to create mankind ("The Measure of America" by Claudia Roth Pierpont, *New Yorker*, 03/08/04).

For a virtual library of Galton's works, see www.galton.org.

For a sketch of Boas' life and work, see "The Measure of America" by Claudia Roth Pierpont, *New Yorker*, 03/08/04 (from which the quotes above are taken).

Our Phylogenetic Heritage

One important perspective on the development of mind is provided by evolution. The phylogenetic point of view on development traces the evolution of mind in the human species as a whole, often by comparing mental processes in subjects of different species. This is the field known as *comparative psychology*. It is an interesting challenge to develop tests of perception, memory, learning, categorization, problem-solving, and even language that can be reasonably applied to nonhuman animals, and comparative psychologists often exercise great ingenuity in their work.

Three Cheers for Evolution!

Somewhere Steven Jay Gould, the late paleontologist and evolutionary biologist, cited three classes of evidence for evolution:

- **Evolution Around Us**: Although Darwinian evolution transpires over millions of years, we can see similar sorts of changes, on the smaller scale of *micro-evolution*, occurring over the course of just a few generations or even a single lifetime. Examples include the domestication of dogs and of crop plants, and the emergence of DDT-resistance in agricultural pests, and of antibiotic-resistance in human pathogens.
- **Intermediate Forms**: Although there are definite gaps, the fossil record contains ample evidence of extinct species that mark the transition between one species and another. Examples include the shift from reptiles to mammals, the origins of whales in cow-like land creatures, and "Neanderthals" and other species of hominoids (see below).
- **Oddities and Imperfections**: Various physical traits that serve no current adaptive purpose, or that reveal the "attempts" of evolution to solve some problem of adaptation. Gould's favorite example was the panda's thumb, which also provided the title for one of his best popular-science books.

Another expression of the phylogenetic point of view is *evolutionary psychology*, an offshoot of the *sociobiology* proposed by E.O. Wilson in his book by that title. Sociobiology assumed that patterns of social behavior evolved in the service of adaptation. Put another way, large segments of social behavior are instinctual in nature. Similarly, evolutionary psychology assumes that mental functions also evolved to serve adaptive purposes. Put another way, these modes of experience, thought, and action are also instinctual in nature -- they are part of our innate biological endowment, a product of evolution.

Mammals, Primates, Hominoids, Humans

Humans have a particular place in the phylogenetic scheme of things. The earliest analyses of the human place in nature were based on **morphological similarity** -- the similarity in form and structure between humans and other animals. From this perspective, humans are warm-blooded vertebrates, primates related to the **hominoid apes**: orangutans, chimpanzees, gorillas, and gibbons. One popular morphological analysis holds that we are most closely related to orangutans.

The fossil evidence suggests a gradual divergence among the hominoids. Life on earth began about 3 billion years ago, during the **Precambrian era** of geologic time, in a **probiotic soup** of organic molecules (i.e., molecules containing the element carbon). For the next 2 billion years, only very simple life forms -- bacteria and algae -- existed. About 500 million years ago, during the **Paleozoic era,** complex invertebrates began to evolve. Then, especially in the **Mesozoic era**, about 250 million years ago, came the vertebrate species -- fish, then amphibians, then reptiles. Finally, in the **cretaceous period** of the Mesozoic era, beginning about 145 million years, ago, and especially in the **tertiary period** of the **Cenozoic era**, beginning about 65 million years ago, birds, and mammals.

Among mammals, **primates** are a relatively recent development. All primates have a set of morphological features in common, that tend to distinguish them from other mammals:

- grasping hands and feet, with opposable thumbs and big toes;
- nails (rather than claws) on the digits;
- converging eye sockets (i.e., eyes that face forward);
- postorbital bars (bony rings around the orbits);
- other physical characteristics that enable the animal to leap from branch to branch and tree to tree;
- large brains.

The earliest primates, emerging more than 60 million years ago, were tree-dwelling ancestors of present-day tree-shrews and lemurs. About 40 million years ago, the "higher primates" -- or, more correctly, the **anthropoid** primates -- began to emerge. These came in two groups, evolving in distinct areas of the globe: the "New World" monkeys, first appearing in North America, but then colonizing Central and South America; and the "Old World" monkeys and great apes, in Eurasia, diversifying into Africa.

The Cosmological Backdrop

The earth, and the rest of the physical universe, evolved too -- just not through such processes as natural selection. Like our understanding of human evolution, our knowledge of the evolution of the universe changes constantly, with new scientific discoveries. However, the rough outlines can be drawn below, beginning with the "Big Bang", about 14 billion years ago.

The point is that the universe has not always existed, in a sort of steady state. As far as we can tell, the universe had its origins in the (extremely brief) era known as "Quantum Gravity", shortly before the Big Bang -- very shortly before, about 10^{-43} second into the existence of the universe (that's a zero, a decimal point, and a 1, with 42 zeroes in

between). The entire universe was essentially a point in space, measuring 10^{-33} centimeters in diameter (so it wasn't exactly a point, but that's close enough for government work). Space and time were discontinuous, and all the physical forces in the universe were unified. Time began at this point, but there was not yet any space -- that is, there weren't any meaningful dimensions of length, width, and depth.

The "Era of Unification"

At 10^{-39} seconds, the "strong force" split from the "weak force" and from electromagnetism, beginning the "era of unification".

At 10^{-34} seconds, the Big Bang caused the cosmos to swell.

At 10^{-11} seconds, the "weak force" split from electromagnetism.

"Quark Soup"

At 10^{-5} seconds, quarks combined into protons and neutrons, beginning the era of "quark soup". All this so far, and we're still less than a second into the age of the universe!

The "Primordial Fireball"

From 10^{-2} seconds to 3 minutes, nucleosynthesis occurred. Protons and neutrons formed the nuclei of atoms, yielding the light elements -- helium, lithium, and deuterium.

In about 400 thousand years, atomic nuclei began capturing electrons. The universe became transparent, and cosmic radiation was released.

The "Dark Ages"

After about 1 million years, the cosmic background radiation faded, leaving the universe empty and dark.

"First Structures"

At about 500 million years of age, the dark ages ended with the formation of the first stars. These stars then exploded, filling the universe with heavy elements. At this point, the era of "first structures" began.

Beginning at about 1 billion years, the first galaxies formed, with black holes at their centers. These were the quasars, the farthest objects that can be seen from the earth today.

From 2 to 6 billion years of age, other galaxies formed, including our own Milky Way.

At 7 billion years, "dark energy", began to accelerate the expansion of the universe.

At 9.5 billion years, or about 4.5 billion years ago, our solar system, including the Sun and the Earth, were born, essentially completing the universe essentially as we know it -- a universe built from about an ounce of primordial stuff that exploded in the Big Bang.

Interestingly, though, it appears that most of the universe appears to be composed of unseeable "dark matter" of subatomic particles left over from the Big Bang.

The Modern Universe

Some 3.5 billion years ago, life began on earth. The universe was about 10.5 billion years old.

About 3 billion years ago, dark energy outweighed matter in the universe.

And here we are today, about 14 billion years after the birth of the universe, about 4 billion years after the origin of the Earth, and about 3.5 billion years after the first emergence of life on Earth.

The Future Universe

Cosmologists predict that things aren't over yet. In about 2 billion years, the warming Sun will make Earth uninhabitable. About 3 billion years after that, the Sun will swell into a red giant, burning the Earth to a crisp. As if that weren't enough, the Milky Way will collide with our nearest galactic neighbor, Andromeda. About 131 billion years later, *if* the universe keeps expanding, the galaxies will be moving away from each other at such a high speed that they will outpace the speed of light, and will no longer be seen. The universe might continue expanding this way forever.

Alternatively, the expansion of the universe might come to a stop, in what is known as a

"Flat State", and just stay that way forever.

Of course, there's also the possibility that the universe will fall back on itself, in what is called the 'Big Crunch". If so, this will likely be followed by another Big Bang, and the evolution of the universe will start all over again. Given the contingent nature of evolution, with details depending on accidents of circumstance, it's not clear that the Milky Way (and other galaxies), or our solar system (and other solar systems), would appear again in the form(s) we know them.

Or, it may be that there are already several alternative universes, each produced by the same process that ignited the Big Bang that created our own universe, and each reflecting the operation of different contingencies in the process just described -- and each outside the boundaries of the only universe we can know.

Source: "In the Beginning", by Dennis Overbye

New York Times, 07/23/02

Hominoids and Hominids

The great apes -- present-day gibbons, gorillas, chimpanzees, and orangutans -- are also known as **hominoid** primates, and they share ancestors in common with modern-day humans.

The **fossil evidence** further indicates that the gibbons split off from the rest of the primates about 25 million years ago. Then, about 19 million years ago there was a big split, dividing chimps and gorillas from humans and orangutans. Finally, about 18 million years ago, **hominids** -- the ancestors of modern humans -- split from orangutans. Thus, by the morphological and fossil evidence, humans are most closely related to orangutans.

For many years this was the standard view in the field. More recently, however, this view has been revised by **genetic evidence**. The human genetic endowment consists of 23 pairs of **chromosomes**, which are contained in the **nucleus** of each cell in the human body. (There is one exception to this rule: the sperm cells of men, and the egg cells in women, contain only one randomly selected member of each pair. When the egg is fertilized by the sperm, the chromosomes in one cell are matched with their counterparts in the other, yielding a one-celled **embryo** that contains all 23 of the required pairs, one chromosome in each pair contributed by each parent.

Each chromosome consists of thousands of **genes**. These are the basic units of heredity, and affect the organism's physical features, and the course of its development. The genes themselves are composed of **DNA** (deoxyribonucleic acid), a chain of four chemical **bases** (adenine, guanine, thymine, and cytosine). Every gene is located at a particular place on a specific chromosome. According to the theory of evolution, closely related species have closely similar sequences of

bases. Thus, examining the similarity in DNA molecules between modern humans and modern nonhuman hominoids indicates the evolutionary relations among these species. And with knowledge of the rate of DNA change, we can determine how early, or how recently, these species diverged.

It turns out, somewhat paradoxically, that morphological change is not necessarily related to genetic change. Comparisons of the structure of DNA in the blood (see material on genetics, below) indicate that humans are most closely related to chimpanzees -- in fact, we have about 98.5% of our genetic material in common what that species. Further, the genetic evidence indicates that the split between chimpanzees and hominids occurred only about 6 to 8 million years ago.

So, our evolutionary history is encoded in our genes, and our genes tell us that we are most closely related to chimpanzees. At the same time, those 1.5% of genes that are not held in common by the two species can make quite a difference. Our characteristically hominid features include:

- The ability to walk upright on two legs, freeing our hands to manipulate objects.
- Opposing thumbs on both hands, giving us a unique manual dexterity, and ability to grasp. All mammalian species tend toward pentadactylism, or having five digits per limb (the hooves of horses and deer evolved from the five-digit limbs of earlier species, not the other way around). The digits of primates have nails rather than claws, sensitive tactile pads on the tips, and the ability to grasp. The opposable thumb (meaning that it can face the other fingers) permits both a precision grip and a power grip.
- Binocular vision, in which two eyes focus on objects, giving a different image in combination than either eye could give alone;
- A uniquely structured vocal tract, tongue, and mouth cavity, that permits highly flexible vocal communication;
- An extremely large cerebral cortex, much larger than would be expected given our body mass, and much larger than would be expected given the size of the rest of our brains.

The last two features, **vocal apparatus and brain mass**, are the most characteristically human. And, of course, the brain provides the biological substrate of cognition -- it supports our learning, thinking, and problem-solving. It also contains specific cortical structures specialized for language, permitting symbolic representation of objects and events, and flexible, creative communication with other humans. Thus, the most important legacy of evolution is the human mind -- a particularly powerful cognitive apparatus coupled with a capacity for linguistic representation and communication. This feature, the human mind, sharply divides the dullest human from the smartest chimpanzee -- it is the difference that 1% makes.

The special features of the human brain doesn't mean that other animals don't have minds. For example, pigeons have a high capacity for abstracting concepts. And chimpanzees and dolphins have some limited linguistic abilities (symbolic representation, some degree of flexibility and creativity) -- though no capacity for speech because of the different configuration of their vocal tracts. The mental abilities of nonhuman animals are interesting in their own right, and we can learn a great about ourselves from studying other species.

But this does mean that the human mind is something quite special, and that we should focus on its development in the life of the individual -- that is, move from the phylogenetic perspective on development to the ontogenetic perspective.

The Evolution of Hominids

The precise manner in which modern humans evolved from ancient hominids is not known, and there is considerable controversy over this matter among physical anthropologists. To make life even more interesting, every so often a new discovery will shake up the field of paleontology. Still, the basic outlines are known. The account that follows is based on my understanding of the theory of Donald Johanson, discoverer of the skeleton of Lucy, one of our earliest ancestors (the rival theory is by Louis and Mary Leakey). According to Johanson's view, the earliest hominids split off from the ancestors of African apes (gibbons, gorillas, orangutans, and chimpanzees) about 6-8 million years ago.

About 4.4 million years ago, in the midst of the Ice Age, the genus **Australopithecus** ("Southern ape") emerged. Australopiths have humanlike teeth, but in other respects they resembled terrestrial apes: short body, long arms, small brain. Perhaps their most important physical feature was that they walked upright on two feet, thus freeing their arms and hands to make and use tools -- something which began about 2.5 million years ago, and coincided with a period of increasing brain size.

The earliest known example of Australopithecus is, in fact, Lucy -- discovered in the Afar Triangle of northern Ethiopia, and thus named **Australopithecus afarensis** ("Selam", an infant *A. afarensis* also dubbed "Lucy's baby", although the fossil was about 100,000 years older than was also discovered nearby). A. afarensis lived from about 4 million to about 2.5 million years ago. Another ancestor, **Australopithecus africanus**, lived from 3 to 1 million years ago: specimens have been found in eastern and southern Africa; the most famous sites are in Kenya and Tanzania. Yet another ancestor, **Australopithecus robustus**, bigger and more powerful than the others of its kind (hence the name), lived from 2.5 to 1.5 million years ago: specimens have been found in southern Africa. A fourth ancestor, **Australopithecus boise** (named for Charles Boise, a benefactor of many fossil hunts) lived from 2.5 to 1 million years ago.

Another hominid line, **Paranthropus**, lived from about 2.8 million to about 1.4 million years ago.

Actually, according to Johanson, neither Australopithecus nor Paranthropus is not a direct ancestor of humans. That honor belongs to another hominid entirely: **Homo habilis** ("handy Man", the initial capital indicating that it refers to both males and females of the species), discovered in eastern Africa by the Leakeys. H. habilis had a much bigger brain than any Australopith. It made and used tools, while the Australopiths probably did not. It lived as a community, building shelters and surrounding its camps with fences or windbreaks. H. habilis emerged in eastern, southeastern, and southern Africa about 2 million years ago, and lived alongside several genera of Australopiths for about 500 thousand years. Homo habilis apparently gave direct rise to another ancestor, **Homo erectus** ("upright Man"), which lived from about 1.6 million years ago to about 200 thousand years ago. H. erectus has been found everywhere in the Old World, including Europe, Asia ("Peking Man"), and Southeast Asia ("Java Man"). It had an even bigger brain, a better toolkit and building materials, hunted, and used fire.

The Geological "Ages"

What's this about an "ice age"?

The geological timescale is a chronology of the history of the earth, divided into

- eons, which in turn are divided into
- eras, which in turn are divided into
- periods, which in turn are divided into
- epochs, which in turn are divided into
- ages.

In the Cretaceous period, animal life was dominated by reptiles. According to Luis Alvarez, about 65 million years ago an asteroid or comet struck the Earth, spreading dust into the atmosphere and suppressing photosynthesis, leading to the death of the dinosaurs and the emergence of mammals as the dominant animal species. The "Cretaceous-Tertiary Barrier (K-T barrier, after its abbreviation in German) is marked by a layer of iridium in the earth's crust, apparently the remains of the meteor.

Early humans began to emerge during the Miocene Epoch of the Cenozoic Era, and *H. sapiens* emerged during the Pleistocene Epoch -- the "Environment of Early Adaptation" touted by evolutionary psychologists.

The last "Ice Age" (there have been others) occurs at this time as well, with a sheet of Arctic ice covering North America as far south as the Ohio and Missouri rivers, Europe as far south as the British Isles and northern Germany, and Asia as far south as the Himalayas; it permitted early emigrants to walk across the Bering Sea from Siberia to Alaska, beginning the population of the Americas (an Antarctic ice sheet covered South America as far north as Patagonia and the southern Andes).

Era	*Period*	*Epoch*	*Age*	*Ended Years Ago*
Precambrian				600 million
Paleozoic	Cambrian			500 million
	Ordovician			425 million
	Silurian			405 million
	Devonian			345 million
	Carboniferous			280 million
	Permian			225 million
	Triassic			190 million
	Jurassic			136 million
			Lower	

	Cretaceous		Cretaceous Upper Cretaceous	65 million
Cenozoic	Tertiary	Paleocene		58 million
		Eocene		36 million
		Oligocene		25 million
		Miocene		13 million
		Pliocene		2 million
	Quarternary	Pleistocene		10 thousand
		Holocene (Recent)		The Present

About 300 thousand years ago, yet a new subspecies, ***Homo sapiens*** ("wise Man"), emerged. To put it bluntly, this is us. The archaic form of H. sapiens, popularly known as Neanderthal Man (from fossils found in the Neander Valley near Dusseldorf, Germany), controlled fire and made clothes; thus they were the first hominids to be able to survive in cold climates (naked humans cannot survive outside the tropics). They cared for the sick and buried their dead. They produced art. But they didn't last. They competed unsuccessfully with another subspecies, ***Homo sapiens sapiens*** ("very wise Man", I guess), popularly known as Cro-Magnon Man (from fossils found at Cro-Magnon, in southwest France). Neanderthals went extinct approximately 30,000 years ago. Recently, Neanderthal Man has been renamed **h. neanderthalensis**, and modern man, simply, **h. sapiens**.

Neanderthals and Cro-Magnons were closely related in genetic terms. In 2006, two different teams of researchers reported the first steps in reconstructing the Neanderthal genome, based on samples from preserved bone tissue: preliminary results indicate that the two genomes are about 99.5% identical. So, that's 1.5% genetic difference between us and chimpanzees, and 0.5% difference between us and Neanderthals.

The Origins of Fire

Anthropologists and paleontologists generally date the control of fire to about 250,000 years BCE. However, deposits of burned wood and flint discovered in the Gesher Benot Ya'aqov site in northern Israel strongly suggest that early humans may have controlled fire (as opposed to simply using it) as long as 800,000 years ago. If validated, the discovery would help explain how early humans were able to migrate out of Africa and into the colder climates of Europe and Asia -- a migration that began at about this time (N. Goren-Inbar et al., *Science*, 04/30/04).

Whether the Neanderthals were killed by Cro-Magnon, or interbred with them, the line died out about 30 thousand years ago. H. sapiens sapiens thrived, through the Old (Paleolithic), Middle

(Mesolithic) and New (Neolithic) Stone Age.

H. sapiens also spread out widely over the earth:

- first, from Africa to the Middle east
- then to Europe, Eurasia, and South Asia;
- to Southeast Asia;
- over a land bridge (or perhaps by boat) to Australia;
- to Asia proper;
- and over another land bridge to North America, migrating to Central and South America.

According to the most widely accepted theory, humans were in the Americas no later than 12 thousand years ago (although some evidence suggests a much earlier date for the first Americans). In this view, these first hunters and foragers were the ancestors of the ancient Hohokam and Anasazi cultures who built great hamlets and towns (e.g., Montezuma Castle and Casa Grande by the Hohokam; Canyon de Chelly by the Anasazi), and gave rise, respectively to present-day Tohono O'Odham and Pueblo cultures in Arizona and New Mexico.

Out of Africa... Into the Americas

For an overview of research on human migration to and through the Americas, see *the First Americans: In Pursuit of Archaeology's Greatest Mystery* by J.M. Adovasio (Random House, 2002). Traditional theory, based on the discovery of an early human site in Clovis, New Mexico, suggests that the first humans crossed the Bering Strait from Asia into North America about 11,000 years ago, and had settled as far south as Tierra del Fuego, at the tip of South America, within about 500 years. However, evidence from other sites, including Adovasio's own excavations near Meadowcroft, Pennsylvania, suggest that the earliest migration occurred 13,000 years ago. In this view, Clovis people were later immigrants, not pioneers.

About the only place we didn't get by walking was Antarctica, and now we're there, too, with permanent settlements since 1959.

Pushing Back Our Origins

The story of human evolution from *Australopithecus* through *Paranthropus* to *Homo* is fairly well accepted, though there are disagreements about the details. However, as noted earlier, occasionally a major discovery will occur that calls for major revisions in the story. The major consequence of these new discoveries is to push the origins of hominids back a little (or, in some cases, *a lot*) further back in time, or to add a branch to the main lines of human descent.

For example, until recently it was generally thought that the earliest hominids, known as *Australopithecus*, dated back some 4.5 million years ago, to an area in eastern Africa. But in just two short weeks in 2002, different teams of paleontologists reported discoveries that pushed the emergence of hominids back a lot in time and over a bit in space.

- The first of these, and the most surprising, was the discovery by Dr. Michel Brunet of the University of Poitiers, in France, of the "Chad skull" in Chad (hence its name), in the region of the southern Sahara desert known as the Sahel (actually, the skull was discovered by Ahounta Djimdoumalbaye, an undergraduate at Chad's University of N'Djamena, who was a member of Brunet's resaerch group). This skull apparently belongs to a new hominid species known as *Sahelanthropus tchadensis* ("Sahel man of Chad") -- or Toumai ("Hope of Life") in Goran, the language of the people in the area where it was discovered. Toumai lived as long as 7 million years ago, about 1 million years earlier than the earliest hominid previously known, and more than 2 million years before the famous *Australopithecus* known as "Lucy" (see below). Moreover, previous hominid skulls were found in the eastern and southern portions of Africa.

  Before Toumai, the earliest known hominid, *Orrorin tugenensis*, dating from about 6 million years ago, was discovered in Kenya.

  Another early hominid, *Ardipithecus ramidus*, dating from 5.2 to 5.8 million years ago, had been found in Ethiopia.

  The fact that the Toumai skull was found in western Africa suggests that our ape and hominid ancestors were more widely dispersed on the continent than previously believed. The Toumai skull mixes features of apes, such as a small braincase, with features characteristics of hominids, such as a flat rather than protruding face. For this reason, it has been suggested that it may be an ancestor of *both* chimpanzees and hominids, living before the two lines diverged. Another theory is that it represents another primate branch that has simply gone extinct.

- The other discovery, known as the "Georgia skull" because it was found in Georgia, a country that was formerly part of the Soviet Union, in an area near Tbilisi between the Black and Caspian Seas, is about 1.75 million years old and belongs to one or the other of three hominid species already known -- *Homo habilis*, *H. ergaster*, or *H. erectus*. But it and similar skulls were found with stone tools, such as choppers and scrapers, that seem much more primitive than those typically associated with *H. erectus*, so some theorists , So, unlike the Toumai skull, it doesn't suggest any sort of "missing link". Rather, the surprise here is that the skull was found outside of Africa. Previously, it was believed that the *Homo* species evolved in eastern Africa, and that *H. erectus* moved out of Africa sometime more recently than 1.6 million years ago. But here's a *homo* skull well outside Africa, and more than 1.6 million years old. So, the migration out of Africa might have begun earlier than we previously thought.

In October 2004, a team of Australian anthropologists discovered a "downsized" or "hobbit" version of *homo erectus*, with adults standing only 3-31/2 feet high, in a cave on Flores, an island in the Indonesian archipelago near Bali. Individual members of this species, named *homo floresiensis*, have been dated between 95,000 and 13,000 years ago -- meaning that they overlapped with *h. sapiens*, which arrived in Australia about 40,000 years ago. Stone tools also found have been attributed to *h. floresiensis* rather than later Neanderthals -- which is interesting, because these humans had brains hardly larger than those of adult chimpanzees. So, it's not brain *size* that's related to intelligence, as brain *structure* -- including, perhaps, the sulci and gyri that feature so prominently in human brains, and that permit humans to pack a large amount of cortex into a relatively small space.

Still, as I noted earlier, the main outlines of the story of human evolution remain intact.

Fossil Hominids

For a comprehensive, detailed, up-to-date overview of human evolution, check out *Fossil Hominids: The Evidence for Human Evolution*, a website maintained by Jim Foley that features a timeline of recent fossil finds: www.talkorigins.org/faqs/homs.

As *H. sapiens sapiens* proliferated around the world, adaptation to different climatic zones produced the physical differences associated with the different "races" of humans (much as *h. floresiensis* developed small stature in an. For example, pale skin is an advantage to those living in cool, cloudy lands because it facilitates the absorption of ultraviolet radiation, promoting the manufacture of vitamin D, a substance necessary for healthy bone growth. For people who live in the tropics, skin darkened by melanin protects against peeling and blistering, cancers caused by constant exposure to these same ultraviolet rays. In the tropics, a tall, slim physique radiates surplus heat, and keeps the body cool. In the cold climates of the far north, a short, squat body with high fat levels serves an insulating function. In areas with unreliable or inadequate supplies of food, short stature is adaptive, as are fatty buttocks. Improved diets increase stature and shrink teeth, muscles, and bones.

Much ink (and blood) has been spilled over the biological reality of various racial distinctions. In fact, research by Marc Feldman and associates, based at Stanford University, suggests that there are, after all, small genetic differences among the races. Surveying the DNA sequences of 1000 people sampled from each of 52 populations, he found that DNA differences between the groups fell into five clusters, or groups, roughly corresponding to their continents of origin: Africa, Eurasia (including Europe, the Middle East, and South Asia), East Asia, Oceania (including Australia), and North and South America. These, of course, correspond to the five "races" of folk taxonomy: Negroid, Indo-European, Mongolian, Pacific Islander, and (American) Indian.

The important thing to remember is that despite superficial physical differences (and even more superficial differences in biochemistry), all "races" of H. sapiens sapiens, Black, White, Mongoloid, or whatever, reflect differences in the same species of animal. Moreover, there are major individual differences among members of any single "race", and there are people with superficially similar features -- Africans and Australian Aborigines, for example, who are not members of the same

"race". The bottom line is that while "race" has some degree of biological reality, it is largely a mythical concept that is better discarded. All of us have a single common ancestor. In fact, there is a theory, based on analyses of mitochondrial DNA (which is passed only from female to female) that the entire race of modern humans -- black, white, and yellow -- are the descendants of a single female who lived in East Africa 200 thousand years ago. This theory has been called into question, but the essential point remains: we are all very closely related to each other, so we might as well treat each other with respect and affection.

Since the Ice Age ended, about 10 thousand years ago, H. sapiens sapiens has continued to thrive. During the New (Neolithic) Stone Age, hunters and foragers became farmers and herders who cultivated plants and domesticated animals.

- Rye was first grown as a crop cereal in about 11,000 BCE, and wheat about 8700 BCE, both in the Near East;
- Rice was cultivated in China around 7000 BCE;
- Cattle were domesticated in Africa by 5900 BCE;
- Maize (corn) was cultivated in Central America about 3500 BCE; and
- Pearl millet was cultivated in sub-Saharan Africa about 2000 BCE.

Neolithic people built villages and towns that gave rise to cities, the development of economies that were not devoted solely to the production of food, and the rise of hierarchical social structures. Ceramics were developed to store food. Reliance on stone tools gave way to bronze and copper -- first by hammering metal, later by forging and casting it. The earliest wooden plows date from 6 thousand years ago; the first wheels for transportation, 5.5 thousand; the first sailing ships, and the first writing, 5 thousand years ago.

The Origins of Writing

In the New World, systems for writing are generally thought to have emerged first in Zapotec culture near present-day Oaxaca, Mexico, about 300 BC, and in Mayan culture in southern Mexico and Central America about 200 AD. However, new archeological findings, reported in 2002 by Mary E.D. Pohl and her colleagues, suggests that some form of symbolic writing, known as *glyphs*, may have been available to the Olmec civilization in what is now Tabasco, Mexico, as early as 650 BC. The issue is not settled among archeologists: what appear to be glyphs may really be pictures, and the artifacts may not be as old as their discoverers originally thought.

Not all of these developments occurred simultaneously in every geographical area; and in some areas, some developments did not occur at all.

The Beginning (and Perhaps the End) of History

When writing begins, where it begins, history begins too, and science and culture begin to develop and proliferate extremely rapidly. At this point, about 5000 years ago, biological evolution

essentially ends: in genetic terms, and speaking metaphorically, we are the same species as Adam and Eve. The development of tools, clothes, medicine, and social structure mean that we are protected -- or, more correctly, *we protect ourselves* -- against the biological pressures that formerly killed those who were weak or stupid. The evolution of a new species requires biological isolation, and migration and inbreeding, within and between "racial" groups, effectively precludes that. It also requires a hostile environment, which insures the survival only of the fittest. So, biologically speaking, we are pretty much at the end of our line. Now the only threats to our existence come from ourselves -- overpopulation, ecological disaster, and nuclear holocaust.

To our knowledge, few other species have lasted even three million years before their inevitable extinction. But unlike nonhuman animals, we know what the threats to our existence are, we understand that they are largely of our own making, and we have the intelligence and technology to do something about them. We can save ourselves from extinction, but only if we think, and try. That's where human intelligence comes in. The ultimate gift of evolution, the human mind, has been and will remain the key to our survival as a species.

Actually, Tough, It Ain't Over 'Till It's Over

It's common to think that the biological evolution of the human species has pretty much reached its end point. That's pretty much the point of view taken here: once people start changing the environment, the environment has less chance to change *them* through natural selection. And, more or less, that's also the point of view taken by evolutionary psychologists (see below), who argue that patterns of human thought and behavior that evolved in the late Pleistocene era have remained pretty much unchanged up to the present.

These are good arguments, but they're apparently not quite true. Obviously, there's still opportunity for natural selection to operate on the human genome. In fact, in 2006, Jonathan Pritchard and his colleagues identified a number of segments of the human genome that have been subject to change via natural selection as recently as the last 5-10,000 years -- roughly since the beginning of agriculture. Some of these genes code for differences in skin color -- for example, between Europeans and Africans (Asians apparently acquired their light skins earlier, and through a different genetic route). Another gene facilitates the digestion of lactose -- a gene that was particularly useful to early European farmers who domesticated cattle and drank their milk.

So, evolution continues at the genetic level, if not at the level of body morphology, mind, and behavior.

Still, the best guess is that any two randomly selected individuals are more than 99% identical in their genes -- if not 99.9% identical, then maybe 99.5% identical. So, there may be some minor genetic differences between people of different continental ancestries, but "race" is still largely a social construct -- a way of classifying people that has no biological justification.

Evolutionary Psychology

Evolution doesn't just leave its mark on body morphology, giving fish scales and birds feathers, and humans opposable thumbs. It also leaves its mark on behavior, as seen in the "instincts", or fixed action patterns, discussed in the lectures on learning. In the 1970s, the evolutionary biologist E.O. Wilson coined the term *sociobiology* to represent the idea that patterns of social behavior evolved under the pressure of natural selection, just as physical traits did. In other words, a number of human social behaviors are instinctive, part of our innate behavioral endowment. We've seen instincts before, in the context of innate stimulus-response connections (remember reflex, taxis, instinct?). In the last chapter of his book, Wilson argued that instinctual social behavior might not be restricted to nonhuman animals like ants (the species Wilson studied) or the species studies by ethologists like Tinbergen, Lorenz, and von Frisch, but might extend to humans as well.

Taking a leaf from Wilson's book, some psychologists -- led by Leda Cosmides, John Tooby, and David Buss, among others -- have argued that mental traits evolved in the same way: that human beings, no less than other animals, have evolved specific patterns of thought, feeling, and desire through natural selection (in fact, Buss's first book was entitled *The Evolution of Desire*). The reason some of our behaviors and thought processes seem maladaptive, or at least inappropriate, in today's world is that they evolved to foster adaptation to a particular environment, known as the *environment of early adaptation* (also known as the "environment of early adaptation", in either case abbreviated *EEA*) -- roughly the African savanna of the Pleistocene epoch (modern Ethiopia, Kenya, and Tanzania), where *homo sapiens* first emerged about 300,000 years ago -- and have changed little since then.

Although this assertion is debatable, to say the least, the literature on instincts makes it clear that evolution shapes behavior as well as body morphology. Many species possess innate behavior patterns that were shaped by evolution, permitting them to adapt to a particular environmental niche. Given the basic principle of the continuity of species, it is a mistake to think that humans are entirely immune from such influences -- although humans have other characteristics that largely free us from evolutionary constraints. Since the emergence of humans, the cultural environment has changed a great deal, but there has not been enough time for biological evolution to produce new, more adaptive traits.

Certainly there are good reasons for believing that the uniquely human capacity for language is a product of evolution. So, arguably, are the kinds of mechanisms envisioned by Gibson's idea of direct perception. But there are reasons for thinking that the theory of biological evolution is not the answer to psychology's problems.

Evolutionary psychologists who study mating frequently place a great deal of stress on a particular dimorphism in which older males prefer younger females. This pattern makes evolutionary sense, given that young females (at least, young *women*) have greater childbearing capacity than older ones (at least, women who have reached menopause). In turn, evolution is evoked to explain a wide variety of mating phenomena, from President Bill Clinton's entanglement with Monica Lewinsky to the common practice of rich men abandoning their first wives (or their second, or their third...) to take younger, ostensibly more attractive "trophy wives" (a term coined by *Fortune* magazine in the 1980s). **But...**

- It should be remembered that Clinton and Lewinsky did not actually engage in sexual intercourse, but rather stuck with oral sex (and if you believe the stories, Clinton also preferred oral sex with his other extramarital partners). Therefore, whatever the causes of Clinton's behavior, it appears to have had nothing to do with any desire on his part to propagate his genes by impregnating multiple, youthful, partners.
- While it's certainly a trend for older, successful men to divorce and marry trophy wives (someone once referred to it as "changing a 40 for two 20s"), it is not at all clear that they go on to have children by these women. In fact, an article in the *New York Times* notes the increasing trend to write a prohibition on children into prenuptial agreements -- although it is not clear that such provisos will hold up if challenged in court ("A Promise to Love, Honor, and Bear No Children" by Jill Brooke, 10/13/02). Some young women may make children a condition for marrying an older man, or may desire children of their own to inflate their claims for support in the event of divorce -- or just because they want to bear children; but that doesn't mean that the older man is motivated, in taking a new, younger wife, by the desire on his part to further propagate his genes.

Steven Pinker has written (2008): "To understand human nature, first understand the conditions that prevailed during most of human evolution, before the appearance of agriculture, cities, and government". Perhaps. Then again, it was by virtue of human nature that we *invented* agriculture, cities, and government in the first place. Human nature is not restricted to biological givens: it also extends to sociocultural constructions.

The Ontogenesis of Personhood

Phylogenesis has to do with the development of the species as a whole. Ontogenesis has to do with the development of the individual species member. In contrast to comparative psychology, which makes its comparisons across species, developmental psychology makes its comparisons across different epochs of the life span.

Mostly, developmental psychology focuses its interests on infancy and childhood -- a natural choice, given the idea that mental development is correlated with physical maturation. At its core, developmental psychology is dominated by the these of nature vs. nurture, or nativism vs. empiricism:

- Is the newborn child a "blank slate", all of whose knowledge and skills are acquired through learning experiences?
- Or are some aspects of mental functioning innate, part of the child's genetic endowment, acquired through the course of evolution?

Of course, neither physical nor mental development stops at puberty. More recently, developmental psychology has acquired an additional focus on development across the *life span*, including adolescence and adulthood, with a special interest in the elderly.

The Human Genome

The human genetic endowment consists of 23 pairs of **chromosomes**. Each chromosome contains a large number of **genes**. Genes, in turn, are composed of deoxyribonucleic acid (**DNA**), itself composed of a sequence of four chemical bases: adenine, guanine, thymine, and cytosine (the letters A, G, T, and C which you see in graphical descriptions of various genes). Every gene is located at a particular place on a specific chromosome. And since chromosomes come in pairs, so do genes.

Corresponding pairs of genes, contain information about some characteristic, such as eye color, skin pigmentation, etc. While some traits are determined by single pairs of genes, others, such as height, are determined by several genes acting together. In either case, genes come in two basic categories. **Dominant** genes (indicated by upper-case letters) exert an effect on some trait regardless of the other member. For example, in general the genes for brown eyes, dark hair, thick lips, and dimples are dominant genes. **Recessive** genes (indicated by lower-case letters) affect a trait only if the other member is identical. For example, in general the genes for blue eyes, baldness, red hair, and straight noses are recessive. The entire set of genes comprises the organism's **genotype**, or genetic blueprint.

One of the most important technical successes in biological research was the decoding of the human genome -- determining the precise sequence of As, Gs, Ts, and Cs that make us, as a species, different from all other species. And along with this advance in gene mapping, it has been possible to determine specific genes that put us at risk for various diseases, and which dispose us to various personality traits. Some sense of this situation is given by the "genetic" autobiography (*A Life Decoded*, 2007) published by Craig Venter, the "loser" (in 2001, to a consortium government-financed academic medical centers) in the race to decode the human genome -- though, it must be said, the description of the genome produced by Venter's group is arguably superior to that produced by the government-financed researchers. Anyway, Venter has organized his autobiography around his own genome (which is what was sequenced by his group in the race), which revealed a number of such genes, including:

- on Chromosome 1, the gene TNFSF4, linked to heart attacks;
- on Chromosome 4, the CLOCK gene, related to an evening preference (i.e., a "night person" as opposed to a "day person");
- on Chromosome 8, the gene CHRNA8, linked to tobacco addiction;
- on Chromosome 9, DRD4, linked to novelty-seeking (Venter is an inveterate surfer);
- on Chromosome 18, the gene APOE, linked to Alzheimer's disease; and
- on the X Chromosome, the MAOA gene (about which more later, in the lectures on Personality and Psychopathology), which is linked to antisocial behavior and conduct disorder (among genetics researchers, Venter has a reputation as something of a "bad boy").

None of these genes means that Venter is predestined for a heart attack or Alzheimer's disease, any more than he was genetically predestined to be a surfer. It's just that these genes are more common in people who have these problems than in those who do not. They're risk factors, but not an irrevocable sentence to heart disease or dementia.

From Genotype to Phenotype

Of course, genes don't act in isolation to determine various heritable traits. One's genetic endowment interacts with environmental factors to produce a **phenotype**, or what the organism actually looks like. The genotype represents the individual's biological potential, which is actualized within a particular environmental context. The environment can be further classified as prenatal (the environment in the womb during gestation), perinatal (the environment around the time of birth), and postnatal (the environment present after birth, and throughout the life course until death).

Because of the role of the environment, phenotypes are not necessarily equivalent to genotypes. For example, two individuals may have the same phenotype but different genotypes. Thus, of two brown-eyed individuals, one might have two dominant genes for brown eyes (BB), while another might have one dominant gene for brown eyes and one recessive gene for blue eyes (Bb). Similarly, two individual may have the same genotype, but different phenotypes. For example, two individuals may have the same dominant genes for dimples, (DD), but one has his or her dimples removed by plastic surgery.

The chromosomes are found in the nucleus of each cell in the human body, except the sperm cells of the male and the egg cells of the female, which contain only one element of each pair. At fertilization, each element contributed by the male pairs up with the corresponding element contributed by the female to form a single cell, or **zygote**. At this point, cell division begins. The first few divisions form a larger structure, the **blastocyst**. After six days, the zygote is implanted in the uterus, at which point we speak of an **embryo**.

Personality, Behavior, and the Human Genome Project

Evidence of a genetic contribution to individual differences (see below), coupled with the announcement of the decoding of the human genome in 2001, has led some behavior geneticists to suggest that we will soon be able to identify the genetic sources of how we think, feel, and behave. However, there are reasons for thinking that behavior genetics will not solve the problem of the origins of mind and behavior.

- In the first place, there aren't enough genes. Before 2001, it was commonly estimated that there were approximately 100,000 genes in the human genome. The reasoning was that humans are so complex, at the very apex of animal evolution, that we ought to have correspondingly many genes. However, when genetic scientists announced the provisional decoding of the human genome in 2001, they were surprised to find that the human genome contains only about 30,000 genes -- perhaps as few as 15,000 genes, perhaps as many as 45,000, but still far too few to account for much important variance in human experience, thought, and action. (As of 2004, there were still a couple of gaps in our

knowledge of the human genetic code, and by the time these are closed, the number of human genes may well have fallen again!)

- The situation got worse in 2004, when a revised analysis (reported in *Nature*) lowered the number of human genes to 20-25,000.
- By comparison, the spotted green pufferfish also has about 20-25,000 genes.
- On the lower end of the spectrum, the worm *c. elegans* has about 20,000 genes, while the fruit fly has 14,000.
- On the higher end of the scale, it was reported in 2002 that the genome for *rice* may have more than 50,000 genes (specifically, the *japonica* strain may have 50,000 genes, while the *indica* variety may have 55,600 genes).

If it takes 50,000 genes to make a crummy grain of rice, and humans have only about 23,000 genes, then there's something else going on. For example, through *alternative splicing*, a single gene can produce several different kinds of proteins -- and it seems to be the case that alternative splicing is found more frequently in the human genome than in that of other animals. Alternatively, the human genome seems to contain more sophisticated *regulatory genes*, which control the workings of other genes.

- Before anyone makes large claims about the genetic underpinnings of human thought and action, we're going to need a much better account of how genes actually work.
- Of course, it's not just the sheer number of genes, but the genetic code -- the sequence of bases A, G, T, and C -- that's really important. Interestingly in 2002 the mouse genome was decoded, revealing about 300,000 genes. Moreover, it turned about that about 99% of these genes were common with the human genome (the corresponding figure is about 99.5% in common for humans and our closest primate relative, the chimpanzee). This this extremely high degree of genetic similarity makes sense from an evolutionary point of view: after all, mice, chimpanzees, and humans are descended from a common mammalian ancestor who lived about 75 million years ago. And it also means that the mouse is an excellent model for biological research geared to understanding, treating, and preventing human disease, it is problematic for those who argue that genes are important determinants of human behavior. That leaves 300 genes to make the difference between mouse and human, and only about 150 genes to make the difference between chimpanzees and humans. *Not enough genes.*
- Perhaps the action is not in the genes, but rather in their constituent proteins: *indica* rice has about 466 million base pairs, and *japonica* about 420 million, compared to 3 billion for humans (and about 2.5 billion for mice).

In any event, for all the talk about the genetic underpinnings of individual differences, as things stand now and behavior geneticists don't have the foggiest idea what it is.

> "In the god-drenched eras of the past there was a tendency to attribute a variety of everyday phenomena to divine intervention, and each deity in a vast pantheon was charged with responsibility for a specific activity -- war, drunkenness, lust, and so on. 'How silly and primitive that all was,' the writer

Louis Menand has observed. In our own period what Menand discerns as a secular 'new polytheism' is based on genes -- the alcoholism gene, the laziness gene, the schizophrenia gene.

> Now we explain things by reference to an abbreviated SLC6A4 gene on chromosome 17q12, and feel much superior for it. But there is not, if you think about it, that much difference between saying 'The gods are angry' and saying 'He has the gene for anger.' Both are ways of attributing a matter of personal agency to some fateful and mysterious impersonal power."

---Cullen Murphy in "The Path of Brighteousness" (*Atlantic Monthly,* 11/03)

Embryological Development

What are the mechanisms of embryological development? At one point, it was thought that the individual possesses adult form from the very beginning -- that is, that the embryo is a kind of **homunculus** (little man), and that the embryo simply grew in size. This view of development is obviously incorrect. But that didn't stop people from seeing adult forms in embryos!

In the 19th century, with the adoption of the theory of evolution, the homunculus view was gradually replaced by the **recapitulation** view, based on Haeckel's **biogenetic law** that

"Ontogeny recapitulates phylogeny".

What Haeckel meant was that the development of the individual replicates the stages of evolution: that the juvenile stage of human development repeats the adult stages of our evolutionary ancestors. Thus, it was thought, the human embryo first looks like an adult fish; later, it looks like adult amphibians, reptiles, birds, mammals, and nonhuman primates. This view of development is also incorrect, but it took a long time for people to figure this out. For a history of the rise and fall of Haeckel's law, see S.J. Gould's *Ontogeny and Phylogeny*.

The current view of development is based on von Baer's principle of **differentiation**. According to this rule, development proceeds from the general to the specific. In the early stages of its development, every organism is homogeneous and coarsely structured. But it carries the potential for later structure. In later stages of development, the organism is heterogeneous and finely built -- it more closely represents actualized potential. Thus, the human embryo doesn't look like an adult fish. But at some point, human and fish embryos look very much alike. These common structures later differentiate into fish and humans. A good example of the differentiation principle is the development of the human reproductive anatomy, which we'll discuss later in the course.

Ontogeny and Phylogeny

For an engaging history of the debate between recapitulation and differentiation views of development, see *Ontogeny and Phylogeny* (1977) by S.J. Gould.

Neural Development in the Fetus

At the end of the second week of gestation, the embryo is characterized by a **primitive streak** which will develop into the spinal cord. By the end of the fourth week, **somites** develop, which will become the vertebrae surrounding the spinal cord -- the characteristic that differentiates vertebrates from invertebrates.

> Bodily asymmetries seem to have their origins in events occurring at an early stage of embryological development. Studies of mouse embryos by Shigenori Nonaka and his colleagues, published in 2002, implicate a structure known as the node, which contains a number of cilia, or hairlike structures. The motion of the cilia induce fluids to move over the embryo from right to left. These fluids contain hormones and other chemicals that control development, and thus cause the heart to grow on the left, and the liver and appendix on the right -- at least for 99.99% of people. On rare occasions, a condition known as *situs inversus*, the position of the embryo is reversed, so the fluids flow left to right, resulting in a reversal of the relative positions of the internal organs -- heart on the right, liver and appendix on the left. It is possible that this process is responsible for including the hemispheric asymmetries associated with cerebral lateralization -- although something else must also be involved, given that the incidence of right-handedness is far greater than 0.01%.

In the second month, the **eye buds** move to the front of the head, and the limbs, fingers, and toes become defined. The internal organs also begin to develop, including the four-chambered heart -- the first characteristic that differentiates mammals from nonmammals among the vertebrates. It's at this point that the embryo changes status, and is called a **fetus**.

The development of the nervous system begins in the primitive streak of the embryo, which gradually forms an open **neural tube**. The neural tube closes after 22 days, and brain development begins.

In the 11th week of gestation the **cerebral cortex** becomes clearly visible. The cortex continues to grow, forming the folds and fissures that permit a very large brain mass to fit into a relatively small brain case.

In the 21st week of gestation **synapses** begin to form. Synaptic transmission is the mechanism by which the nervous system operates: there is no electrical activity without synapses. So, before this time the fetal brain has not really been functioning.

In the 24th week **myelinization** begins. The **myelin sheath** provides a kind of insulation on the axons of neurons, and regulates the speed at which the neural impulse travels down the axon from the cell body to the terminal fibers.

All three processes -- cortical development, synaptic development, and myelinization -- continue for the rest of fetal development, and even after birth. In fact, myelinization is not complete until late in childhood.

Studies of premature infants indicate that an EEG signal can be recorded at about 25 weeks of gestation. At this point, there is evidence of the first organized electrical activity in the brain. Thus, somewhere between the 6th and 8th month of gestation the fetal brain becomes recognizably human. There are lots of the folds and fissures that characterize the human cerebral cortex. And there is some evidence for hemispheric specialization: premature infants respond more to speech presented to the left hemisphere, and more to music presented to the right. At this point, in the 3rd semester of gestation, the brain clearly differentiates humans from nonhumans.

Interestingly, survivability takes a big jump at this point as well. If born before about 24 weeks of gestation, the infant has little chance of survival, and then only with artificial life supports; if born after 26 weeks, the chances of survival are very good. If born at this point, the human neonate clearly has human physical characteristics, and human mental capacities. In other words, by some accounts, by this point the fetus clearly has **personhood**, because its has actualized its potential to become human. At this point, it makes sense to begin to talk about personality -- how the person actualizes his or her potential for individuality.

Much of this information has been drawn from *The Facts of Life: Science and the Abortion Controversy* (1992) by H.J. Morowitz and J.S. Trefil. Advances in medical technology may make it possible for fetuses to live outside the womb even at a very early stage of gestation, but no advance in medical technology will change the basic course of fetal development, as outlined here and presented in greater detail in the book.

Development as Quantitative Change

The earliest theories of psychological development focused on **maturation** and **learning**. In general, these theories offered a view of the child as a *short, stupid adult* who grows smarter as he or she grows bigger. Viewed in this way, there is a continuum between childhood and adulthood, with no abrupt, qualitative changes.

Maturation

Maturation may be defined as the progressive, inevitable unfolding of certain patterns of behavior under genetic control. These behavior patterns occur in a regular sequence, unaffected by practice or environmental change.

Maturation is a good description of certain developmental processes, such as **walking**. We speak of children "learning" to walk, but we know from the stepping reflex in infants (see the lecture supplement on Learning) that walking occurs naturally, requiring only that the child be able to support itself. Thus, walking occurs as soon as the skeletal musculature develops sufficiently to provide that support.

- A classic study of maturation involved traditional Hopi and Navajo children, who are swaddled and bound to a cradle for the first year of life. This severely restricts motor behavior, but once released from the cradle there is little retardation in the emergence of walking.
- In another classic study, by Arnold Gesell, some children were trained in walking and climbing stairs. They did, in fact, show these behaviors earlier than untrained children. But the untrained controls quickly caught up, and the further progress of the experimental group was not accelerated by their training. Both groups advanced beyond walking at the same pace.

The continuous view of development is exemplified by the measurement of intelligence in terms of IQ:

- Alfred Binet measured IQ as the ratio of the individual's mental age to his or her chronological age, imposing an artificial ceiling of 18 years on both ages. An individual with an IQ of 100 is exactly as old mentally as he is chronologically.
- David Wechsler substituted the "deviation IQ" for the "ratio IQ" of Binet, so that an individual with an IQ has the same IQ test score as the average person in his age group.

The implication is either method of measuring intelligence is that children continuously grow smarter as they grow older.

Despite debates over whether IQ is heritable, the classical "continuity" view is that the child gradually acquires knowledge through learning, where learning was construed as tantamount to classical or instrumental conditioning. John Locke, an English philosopher of the 18th century, famously argued that the infant is a *tabula rasa*, or "blank slate", which is "written on" by experience. In the Lockean view, development is a matter of learning more than you already know.

Whether the theoretical focus is on maturation or learning, the process of development is viewed as a matter of *continuous, quantitative change*: the infant starts out small, physically and mentally, and gets bigger, physically and mentally, as he or she grows up.

Is Childhood a Recent Cultural Invention?

In his book, *Centuries of Childhood* (1960), Philippe Aries, a French social historian, created quite a stir by arguing that what we call "childhood" did not exist for most of history, and instead was a creation by modern liberal thought (by which he meant the liberalism of the Enlightenment of the 17th and 18th centuries). In medieval times, Aries argued, children joined the adult world pretty much as soon as they could walk, talk, and eat solid food. They married early (think of *Romeo and Juliet*, and they went to war

(think of the Children's Crusade), and they earned money (in the fields or as domestic servants or apprentices). They were, in fact, short, stupid adults. It was only in the modern era that children were seen as different, as innocents who were sent to school, or protected at home (in what became the nuclear family), as opposed to going out to work with the rest of their extended family. The prime mover in this shift, according to Aries, was Jean-Jacques Rousseau, who promoted a sentimental view of children. Other historians quickly picked up the general thrust of his argument, particularly Edward Shorter (in *The Making of the Modern Family*, 1975) and Lawrence Stone (in *The Family, Sex, and Marriage in England, 1500-1900*, 1977).

Relatedly, it has been argued that adolescence is largely an invention of the 20th century, with its laws against child labor and compulsory schooling.

However, there were also dissenters, such as Steven Ozment (in *Ancestors*, 2001), who argued that children have always been children, pretty much as they are today.

Eventually, the dispute spawned a great deal of historical research on childhood and the family. Joan Acocella, reviewing the three-volume *History of the European Family* (2001, 2003, 2004), shows how family life did indeed change radically in the 17th and especially the 18th centuries. But it turns out that Aries generalized way too far beyond his limited data, which he generally selected in ways that would support his theory. The actual picture is pretty complex, but in the end Acocella generally sides with Ozment: "there had been a culture of childhood ever since there were documentable children" ("Little People", *New Yorker*, 08/18-25/03, from which the illustration, by Saul Steinberg, is also taken).

Development as Qualitative Change

Later theories of development focused on *qualitative* changes. The child is not just a short, stupid adult, but rather the young child is held to *think differently* than older children and adults. Thus, developmental differences are qualitative, differences in kind, not just quantitative, differences in amount. Children are not stupid, compared to adults, but their intelligence needs to be appreciated on its own terms.

Piaget's Stage Theory of Cognitive Development

This was the view propounded by Jean Piaget, who argued that the development of intelligence proceeds through a sequence of stages, each defined by cognitive landmarks:

- sensory-motor intelligence,

- preoperational thought,
- concrete operations, and
- formal operations.

An important concept in Piaget's theory is the **schema**, a term which should be familiar from Bartlett's work on memory reconstruction and Neisser's concept of the perceptual cycle. For Piaget, a schema is an organized mental structure that produces a particular coordinated response to a certain class (or category) of stimulation. Thus, a schema is a kind of concept, that renders diverse objects functionally equivalent -- because they belong in the same class.

In a very real sense, cognitive development is the development of schemata (the plural of schema, although *schemas* is also an acceptable alternative) -- their elaboration and differentiation. Schemata are like categories, and guide the perception of (and thus response to) particular objects and events. The interaction between schemata and the objects with which they come into contact is characterized by the twin processes of **assimilation** and **accommodation**. By virtue of assimilation, the mental representation of the stimulus is altered so that it will fit into the schemata employed to process it; by virtue of accommodation, the schema itself is altered so that it can receive the stimulus. Thus, the final representation of the stimulus is a sort of compromise between what was expected and the actual stimulus itself. The neonate confronts the world with a primitive set of innate schemata; through assimilation and accommodation, the nature of these schemata gradually change. At certain points, however, the changes in mental schemata are so dramatic that they appear qualitative rather than merely quantitative; these shifts mark the child's move from one stage of cognitive development to another.

The first of Piaget's stages is **sensory-motor intelligence** (also known as the sensory-motor period). In this stage, which encompasses the first two years of life, the world of the child is one of unrelated sensory experiences and reflex-like motor reactions to them. The child has no ability to connect the present with the past or the future, and no ability to distinguish between self and other. At least, that is how the child starts out. To take a phrase from William James, for the sensory-motor infant the world is a "blooming, buzzing confusion". Over the first two years of life, these capacities develop; according to Piaget, their complete acquisition terminates this stage of cognitive development.

One of the major accomplishments of the sensory-motor period is the development of **object permanence**. The newborn's behavior is tied to what comes through its senses, which are processed by **sensory-motor schemata**. Out of sight is out of mind. Eventually, however, the child comes to behave as if they have internal representations of objects that are not actually present in their sensory environment. Early on, if a toy is hidden they will turn their attention to something else. Later, if a toy is hidden they will search for it. This searching behavior shows that the child has an idea of the object that persists despite its physical disappearance -- at this point, the child has acquired the capacity for forming internal, mental representations -- *memories* -- of the outside world.

At this point, about 24 months after birth, the infant moves fully into the nest stage of cognitive development, the **preoperational period**. At this point, the child is able to form and retain internal representations of objects and events, but these representations exist as individual mental units, unrelated to each other. The major achievement of the preoperational period is the ability to relate one representation to another, through higher-order schemata called **operations**. This takes about

the next five years.

The developmental of operational modes of thought is marked by the emergence of **conservation**, which occurs by about the time the child is seven years of age. In the earliest portion of the preoperational period, the child does not conserve at all. If a short, wide cup of liquid is poured into a tall, thin glass, he or she may well say that there is more liquid in the former than in the latter. This is because the child can track changes in either height or diameter (actually, if you want to be technical, radius), but not both simultaneously. Thus, the child cannot understand that volume, which is a product of height and radius, remains constant when the liquid is poured from one container into the other. Similarly, if a young child is shown five objects lined up over a short distance, and later the same five objects arrayed over a longer line, he or she is likely to say that there are more objects in the latter case than in the former. Thus, the child confuses the number of the objects with the linear distance over which they are arrayed. At some point, however, the child no longer makes these mistakes: he or she has acquired the ability to consider height and radius, number and distance, simultaneously, and compensate for one with the other. At that point, the child has acquired the ability of conservation.

An analogue of conservation failure in the interpersonal domain is **egocentrism**, which is not to be confused with selfishness. From Piaget's point of view, egocentrism reflects the child's inability to take another's point of view, or to appreciate the viewpoints of other peoples. Thus, an egocentric child will say that other people view the world from the same perspective as he or she does; and that others will react to events as he or she does. By the age of seven, however, the child has abandoned the egocentric attitude, and is able to represent the world as others see it, as well as he or she sees it.

At about age seven, the child enters the stage of **concrete operations**, in which children are capable of thinking and reasoning about objects and events which they have actually experienced. Concrete-operational children are actually pretty powerful thinkers. They conserve, they can pay attention to objects other than the most salient ones, they can take another's point of view, they can take account of transformations in state, they can classify objects into groups based on shared properties, and they can generate and use hierarchical classification schemes. You can get along pretty well in life with nothing more than concrete operations, so long as you are reasoning about familiar problems involving familiar objects and events.

Unfortunately, concrete operations aren't always enough. It is often useful to go beyond our own past experiences, and to reason about things we haven't seen or touched, and about things that aren't visible or touchable. Concrete operations don't suffice for this purpose. Good thing, then, that around age twelve the child enters into the last of Piaget's stages, **formal operations**. In formal operations, the thinking can be purely symbolic, without referring to anything at all by way of concrete objects and events. It is necessary, for example, for the transition from arithmetic to algebra -- where *x*, for example, is just an abstract symbol and doesn't refer to anything at all.

The hallmark of formal operations is scientific thinking, which is what lies behind Piaget's notion of the child as a naive scientist. This is marked by four different qualities: (1) hypothetico-deductive reasoning, in which we can hypothesize about a certain state of affairs, and then reason deductively from that hypothesis (that is, we can *assume* that something is true without requiring that it actually *be* true); (2) inductive reasoning, in which the person generalizes from specific observations to general principles; (3) reflective abstraction, in which the child is able to reflect on

their own thoughts to arrive a novel ideas; and (4) propositional logic, in which the child can reason about two or more abstract entities represented by statements such as "If there is a P, then there is a Q". Children who have developed the capacity for formal operations are able to deal with several abstract variables at the same time.

If concrete operations are analogous to arithmetic,

formal operations are analogous to algebra.

Piaget traced cognitive development only up to adolescence. One aspect of the debate about his theory is whether cognitive development does in fact end with the acquisition of formal operations, or whether there are other, more advanced, stages of thought.

Piaget and the "Science of Creative Intelligence"

One proposal for further stages of cognitive development, beyond Piagetian formal operations, has come from Maharishi Mahesh Yogi, founder of the Transcendental Meditation movement and guru to the Beatles. The Maharishi now promotes a *science of creative intelligence* in which meditation -- Transcendental Meditation, of course -- moves the practitioner to higher stages of cognitive development.

Another question is whether Piaget's stages are stages at all -- that is, whether it is true that children progress from sensory-motor intelligence through preoperational logic and concrete operations to formal operations in the way that he thought. An important part of this question concerns the lower boundaries of Piaget's stages. Is it really true that children younger than age 7 are generally incapable of abstract thought? A very large research tradition has developed out of questions like these, the general conclusion of which is that cognitive development is probably more continuous than Piaget thought, and that even very young children have amazing powers of thought, at least in limited domains. For example, it has been shown that five-month-old infants are capable of rudimentary arithmetic operations of addition and subtraction, so long as they are only asked to deal with very small number of objects.

Kohlberg's Theory of Moral Development

Following in Piaget's footsteps, Lawrence Kohlberg developed a theory of the stages of moral development -- by which he meant moral *reasoning*, not moral behavior. Like Piaget, Kohlberg believed that his stages were universal, but in fact his studies were largely confined to male subjects -- leading him to conclude, for example, that women generally failed to reach the highest stages of moral development (roughly equivalent to the views of a liberal Democrat). Carol Gilligan argued that Kohlberg's procedures were flawed, and that women went through stages of moral development that were qualitatively different from those of men. In this way, Gilligan laid the foundation for "difference feminism", based on the "essentialist" view that women's mental lives follow different principles than those of men.

Freud's Theory of Psychosexual Development

In the domain of personality, another theory postulating qualitatively different developmental stages is Freud's theory of **psychosexual development**. The fundamental assertion of Freud's **psychoanalytic theory** is that personality is rooted in conflict between certain biological instincts (sex, aggression) and environmental constraints and demands. This conflict must be resolved in some way. The child's adaptation to conflict interacts with other developmental events, and personality is formed from the resulting habitual adaptation.

For Freud, sexual and aggressive motives are at the center of personality. These instincts arise from the **id** and are controlled by the **ego** and **superego**. They are the urges that the **defense mechanisms** defend us against. Now, nobody would argue that sexual issues are not important for personality. Many of the issues that confront adolescents and adults are sexual in nature. Once you reach puberty, if not before, sex is an issue. But Freud went further, by stating that sex is the paramount issue, from birth. He believed that sexual impulses were present in the newborn child, and that they continued to seek expression and gratification until death. The theory of **infantile sexuality** was Freud's most radical hypothesis. However, the student should understand that for Freud, sexuality was not confined to intercourse and orgasm. Rather, Freud defined sex as anything that lead to pleasure. Thus, the theory of infantile sexuality is a portrait of the infant as an active seeker of pleasure. The precise form that this pleasure takes is determined by the child's stage of development.

For Freud, all instincts have their origins in some somatic irritation -- metaphorically, some itch that must be scratched. At any time, a particular portion of the body is the focus of that instinct -- the place where arousal and gratification occur. These somatic loci change systematically through childhood, and stabilize in adolescence. These systematic changes comprise the stages in psychosexual development, and the child's progress through these stages is decisive for the development of personality.

The **oral stage** comprises the period from birth to approximately 12 months of age. According to Freud, the newborn child begins as "all id", "no ego", experiencing only pleasure and pain. In utero, nourishment was provided automatically. After birth, with feeding, the child must begin to respond to the demands of the external world -- what it provides, and the schedule with which it provides it. Thus, instinct gratification is initially centered on the mouth: sucking at breast or bottle. This sucking activity has obvious nutritive value, in that is satisfied hunger and thirst. But Freud also asserted that it also had sexual value, because the child gained pleasure from sucking. In addition, aggressive instincts can be displayed through the mouth, as in biting.

The legacy of the oral stage is a complex of dependency and separation anxiety. The child needs its mother for instinct-gratification, and her absence leads to feelings of frustration and anxiety. It also leads to the development of the **ego**, the mental structure whose job it is to separate fantasy from reality.

The **anal stage** lasts from about 1 to 3 years of age. Toilet training provides the child with his or her first experience of the regulation of impulses -- the child must learn to postpone the pleasure that

comes from the relief of anal tension.

The legacy of the anal stage is the sense that one can acquire desirable goods (e.g., praise) by giving or retaining; the first pangs of loss; and, especially, the first sense of self-control.

The **phallic stage** lasts from about 3 to 5 years of age. In this period, Freud believed the child, boy or girl, was preoccupied with sexual pleasure derived from the genital area -- curiosity, exhibitionism, and masturbation. Why is this stage called phallic, when only boys have a penis? His idea is that in different ways, both males and females are interested in the penis. How this is so leads us to one of Freud's most startling theories, the **Oedipus complex**.

During the phallic period, Freud thought there occurred an intensification of sexual interest in the parent of the opposite sex. In his terms, there is a sexual **cathexis** (e.g., heightened attention) toward the parent of the opposite sex, and an aggressive cathexis toward the parent of the same sex. This is the Oedipus complex, named after the Greek myth about the man who unknowingly killed his father and married his mother, and the phallic stage revolves around its resolution.

The beginnings of the Oedipus complex are the same for males and females. They love their mother because she satisfies their needs, and they hate their father because he competes for the mother's attention and love.

In the male, the Oedipus complex occurs as the jealousy of the father combines with **castration anxiety**. The child, remember, is engaging in autoerotic activity, which is often punished by a threat to remove the penis. This threat is reinforced by observation of the female genitalia, which obviously lack a penis. So the child gets the idea that this threat is real. Nevertheless, the boy's love for his mother intensifies, and these incestuous desires increase the risk of being harmed by the father. The father is too powerful, and must be appeased. Thus, the boy **represses** his hostility and fear, and converts it by means of **reaction formation** into expressions of love. At the same time, mother must be given up, though she remains desirable. Thus, the child also represses his sexual longings. The final solution of the boy's problem is **identification** with his father. His father is now an ally instead of an enemy, and through this identification the boy can gain vicarious satisfaction of his desire for his mother.

In the female, the same sort of process works itself out in the **Electra complex**, named after the Greek myth of the princess, daughter of Agamemnon and Clymenestra, who conspires with her brother Orestes to murder her mother and her mother's lover, in order to avenge their father's death. But the Electra complex is not the mirror-image of the Oedipus complex. For example, the girl's problem is not castration anxiety, since there is no penis to injure, but resentment at deprivation. Initially, the girl loves her mother for her role as caretaker, and has no particular feelings toward her father. Nor is she punished for autoerotic activity -- perhaps because it doesn't occur, perhaps because it isn't discovered. Eventually, however, the girl discovers that she lacks the phallic equipment of the male: this leads to disappointment and feelings of castration -- what Freud called **penis envy**. She blames her mother for her fate, which weakens her cathexis toward her; and she envies her father's equipment, which strengthens her cathexis toward him. The result is that the girl feels love for her father, and hatred and jealousy for her mother. She wants her father to give her a penis, and accepts a baby -- represented by a doll -- as a substitute. Thus, there is no clear-cut resolution of the Electra complex in girls. Castration is a fact, not a threat. In the end, however, the girl identifies with her mother in order to gain vicarious satisfaction of her love for her

father.

In any event, the first legacy of the phallic stage is the **superego** -- the child internalizes social prohibitions against certain object-choices, as well as parental rewards and punishments.

The second legacy is psychosexual identification: the boy identifies with his father, the girl with her mother, and take on the characteristic roles, and personality, of the same-sex parent.

During the **latency period**, which lasts from about age 5 to age 11, Freud thought that the child's instinctual impulses subsided, with a slowing of the rate of physical growth, and the effects of the defenses brought to bear in the resolution of the Oedipus/Electra complex. During this period the child is not actively interested in sex and aggression, but works on the task of learning about the world, society, and his or her peers.

During the **genital period**, which lasts from age 12 to death, the person moves into another period of sexual interest. Sexual maturity reawakens the sexual instincts which have been dormant. But with a difference. There is a shift away from **primary narcissism**, in which the child takes pleasure in stimulating his or her own body, to **secondary narcissism**, who takes pleasure from identifying with an ideal. Sexuality shifts from an orientation toward pleasure to an orientation toward reproduction, in which pleasure is secondary. There is strong attraction to the opposite sex, and an interest in romance, marriage, and children. There is a continued focus on socialization. However, the earlier stages of psychosexual development can influence the nature of the individual's genital sexuality, in terms of the preferred locus of sexual foreplay, and the bodily focus of erotic interest.

Freud believed that the individual's passage through these stages left its imprint on adult personality. If all goes well, the person develops a **genital character**, as reflected in full sexual satisfaction through orgasm. The genital character is able to effectively regulate his (or her) sexual impulses for the first time. The person need no longer adopt primitive defenses such as repression, though certain adaptive defenses are still operative. The person's emotions are no longer threatening, and can be expressed. The person is no longer ambivalent, and is able to love.

However, all doesn't usually go well -- else there wouldn't be a need for psychoanalysts! Freud believed that people rarely, if ever, passed through the psychosexual stages without incident, and people rarely develop the genital character spontaneously. Usually, the person experiences some sort of **developmental crisis** at an earlier stage -- a crisis that prevents growth, fulfillment, and the final achievement of genital sexuality.

These difficulties are resolved through the aid of additional defense mechanisms.

In **fixation**, for example, the anxiety and frustration experienced while advancing to a new stage cause growth to halt, so that the individual remains at the earlier stage.

In **regression**, the anxiety and frustration occur after the advance is completed; growth is lost as the person defensively reverts to an earlier stage of adjustment. The point at which fixation or regression occur determines the adult character.

By virtue of fixation and/or regression, the person -- that means you, and me, and everyone -- develops a particular neurotic character, depending on the developmental stage at which the

person has fixated, or to which he or she has regressed.

The **oral character** develops through the resolution of conflicts over feeding and weaning. The **oral-dependent type** relies on others for self-esteem and relief of anxiety; he or she manifests oral preoccupations -- smoking, eating, drinking -- to overcome anxiety. The **oral-aggressive type** expresses hostility towards those who are responsible for his or her frustrations; this is expressed not through physical biting, but rather through "biting" sarcasm.

The **anal character** develops through the resolution of conflicts over toilet training. The **anal-expulsive** type engages in retaliation towards those responsible for his or her suffering. The person is messy, irresponsible, disorderly, and wasteful; alternatively, by virtue of reaction-formation, the person appears to be neat, meticulous, frugal, and orderly; but, Freud asserted, somewhere, something is messy -- revealing the person's essential anal-expulsive character. The **anal-creative** type produces things to please others, and also oneself. He or she displays generosity, charity, and philanthropy. The **anal-retentive** type shows a marked interest in saving and collecting things. The basic traits are parsimony and frugality; alternatively, again via reaction-formation, a record of foolish investments, reckless gambling, and spending.

The **phallic character** reflects an overvaluing of the penis. The male, compelled to demonstrate that he has not been castrated, is reckless, vain, and exhibitionistic ("Look what I've got!"). The female, resentful at having been castrated, is sullen, provocative, and promiscuous ("Look what I've lost!").

> As you can see, this is the kind of theory that only a particular kind of man could conjure up. In discussing Freud's psychoanalysis, the student is warned that there is hardly a shred of clinical or experimental evidence in support of the theory. And a lot of it will strike a contemporary reader as quaint, if not downright silly. Nevertheless, psychoanalysis has had such an enormous impact on our culture -- literature, cinema, and art -- that it would be criminal to ignore it entirely. So you get some introduction to psychoanalysis in this course, but this is it -- a couple of crummy paragraphs buried in a lecture supplement on development.

Erickson's Theory of Psychosocial Development

Traditionally, mental development was thought to stop with adolescence -- or, at latest, the entry to adulthood.

- In the earliest method of calculating IQ (mental age / chronological age), a ceiling of 18 years was established for both variables. Thus, mental growth was assumed to be complete in late adolescence.
- In Freud's stage theory of psychosexual development, the oral, anal, and phallic stages were all negotiated before age 5, and the person was held to have achieved full adult psychosexual development -- the genital stage -- at adolescence.
- In Piaget's theory, the highest level of thought -- formal operations -- is also achieved at adolescence.

- Same for Kohlberg's and Gilligan's theories of moral development.

Even so, there has always been some sense that development was not complete at adolescence -- that change and growth were still possible in young adulthood, middle age, and old age.

This concern with development throughout the lifespan, from birth to death, is expressed in the **psychosocial theory** of Erik Erikson, a disciple of Freud's. Erikson argued that personality was the product of the social environment as well as of biology. He de-emphasized the instincts, and especially, infantile sexuality, and focused instead on the social conditions of child development and adult life. Mostly, Erikson focused on the issue of **ego identity** -- one's awareness of oneself, and one's meaning for other people. He also expanded the notion of development by arguing that there is, indeed, life after puberty. Not only did he propose stages of growth beyond the genital, but he also introduced a social reinterpretation of the classic Freudian stages -- hence the label "psychosocial", rather than "psychosexual".

A Self-Made Man

Erickson was personally consumed by issues of identity. He described himself as a "child of the borders". His adopted name was Erik Homburger, but he changed it to Erik Erikson -- literally, "Erik Son of Erik". As a self-made man, Erikson remade himself as his own father and his own son.

In the end, Erikson gave us an **epigenetic** conception of development similar to Freud's. That is, the individual progresses through an inevitable sequence of stages; and, at each, meets and resolves some crisis. Each stage builds on the one(s) that went before. Each stage has several elements, including a crisis that must be met and a strength that develops during the crisis. The resulting stage theory is sometimes known as the "Eight Ages of Man".

In the **oral-sensory** stage, from birth to 1 year, the child comes to recognize some objects as familiar, experiences hunger for nourishment and stimulation, and deals with teething and grasping. The crisis is **basic trust vs. mistrust**: the child must trust that his or her wants will be frequently satisfied, while others must trust that the child will learn to cope with its impulses (to cry or bite). The legacy of the oral-sensory stage is **hope**, the enduring belief in the attainability of wishes.

In the **muscular-anal** stage, from 1 to 3 years, the child learns to walk and talk, dress and feed itself, and control elimination. The crisis is **autonomy vs. shame and doubt**: the child learns to rely on its own abilities, or that its efforts will be ineffectual and criticized. The relevant strength is **will**, the determination to exercise free choice and self-restraint.

In the **locomotor-genital** stage, from 3 to 6 years, the child really begins to move about, find its place in the group, and approach objects of desire. The crisis is **initiative vs, guilt**: the child learns to approach what seems desirable, and experiences the contradiction between desires and restrictions. The relevant strength is **purpose**, the courage to envisage and pursue valued goals.

In the **latency period**, from 6 to 11, the child makes the transition to school life, and begins to learn about the world. The crisis is **industry vs. inferiority**: the child learns and practices adult roles, but may conclude that it cannot operate the things of the world. The strength is **competence**, the free

exercise of dexterity and intelligence.

In the stage of **puberty-adolescence**, from 11 to 18, the young person experiences physiological growth, sexual maturity, adolescent love, and involvement with cliques and crowds. The crisis is **identity vs. role confusion**: the idea that one's past has prepared one for the future, as opposed to the failure to differentiate oneself from others and find one's place in the world. The strength is **fidelity**, the ability to sustain loyalties.

In the previous stages, Erikson reinterpreted Freud (as some of their names imply). In the following stages, emerging after adolescence, Erikson added to the basic Freudian conception.

In the stage of **young adulthood**, from 18-30, the person leaves school for the outside world of work and marriage. The crisis is **intimacy vs. isolation**: the ability to share oneself in an intense, long-term relationship, as opposed to an avoidance of sharing because of the threat of ego loss. The strength if **love**, or mutuality of devotion.

In the stage of **adulthood**, from 30 to 50, the person invests in the future through work and home. The crisis is **generativity vs. stagnation**: the ability to establish and guide the next generation, as opposed to a concern only for one's personal needs and comfort. The strength is **care**, a widening concern for what has been generated by love, necessity, or accident.

In the stage of **maturity**, from 50 to 70, death enters one's thoughts on a daily basis. The crisis is **ego integrity vs. despair**: a strong sense of self and of the value of one's past life, as opposed to a lack of satisfaction, coupled with the sense that it is too late to start all over again. The strength is **wisdom**, a detached concern with life itself.

It should be noted that Erikson's theory, like Freud's, is highly impressionistic, and not necessarily based on a proper scientific analysis of lifespan development. Also, like Freud's, it is strongly based on a particular cultural experience, and a particular view of what is important in life. Erikson's theory is not presented as established scientific fact, but rather as a good example of how a stage concept of development can be applied throughout the life span. There are some pearls of wisdom here, but take the whole thing with a grain of salt. The theory has been extremely influential in popular culture, and it has fostered an entire new discipline of life-span developmental psychology.

Cognitive Development After Piaget

There are lots of other stage theories of development, including a Piaget-Kohlberg hybrid stage theory of the development of religious faith. The stage theory of death promoted by Elisabeth Kubler-Ross is another example. In all stage theories, the stages of development are universal, obligatory, stereotyped, and irreversible.

- All normal individuals must pass through them.
- The stages are passed in the same sequence for all individuals;
- Once a stage has been successfully negotiated, there is no going back
- The achievement of one stage is a necessary condition for advancement to the other.

These are essentially hypotheses about the nature of development, and when they are tested, research has usually failed to confirm them. In particular, research testing Piaget's theory revealed a number of anomalies, which led investigators to refocus their theories on continuities in mental development.

Novices and Experts

One post-Piagetian approach construes development as the development of cognitive skills. According to this view, the infant starts out as a **novice** in all domains of problem-solving, and acquires **expertise** through learning - through experience and practice. However, in this view expertise is not just a quantitative difference of "knowing more" than one did before. Rather, the argument is that experts represent problems differently than novices do:

- Expert knowledge is cross-referenced, promoting easy access to it in a variety of situations.
- Expert knowledge focuses on higher-order patterns, so that experts think in bigger "chunks", and take larger steps in problem-solving, than novices do.

One model for the development of expertise is the difference between novice and expert chess players. Both kinds of players know the rules, but experts represent the game differently, and play differently, than novices do.

Of course, all of this is not very far from the theory of development as learning. Recall the definition of learning as "a relatively permanent change in behavior that results from experience"; in the same way, expertise develops with experience and practice. However, there are at least two important differences between the theory of expertise and the theory of learning.

- The acquisition of expertise involves qualitative leaps in skill that represent the individual's successive reorganizations of task performance. These qualitative leaps are somewhat analogous to Piaget's stages, but they aren't the same as Piaget's stages, because even young children can attain more expertise than adults (as an example, consider young children's expertise in dinosaurs).
- The theory of expertise does not consider the infant as a blank slate to be written on by experience. Instead, the child is viewed as bringing a rudimentary cognitive apparatus into the world, such that learning experiences modify his or her innate propensities.

These differences between the theory of expertise and the theory of learning reflect the lasting contribution of Piaget to developmental theory -- despite the fact that his theory appears to be wrong in many salient details.

- Theories of development are no longer so concerned with the cognitive "starting point" -- as in the debate between nativism and empiricism.
- Now, the focus of developmental theory is on the cognitive "end point" -- the outcome of psychological development. The cognitive starting-point is viewed in light of where the child

is going.

Metacognition

Theories of expertise seem to imply some degree of continuity over the course of development, but studies of expertise reveal one big difference between younger and older children: Put bluntly, older children know what they're doing, while younger children don't. Older children are not simply more expert than younger ones: they're also more reflective, more deliberate, and more strategic in their thought and action. In other words, what older children possess, and younger children lack, is *metacognition*.

Metacognition was defined by John Flavell (1979) as, literally, *cognition about cognition* -- or, put another way, our ability to monitor and control our own cognitive processes. Metacognition is one's "knowledge about cognition and cognitive phenomena", including:

- Knowledge of what is going on in your own mind:
  - Whether you're perceiving something or just imagining it;
  - What knowledge you have stored in your memory, and how your memory works (this fund of metaknowledge is sometimes called *metamemory*);
  - Whether you actually understand something that you've learned, or that has been explained to you.

- Appreciation of the rules governing mental processes:
  - How to deploy attention effectively;
  - How to use strategies for encoding and retrieving memories (another aspect of metamemory);
  - How to break down large problems into subproblems.

Flavell has argued that there are several different aspects of cognitive monitoring, including:

- Goals or Tasks: knowing the objectives of a cognitive enterprise.
- Actions or Strategies: cognitions and/or actions employed to attain goals and complete tasks.
- Metacognitive Knowledge: knowledge about factors influencing your own and others' cognition.
- Metacognitive Experiences: Conscious thoughts and feelings pertaining to cognition.

His general idea is that with development, children make more conscious, deliberate use of their mental faculties.

The Theory of Mind

More broadly, we might say that as they develop children come into possession of a *theory of mind*

-- a term coined by Premack and Woodruff (1978; see also Premack, 1988) based on their comparative study of cognition in humans and chimpanzees. Put briefly, the theory of mind is the ability to impute mental states to oneself and to others. It includes:

- Knowledge of Our Own Minds: understanding that we have mental states, and realizing that our experiences are our own -- that, somehow, our experiences are separate from the world outside the mind, and that we can control our own beliefs, feelings, and desires. Knowledge of our own minds entails phenomenal awareness -- introspection -- of what we think, feel, and want.
- Knowledge of Other Minds: understanding that our mental states may differ from those of other people -- that different people have different minds, and thus different experiences. Knowledge of other minds entails an ability to make inferences about what others think, feel, and want.

Egocentrism and the Theory of Mind

In some ways, the theory of mind revives Piaget's notion of *egocentrism*. For Piaget, the preoperational child thinks that his experience is universal. But the older child, having entered concrete or formal operations, understands that others may not think the way he does -- that others' percepts, memories, and knowledge might not be the same as his own.

In fact, the theory of mind usually emerges between 5 and 7 years of age -- exactly the same point as Piaget's shift from preoperational thought to concrete operations.

The "Theory" Theory

In some respects, cognitive development is the development of *social cognition* -- the ability to think about oneself and other people. The acquisition of a theory of mind is a qualitative change, like the shift from one of Piaget's stages to another. But it is a qualitative shift that takes place against a continuous acquisition of knowledge.

But it turns out that the child isn't just developing a theory of self and others. The child is developing a theory of the whole world -- of physics and biology as well as psychology -- and testing it out in much the same way that a scientist would (the metaphor of child as scientist is another legacy of Piaget's theory). This is the essential proposition of what has come to be known as the "theory" theory of development -- that the developing child is engaged in a continuous process of proposing, testing, revising, and rejecting theories of how the world works -- including theories of how minds work, as part of the world.

The Pendulum of Developmental Theory

In some sense, theories of development cycle back and forth between continuity and change, and between qualitative and quantitative changes. Developmental psychologists aren't just on a swinging pendulum, however. Every turn in the cycle represents an increasingly sophisticated shift in our understanding of the nature of mental development -- and, for that matter, in our understanding of the mind.

Nature and Nurture

in Personality Development

So where does personality come from? We have already seen part of the answer: Personality is not a given, fixed once and for all time, whether by the genes or through early experience. Rather, personality emerges out of the interaction between the person and the environment, and is continuously constructed and reconstructed through social interaction. A major theme of this interactional view of personality is that the person is a part of his or her own environment, shaping the environment through evocation, selection, behavioral manipulation, and cognitive transformation. In the same way, development is not just something that happens to the individual. Instead, the individual is an active force in his or her own development.

The Developmental Corollary to the Doctrine of Interactionism

Just as the person is a part of his or her own environment,

the child is an agent of his or her own development.

The development of the individual begins with his or her genetic endowment, but genes do not act in isolation. The organism's genotype, or biological potential (sometimes referred to as the individual's "genetic blueprint", interacts with the environment to produce the organism's phenotype, or what the organism actually "looks like" -- psychologically as well as morphologically.

The individual's phenotype is his or her genotype actualized within a particular environmental context:

- Two individuals can have different genotypes but the same phenotypes. For example, given two brown-eyed individuals, one person might have two dominant genes for brown eyes (blue eyes are recessive), while the other might have one dominant gene for brown eyes, and one recessive gene for blue eyes.
- Two individuals can have the same genotype but different phenotypes. For example, of two individuals might both possess two dominant genes for dimples, one individual might have

cosmetic surgery to remove them, but the other might not.

More broadly, it is now known that genes are turned "on" and "off" by environmental events.

- Sometimes, the "environment" is body tissue immediately surrounding the gene. Except for sperm and egg cells, every cell in the body contains the same genes. But the gene that controls the production of insulin only does so when its surrounding cell is located in the pancreas. The same gene, in a cell located in the heart, doesn't produce insulin (though it may well do something else). This fact is the basis of gene therapy: a gene artificially inserted into one part of the body will produce a specific set of proteins that may well repair some deficiency, while the same gene inserted into another part of the body may not have any effect at all.
- Sometimes, the "environment" is the world outside the organism. A gene known as BDNF (brain-derived neurotrophic factor), plays an important role in the development of the visual cortex, is "turned on" by neural signals resulting from exposure to light. Infant mice exposed to light develop normal visual function, but genetically identical mice raised in darkness are blind.

Nature via Nurture?

For some genetic biologists, facts like these resolve the nature-nurture debate: because genes respond to experience, "nature" exerts its effects via "nurture". This is the argument of *Nature via Nurture: Genes, Experience, and What Makes Us Human* (2003) by Matt Ridley. As Ridley writes:

> Genes are not puppet masters or blueprints. Nor are they just the carriers of heredity. They are active during life; they switch on and off; they respond to the environment. They may direct the construction of the body and brain in the womb, but then they set about dismantling and rebuilding what they have made almost at once -- in response to experience (quoted by H. Allen Orr, "What's Not in Your Genes", *New York Review of Books*, 08/14/03).

The point is correct so far as it goes: genes don't act in isolation, but rather in interaction with the environment -- whether that is the environment of the pancreas or the environment of a lighted room.

But this doesn't solve the nature-nurture debate from a psychological point of view, because psychologists are not particularly interested in the physical environment. Or, put more precisely, we *are* interested in the effects of the physical environment, but we are *even more* interested in the organism's *mental representation* of the environment -- the meaning that we give to environmental events by virtue of such cognitive processes as perception, thought, and language.

- When Ridley talks about experience, he generally means the *physical* features of an environmental event.
- When psychologists talk about experience, they generally mean the *semantic*

features of an environmental event -- how that event fits into a pattern of beliefs, and arouses feelings and goals.

As Orr notes, Ridley's resolution of the nature-nurture argument entails a thoroughgoing reductionism, in which the "environment" is reduced to physical events (such as the presence of light) interacting with physical entities (such as the BDNF gene). But psychology cannot remain psychology and participate in such a reductionist enterprise, because its preferred mode of explanation is at the level of the individual's mental state.

For a psychologist, "nurture" means the *meaning* of an organism's experiences. And for a psychologist, the nature-nurture argument has to be resolved in a manner that preserves meaning intact.

The point is that genes act jointly with environments to produce phenotypes. These environments fall into three broad categories:

- **prenatal**, meaning the intrauterine environment of the fetus during gestation;
- **perinatal**, referring to environmental conditions surrounding the time of birth, including events occurring during labor and immediately after parturition; and
- **postnatal**, including everything that occurs after birth, throughout the course of the individual's life.

In light of the relation between genotype and phenotype, the question about "nature or nurture" is not whether some physical, mental, or behavioral trait is inherited or acquired. Better questions are:

- What is the relative importance of nature and nurture?
- Or even better, How do nature and nurture interact?

Gender Dimorphism

The interaction of nature and nurture can be seen when we look at the development of gender dimorphism:

- **gender identity** (one's sense of oneself as male or female);
- **gender role** (the person's adoption of characteristically masculine or feminine aspects of thought and action); and
- **erotic orientation**, also known as sexual orientation or sexual preference (as heterosexual, homosexual, bisexual -- or, for that matter, not sexual at all).

Some role differences, known as the **procreative imperatives**, are built into us by our biology:

- impregnation in males,
- menstruation, gestation, and lactation in females.

But gender role goes beyond the demands of reproduction to include, at least in this culture:

- typically masculine characteristics of agency and instrumentality; and
- typically feminine characteristics of communality and expressiveness.

It is now very clear that this developmental process is not a simple matter of genetic determination. Rather, it reflects a complex interaction between genetic/biochemical processes (the phyletic imprimatur) and social/environmental processes (the social imprimatur) -- an interaction that is made more complex by the fact that

the developing child is both a target and an instigator of his or her own development.

Gender Differentiation in Fetal Development

As noted earlier, the normal human cell possesses 46 chromosomes, arranged in 23 pairs. Two of these, making up a single pair, are the sex chromosomes, known as X and Y. Normally, males carry one X and one Y chromosome (XY), while females carry two X chromosomes (XX). Genes for sex-linked traits are located on these sex chromosomes. Note that because each parent contributes one chromosome of each pair to his or her offspring, and the mother can contribute only X chromosomes to this process, in the final analysis the father determines the sex of his child: if he contributes an X chromosome, the child will be genetically female (XX); if he contributes a Y chromosome, the child will be genetically male (XY).

Although the fetus is genetically male or female from the beginning (because it's cells carry the XX or XY chromosome pairs from the beginning), early in gestation the fetus is otherwise undifferentiated with respect to gender. That is, although it carries the XX or XY chromosomal endowment, it has no outward appearance of being male or female. This is because at this stage the fetus's gonadal tissue is **undifferentiated**. . Remember the debate between recapitulation and differentiation as basic themes in development? In these terms, the undifferentiated gonadal tissue of the early fetus is a **primordial structure** which will eventually differentiate into the more complex structures representing the male and female reproductive anatomy).

In technical terms, the structures in this undifferentiated gonadal tissue contain the **anlagen** (or foundation) of the male and female reproductive systems:

- the **outer cortex** will become the **ovaries** of the female;
- the **inner medulla** will become the **testes** of the male;
- the **Mullerian ducts** will become the internal reproductive organs of the female -- the uterus, fallopian tubes, and inner portion of the vagina;
- the **Wolffian ducts** will become the internal reproductive organs of the male -- the vas deferens, seminal vesicles, and ejaculatory ducts; and
- the **genital tubercle**, situated above a single **urogenital slit** (itself surrounded by **urethral**

folds and **labio-scrotal swellings** will become the external genitalia: the vagina and clitoris of the female, the penis and scrotum of the male.

After about six weeks of gestation, sexual differentiation begins. In response to genetic messages (carried on the X and Y chromosomes), one set of structures begins to develop while the other one becomes vestigial. If the fetus carries the XY genotype, the inner medulla will grow into the testes of the male, and the outer cortex regresses; if the fetus carries the XX genotype, the outer cortex will grow into the ovaries of the female, while the inner medulla vestigiates.

The genes themselves appear to play no further role in what happens. Rather, further sexual differentiation occurs by virtue of hormones secreted by the gonads -- and in particular, those male hormones secreted by the testes. There may be a role for the female hormones in genetically XX fetuses, but this is not clear at present. As a rough approximation, further sexual differentiation appears to reflect what the biologists call **"nature's rule"**:

add something to masculinize.

Without masculinization instigated by the male gonadal hormones, the remaining gonadal tissue will naturally differentiate into the female reproductive system. So, in a sense, at this point the program for sexual dimorphism passes from the genes to the hormones.

Simone de Bouvoir and *The Second Sex*

In 1949, Simone de Beauvoir (1908-1986), the French writer and existentialist philosopher (and longtime companion of Jean-Paul Sartre), published a book, *The Second Sex* (1949; English edition 1953), which is rightly regarded as instigating the feminist revolution of the 1960s (these things take time: Mary Wollstonecraft published *The Vindication of the Rights of Woman* in 1792, and the feminist revolution among middle-class women in the United States didn't really begin until Betty Freidan, who had once been a graduate student in psychology at UC Berkeley, published *The Feminine Mystique* in 1963).

In her book, de Beauvoir begins with, and details the various ways in which, throughout history and across cultures, women have been relegated to subordinate status. For example, in the *Genesis* myth, Eve was created from one of Adam's ribs, as a kind of afterthought by God. Closer to our own time, Freud held that women were diminished men (that's why he thought they were obsessed with penis envy). As de Beauvoir put it, so far as history and culture is concerned, man was the essential "Subject", an "Absolute"; woman the inessential "Other". In expressing the fundamental doctrine of existentialism, Sartre had written that "Existence precedes essence". Similarly (in perhaps her most famous passage), de Beauvoir wrote "One is not born, but rather becomes a woman". For de Beauvoir, there is no "essence" to womanhood or femininity; the details of gender role are imposed on the individual by the culture, and can be accepted or declined by the individual as a matter of free choice. Of all the many good books of feminist theory and doctrine, de Beauvoir's remains perhaps the most thorough and convincing, but in a sense she got the title wrong. Biologically speaking, anyway, the female is the "first" sex.

A Note of Caution: It turns out that the only English edition of de Beauvoir's book is seriously deficient, with many technical words and phrases simply mistranslated, and large sections of the French original simply cut out. The problem is that the editor who bought the English rights thought that she was buying a sort of French sex manual, and the person who took responsibility for the translation was a zoologist whose knowledge of philosophy was practically nonexistent and whose knowledge of French dated from high school and college. You get the gist, especially if you already know something about the argument (or de Beauvoir, or existentialism), but if you read the book very closely important parts of it don't really make sense, which does a disservice to the quality of de Beauvoir's thought and writing. See "Lost in Translation" by Sarah Glazer, *New York Times Book Review*, 08/22/04).

The hormones secreted by the testes have effects on other structures in the initially undifferentiated gonadal tissue (again, there may be independent effects of female hormones in genetically XX individuals, but this is a controversial point in endocrinology).

- In the third month of gestation, a **Mullerian inhibiting substance** appears to stop the development of the Mullerian duct system (I say "appears to" because the MIS is at present known only by inference -- we know this happens, but we don't exactly know what does it). At the same time, fetal **androgen** promotes the development of the Wolffian duct system into the male internal reproductive system. In the absence of MIS and androgen, the Mullerian ducts develop into the female internal reproductive system.
- In the third and fourth months of gestation, we observe more effects of fetal **androgen**. The genital tubercle forms around the urethra into a penis rather than a clitoris; and the labio-scrotal swelling fuses into a scrotum rather than a vagina. Again, in the absence of this dose of androgen, these structures will develop into the clitoris and a vagina of the female.
- In successive months, the vaginal canal will connect the external and internal reproductive anatomy of the female.
- In the seventh month of gestation, the testes descend from the abdomen into the scrotum of the male.

When everything goes as programmed, after nine months of gestation a human baby is born with a set of external genitalia that are recognizably male or female, and a corresponding set of male or female internal reproductive organs.

But sometimes things don't run quite the way they're programmed, and the child is born sexually ambiguous -- individuals who are known technically as **pseudohermaphrodites**.

Anomalies of Gender Differentiation

Chromosomal XX Individuals. If a genetic female somehow experiences an environment to which androgen has been added, she will be born with female internal genitalia, but most likely an enlarged clitoris and fused vaginal labia; rarely, such a girl will be born with a normal penis and scrotum (of course, the scrotum will be empty, because there are no testes to descend into it). This occurs in two principal ways.

- In the **female adrenogenital syndrome**, there is a natural failure of the adrenal glands to function properly, resulting in the circulation of androgen to a fetus that is genetically female. There are no effects on the internal reproductive anatomy, but the external genitalia are masculinized. These children receive surgical correction of the external genitalia. At puberty (because they have malfunctioning adrenal glands) they also receive cortisone therapy to counter the adrenal failure. As a result of this therapy, the girl develops a characteristically feminine physique, menstruates, and can conceive and bear children.
- In **progestin-induced pseudohermaphroditism**, a pregnant woman (with a personal or family history of difficult pregnancy) receives synthetic hormones to prevent miscarriage. In some cases, the hormone treatment results in a masculinization of the external genitalia, which is corrected surgically. Because there is no problem with the endogenous hormones, there is no need for cortisone therapy to feminize the physique or induce menarche.

In both cases, the children are raised as girls.

Chromosomal XY Individuals. In a genetic male, the failure of the Mullerian-inhibiting substance can leave the fetus with a set of male external genitalia, but both the female and male internal reproductive systems. Note, however, that such an individual has only testes (the gonadal tissue becomes *either* testes or ovaries); thus, he cannot menstruate or gestate. The children are raised as boys.

- In **the androgen-insensitivity syndrome**, a genetic defect causes the androgen which circulates naturally to the male fetus to have no effect. The result is that the child is born without male external genitalia (except, perhaps an enlarged clitoris). Following surgical correction, including removal of the testes, the children are raised as girls. At the time of puberty, natural estrogen (which circulates to males as well as females, but which is suppressed by androgen in hormonally normal males) feminizes the physique. However, because these girls do not possess the internal reproductive anatomy of females (under genetic control, the inner medulla differentiated into testes while the outer cortex regressed, and the Mullerian inhibiting substance works even if the androgen does not!), they have no ovaries. Therefore, they will not menstruate, and will be infertile.

Guevodoces. An interesting syndrome, originally discovered in an isolated area of the Dominican Republic (but also documented in an isolated village in Puerto Rico), involves genetically male individuals (chromosomal XY) who are born with a particular defect in their androgen system known as **5-alpha-reductase deficiency syndrome**. Because they do not undergo masculinzation *in utero*, these children are born with apparently female external genitalia; if the condition is undiagnosed, they are raised as girls. At puberty, however, the flow of natural testosterone induces masculinization: the voice deepens, the child develops a typically masculine muscular structure, breasts do not develop as expected and -- surprise! -- the child's scrotal tissue balloons, testes descend, and what originally appeared to be a clitoris enlarges into a functioning penis. Hence the popular name for this condition -- *guevodoces*.

What's especially interesting about this syndrome is that the children readily shift their gender identities, and corresponding gender roles, from feminine to masculine. This is because their culture is prepared for the possibility of a spontaneous "sex change" from previous cases known in the village -- it's as if they say "Oh, that happened to Uncle Jose, too!". The boys' adolescent and adult behavior, including sexual behavior, is not are appreciably different from that of "normal"

males.

Before the arrival of modern medicine, the condition went undiagnosed until adolescence. Now, the condition is diagnosed at birth, either through chromosomal testing or through palpation of the groin (which reveals the undescended testes), and the children are identified and raised as boys, from birth -- appearances to the contrary notwithstanding.

Jeffrey Eugnedies' novel *Middlesex* (Farrar, Straus & Giroux, 2002; he also wrote *The Virgin Suicides*) uses the fictional life of Cal (*nee* Calliope) Stephanides, a Greek-American with "guevodoces syndrome", as a metaphor for the identity crises of immigrant, "hyphenated" ethnic Americans, as well as places "like Berlin, like Korea, like all the other places in the world that were no longer one thing or the other".

Klinefelter's Syndrome, 47 XXY. In another condition, a chromosomal male has an extra X chromosome, thus 47XXY rather than 46XY (this occurs in fewer than 1/500 male births). Common consequences include "feminized" physique, infertility, delayed motor and speech development, difficulties with reading and writing. As adults, these individuals often gradually lose both sexual potency and interest. Many of these symptoms can be reversed with hormone replacement therapy, replacing the testosterone that is missing naturally.

These anomalies of gender differentiation sometimes raise the question of gender identity: is a person male or female. And not just a question about how the individual identifies him- or herself -- but also issues of how s/he is identified by other people. Because of previous gender-related controversies -- including the fact that, in the 1936 Berlin Olympic Games, the Germans cajoled a male athlete, Hermann Ratjen, into living as a woman for three years before entering "her", renamed Dora, into the high jump competition ("she" lost); and the practice, in certain countries of Communist Eastern Europe, of doping female athletes with testosterone and other steroids in order to enhance their performance -- in the 1970s the International Olympic Committee began testing female athletes to confirm their "femaleness" by inspecting their chromosomal material for the presence of a telltale X chromosome. But Stella Walsh, a Polish sprinter who also competed in the 1936 Olympic games, apparently suffered from androgen-insensitivity syndrome -- although chromosomally male, she identified herself as a woman and had lived as a woman all her life. Under current rules, she would have been disqualified from competition. At the same time, since 2004 the IOC's rules have allowed transsexual women -- that is, chromosomally male individuals who identify themselves as women and have undergone sex-reassignment surgery and post-operative hormone-replacement treatment -- to complete as women (though as of 2008, no openly transsexual individuals have qualified for the competition). Like Stella Walsh, these individuals would also have failed a chromosomal test of gender [see "The XY Games" by Jennifer Finney Boylan, *New York Times* 08/03/08.].

All of which begs the questions: *What is the proper criterion for being male or female?* Chromosomal sex? Body morphology? Gender identity? *And how many categories of gender are there, anyway?* The usual two? Or are there at least two more, to cover conditions like androgen-insensitivity?

Hormonal Effects on Mind and Behavior

Pseudohermaphroditic children are of interest because they are genetic females who experience the effects of male hormones, and genetic males who do not experience these effects. Therefore, at least in principle, these the children provide an opportunity to observe the effects of prenatal hormones on behavior -- observations that might provide evidence of a hypothetical "masculinization of the brain" underlying the differences between masculine and feminine gender roles. And, in fact, there is some evidence for hormonal effects on behavior. Thus, for example, girls with the female adrenogenital syndrome and progestin-induced pseudohermaphroditism generally appear more vigorous and aggressive -- in terms of gender role stereotypes, more "tomboyish" -- than control girls; by comparison, the genetic males with the androgen-insensitivity syndrome, who are raised as girls, are behaviorally indistinguishable from control girls. This evidence is controversial, however, and shouting matches regularly erupt when it is presented and discussed at scientific meetings.

Sometimes, pregnant women who suffer from severe diabetes will be treated with exogenous estrogen and progesterone to prevent miscarriage. These female hormones do suppress the action of the androgen that would normally circulate to genetically and hormonally male fetuses, but appears to have no effects on the external or internal reproductive anatomy. These children are, of course, raised as boys. They are relevant to this discussion only because some early literature indicated that they were somewhat less aggressive and competitive than other boys. However, it should also be noted that the mothers of these children are also sicker than the mothers of control boys, and this by itself may inhibit vigorous play -- and effect which has sometimes been attributed to the lack of "masculinization of the brain". When we add controls for race, age, social class, and especially material illness during pregnancy, however, the difference disappears. Therefore, the behavioral differences appear to be caused by environmental, rather than biological factors.

In any event, this process, sometimes called the **phyletic imprimatur**, leaves the developing fetus and newborn child with a set of external genitalia, and an internal reproductive system, that are more or less recognizably male or female. At this point, the influence of biological factors stops, temporarily, and the individual's biographical history takes over as the parents and others structure an environment corresponding to their conceptions of how boys and girls should be raised -- an important part of gender-role socialization referred to as the **social imprimatur**.

In other words, the program for sexual differentiation (or gender dimorphism) passes from the hormones to the (social) environment). However, the program will be passed back to the hormones later, at the time of adolescence (for both sexes), and again at the time of menopause (for females). Actually, from birth on, it is probably best to think of the program being passed back and forth between the hormones and the environment. This is what is meant by the interaction of nature and nurture.

I've Seen Both Sides Now....

In classical mythology, Hermaphroditus, the son of Hermes and Aphrodite (get it?), shared a body with Salmacis, a nymph.

Another mythological character, Tiresias, was a blind soothsayer, the most famous prophet in ancient Greece. His prophecies play a central role in the story of Oedipus, who unknowingly killed his father and married his mother (the story of Tiresias is told in Ovid's *Metamorphoses*, and he appears in many other Greek tragedies, Homer's *Odyssey*, and T.S. Eliot's poem, *The Waste Land*. As the legend goes, Tiresias was out for a walk when he came upon two huge snakes who were copulating. When he struck the female with his staff, he was instantly turned into a woman. Seven years later, he saw the same two serpents copulating again; this time he struck the male, and was changed back into a man. Because he had experienced both sides of love, Tiresias was called upon to settle an argument between Hera and Zeus, as to who enjoyed lovemaking more. Tiresias agreed with Zeus that women enjoyed sex more than men, whereupon he was blinded by Hera. To compensate Tiresias for his loss, Zeus gave him the gift of prophecy and a long life. The gift was apparently heritable: one of Tiresias' daughters became an oracle at Delphi (or maybe this was an effect of the environment).

> In another version of the legend, Tiresias was blinded by Athena when he accidentally saw her bathing; as compensation, she gave him the gift of prophecy. In another, Tiresias was blinded not by Athena but according to the laws of Cronos, as punishment for beholding an immortal without his or her consent.

Tiresias is a myth, and Eugenides' Calliope/Cal is a fictional character, and there are no true hermaphrodites, but some cases of male pseudohermaphroditism come close, at least in some respects:

- In one case described by John Money and Anke Ehrhardt (*Man and Woman, Boy and Girl*, 1972), a child was actually given the choice as to whether s/he would be a boy or a girl.
- Some "transgendered" individuals undergo sex-change operations after they have lived for some time as adults. Famous cases include Christine (*nee* George) Jorgensen, James/Jan Morris, the travel writer, and Dierdre McCloskey, the economist.

In the famous "John/Joan" case, also treated by Money, "John", an infant boy (real given name: Bruce), lost his penis through an accident during circumcision. He was subsequently "re-assigned" to be raised as a girl, renamed "Joan" (actually "Brenda"), castrated, and his external genitalia surgically corrected. In their book, Money and Ehrhardt describe this case as a successful instance of gender-reassignment, but they lacked long-term followup. The case was all the more interesting because the child was one of a pair of identical twins; "her" identical twin was uninjured during the circumcision, and was raised as a boy. The case was also highly controversial, because its early apparent success implied that masculinity and femininity were learned, rather than based on biology -- thus contravening the doctrine (favored by both psychoanalysis and evolutionary psychology) that "biology is destiny", and that gender identity and role are encoded in the genes (Milton Diamond was an especially vigorous critic). But was it successful? Apparently, Brenda was never comfortable as a girl, and as an adolescent chose to live as a boy, changed his name to "David", and later

underwent what might be called "re-correction" surgery; he subsequently lived as a man, married, and went public about his own case (he appeared on "Oprah" in 2000). When he committed suicide, at age 38, his family implied that he had been a victim of a "botched medical experiment"; they also noted that he had been depressed by the suicide, two years previously, of his twin brother Brian, who suffered from schizophrenia, as well as the recent loss of his job and separation from his wife ("David Reimer, 38, Subject of the John/Joan Case", *New York Times*, 05/12/04; see also "Being Brenda" by Oliver Burkeman & Gary Younge, *the Guardian*, 05/12/04).

The sad fate of David Reimer is commonly held up as a demonstration that gender identity and role are encoded in the genes, and can't be changed by environmental manipulation. However, in considering the outcome of the Reimer case, a few points should be borne in mind:

- Reimer's identical twin brother Brian suffered from schizophrenia; because schizophrenia is to a large extent heritable, David inherited some disposition to schizophrenia as well. Although neither his parents nor his doctors could have known this at the time (both children were less than 2 years old), Bruce was probably not the best candidate for involuntary sexual reassignment surgery.
- Reimer was about 1 year old when he underwent sex-reassignment surgery, but close to 2 years old when her parents began to treat her as if she was a girl -- by, for example, making her wear dresses. However, children start noticing their own and others' gender by about 2 years of age. Brenda's initial resistance to dresses might have been a product of her initial gender identity as male. Or, perhaps more simply, perhaps she wanted to be dressed in the same way as her brother Brian. Little girls often express an interest in the functional clothing, and more freedom in play, given their brothers.
- Despite Brenda's parents' valiant efforts to treat her as a girl, they may have been unsure about the success of the "experiment", and thus given her mixed messages. Along these lines, Money's own post-surgical treatment of Brenda, which included psychotherapy sessions intended to reinforce her new gender assignment, may have backfired by drawing attention to the fact that she was not, in fact, a "normal" girl.

The point of all of this is not to say that Money was entirely right after all, but only that the critics might not also be entirely right that gender identity and role are encoded in the genes. The case of David Reimer is more complex, on both sides, than it would initially appear to be.

The John/Joan case is related in depth by John Colapino in an article, "The True Story of John/Joan" (*Rolling Stone*, 11/11/97), and a book, *As Nature Made Him: The Boy Who Was Raised as a Girl* (HarperCollins, 2000). In general, Colapinto views Reimer as a victim of radical environmentalism, if not (early) radical feminism.

Joel Meyrowitz has provided an authoritative overview of transsexualism in *How Sex Changed: A History of Transsexuality in the United States* (Harvard, 2002).

Michael Bailey has argued that transsexualism is not, as commonly portrayed, a case of

"a woman trapped in a man's body" (or the reverse). Bailey argues that transsexualism comes in two forms: *homosexual transsexuals*, gay men who are so effeminate, in terms of gender-role behavior, that they want to take on a female gender identity as well -- and the body that goes with it (Bailey also argues, from his extensive survey data, that even gay men who are not transsexuals tend to be extraordinarily effeminate); and *autogynephilic transsexuals*, heterosexual men who are sexually stimulated by the thought, or the act, of a male-to-female sex change. Bailey presents his arguments and data in the provocatively titled book, *The Man Who Would Be Queen: The Science of Gender-Bending and Transexualism* (Joseph Henry Press, 2003).

Postnatal Hormonal Influences

The effects of the sex hormones do not stop with the differentiation of the internal and external genitalia. They come back on the scene at least two more times, at puberty and in old age, each time interacting with the social environment.

Puberty. At puberty, the program for gender dimorphism passes back to the hormones, as indicated by such milestone events as menarche (onset of menstruation) in girls and nocturnal emissions ("wet dreams") in boys. The most obvious post-natal effects of the sex hormones are the development of such **secondary sex characteristics** as the deepening of the voice in males and the development of breasts in females, and the masculinization or femininization of overall body shape. These physical changes are instigated by sex hormones, testosterone and estrogen, secreted by the testes and ovaries, respectively.

Interestingly, there is now evidence that puberty may begin long before adolescence. In girls, for example, the pituitary hormones associated with puberty, along with secretions from the ovaries, are known to begin at about age 9, and breast development often begins between 10 and 11 years of age. Martha McClintock and Gilbert Herdt, researchers at the University of Chicago, have noted that children experience a spurt in physical growth around age 6, accompanied by the appearance in the skin of oil-producing sebacious glands similar to those associated with pimples in adolescence (*Current Directions in Psychological Science*, 12/96). They also reported that signs of sexual attraction, heterosexual or homosexual, can be observed in children as young as 9 or 10 years of age; interestingly, this is also about the time that girl-boy teasing begins. This attraction should not be confused with sexual desire, much less sexual activity; these kick in later, as the individual approaches and enters adolescence. Rather, at this early age there appears to be only a more or less clear "leaning" toward one sex or the other. McClintock and Herdt suggest that these changes are related to the secretion by the adrenal glands of a form of androgen known as *dihydroepioandrosterone* (DHEA), which begins at about age 6 and increases to a critical level at about age 10 -- a point which they call *arenarche*, by analogy to menarche. DHEA reaches adult levels at about age 18 before diminishing over the rest of the life course.

In any event, the hormonal effects of puberty interact with the social imprimatur as parents and others impose culturally bound standards for adolescent behavior. In some cultures, for example, sexual experimentation is permitted, even encouraged; in others, sex is strictly prohibited until marriage. In some cultures, boys and girls are permitted to date, and even engage in light sexual

activity ("petting"); in other cultures, boys and girls can meet only under conditions of strict supervision; in still other cultures, marriages are arranged by the parents, and the engaged couple may have only minimal contact with each other before their wedding day. In all cultures, parents and others scrutinize adolescents for signs of "normality", and the adolescents' gender identities, gender roles, and erotic orientations are strengthened and challenged.

Middle and Old Age. Later in life, there are further dramatic changes in hormone levels. These are most obvious in women, particularly the sudden drop in estrogen levels, and cessation of menstruation, known as *menopause*. Recent evidence suggests that there may be a male version of menopause as well, known as *partial androgen deficiency in aging men* (PADAM), or *andropause*. Although men produce sperm throughout their adult lives, they experience a gradual decline in testosterone levels as they age (about 0.5% per year after age 30), which in turn may be associated with fatigue, loss of muscle tone and bone density, and "decreased libido" (a term derived from Freud's term for the sexual drive). Note, however, that the diagnostic criteria for andropause overlap greatly with those for depression. In the absence of laboratory tests showing abnormally low levels of testosterone, it is not at all clear that andropause is a legitimate diagnosis, or that HRT is a legitimate treatment.

Here again, the hormones interact with the social environment. For example, the cessation of menstruation, and the loss of child-bearing capacity, may challenge women's gender identities and roles. Similarly, age-related erectile difficulties may challenge those of men.

Natural Condition or Manufactured Illness?

As with menopause, it has been suggested that andropause be treated with hormone replacement therapy, and several drugs, such as Androgel (a product of Unimed Pharmaceuticals), have been marketed for that purpose. In fact, between 1997 and 2001 prescriptions for testosterone almost doubled ("Male Hormone Therapy Popular But Untested" by Gina Kolata, *New York Times, 08/19/02).* As with menopause, this suggestion has most frequently been made by the pharmaceutical industry -- giving rise to the suggestion that, like menopause and its pharmaceutical treatment, andropause and male HRT are diseases and treatments that have been "manufactured" by Big Pharma for economic gain (see "Hormones for Men" by Jerome Groopman, *New Yorker*, 07/29/02*).* In 2002, the results from a major study of HRT in healthy women suggested that the treatment did more harm than good, increasing the risk of heart problems, and leading many physicians to discontinue the treatment and many of their patients seeking alternatives. Similarly, because testosterone can promote increase prostate cancer and increase the risk of heart attacks and strokes, a long-term study of HRT in men was also discontinued in 2002.

In women, menopause is a real condition, but it is something that occurs naturally, in the course of aging, and it not at all clear that it should be treated as if it were a disease that could be cured with the right drug -- especially, as in the case of HRT, the risks are so great. This would constitute a "medicalization" of normal aging. The situation is even less clear, and the danger of inappropriate medicalization even greater, in the case of andropause, in that levels of testosterone do not drop as quickly, or with such consequences (such as hot flashes) as estrogen levels drop in women. HRT is valid as

a treatment for hypogonadism, a rare genetic condition (also known as Klinefelter's syndrome, or chromosomal XXY) that can also be induced by chemotherapy or radiation therapy for cancer, and for certain disorders of the pituitary gland. But it is not at all clear that HRT should be considered a pharmaceutical "fountain of youth" -- for either women or men.

In summary, the "program" for gender dimorphism of identity and role begins with the sex chromosomes (XY or XX), which differentiate the gonadal tissue into testes or ovaries; and continues with hormones secreted by the testes, which differentiate the internal and external reproductive anatomy. This **phyletic imprimatur**, a process of gender dimorphism that is common to all humans, and is under direct biological control, endows the fetus with characteristically male or female reproductive anatomy.

At birth the program for gender dimorphism passes from the genes and the hormones to the social environment, as the parents classify the newborn child as male or female, and begin the process of raising him or her according to cultural concepts of masculinity and femininity. Early in childhood, the child recognizes his or her own gender, identifies him- or herself as male or female, and begins to model his or her attitudes, beliefs, and behavior on others of his or her "own kind". These social learning processes, which are under environmental control and vary from one culture to another, is known as the **social imprimatur**. Everyone undergoes gender dimorphism of identity and role, but the outcome differs from one individual to the next, and from one culture to the next, depending on the details of the social imprimatur.

- The biological and social imprimaturs interact to produce the individual's gender identity and gender role, but (setting aside the issue of the masculinization of the brain) the chief effects of the genes and hormones are anatomical and physiological, not psychological. They endow the developing fetus with reproductive anatomy that is more or less recognizably male or female, and that is just about it.
- At birth, the physical appearance of the child's genitalia literally structures the environment. The child is identified as a little girl or a little boy, and raised accordingly. In the process, the social environment organizes itself so as to bring up a masculine boy or a feminine girl. In a classic example of the evocation mode of person-by-situation interaction, the appearance of the child's genitalia literally structures the environment, activating gender-role socialization processes by which the environment constrains and supports the child's development of the appropriate gender role.
- A lot of this socialization is imposed on the child from outside forces:
  - Based on the external genitalia, parents and others (e.g., older siblings) perceive the child as a boy or girl and raise him or her in accordance with cultural concepts of masculinity and femininity.
  - Parents and others engage in differential modeling of gender roles.
  - Differential socialization continues outside the home, especially in the hands of peers (and their parents), teachers, and other authority figures. In the last several decades, television and other media have become increasingly important to gender-role socialization.

In these and other ways the environment constrains and supports the development of "appropriate" gender roles.

Toys and Gender Dimorphism

The environmental forces shaping children's gender roles are not by any means subtle. Consider, for example, the different dolls -- because that's what they are -- offered for girls and boys to play with.

- Girls get Barbie.
- Boys get G.I. Joe.

Barbie in particular raises concerns because her physical proportions may give girls (and, for that matter, boys) an idealized body image that is impossible to achieve (even if it were desirable).

But the effects of Barbie on gender identity and role are not restricted to physical features of the body image. They also extend to mental and behavioral aspects of the gender role. Consider, for example, the controversy that arose in 1967 over the first Talking Barbie, who was famous for saying "Gee math class is hard". Talking Barbie plays directly into gender-role stereotypes about sex differences in mathematical ability, and may discourage girls from taking advanced courses in mathematics.

But gender role socialization is not simply imposed on the child from outside: the child is also an active agent of his or her own gender socialization.

- Beginning at about age 2, children notice (as it were) their own genitalia, and identify themselves as boys or girls. This self-identification has a number of consequences:
  - The child divides people into two categories, according to sex, and identifies him- or herself as the same as some, and different than others.
  - The child attaches a positive affective valence to his or her own gender.
  - The child begins to actively model him- or herself on others who are similarly endowed.
- Children's recognition of gender is perfected by about age 3
  - By this time, they strongly prefer objects labeled as "for" their own gender.
- Differences in gender-role behavior are not reliably observed before age 2, but they are well established by the time the child goes to school:
  - Children prefer playmates of the same gender.
  - Girls prefer to play in smaller groups than boys.
  - Boys engage in more roughhousing than girls.

- Boys playing in groups are more likely to fight than girls.
- Girls are more likely than boys to turn to adults as resources.

Actually, children learn both gender roles, and adopt the role that is appropriate to their gender identity as male or female. Even so, there is some asymmetry in their preferences:

- Boys actively avoid activities that have been stereotyped as "for girls".
- Girls tend to show less stringent gender-role differentiation.
- Similarly, fathers enforce stricter gender boundaries than mothers do.

The active participation of the child in his or her own gender-role socialization illustrates the principle that the child is an active agent of his or her own development. Once the child has categorized him- or herself as male or female, he or she begins the active process of learning and performing the roles deemed appropriate for his or her gender. In this way, gender role socialization illustrates the complex interactions that play out between nature and nurture, and between the person and the environment.

Growing Up Male and Female

For authoritative reviews of the literature on gender-role socialization, see:

- John Money & Anke Ehrhardt, *Man and Woman, Boy and Girl* (Johns Hopkins University Press, 1972). Much of my treatment of gender dimorphism is drawn from this book.
- Eleanor E. Maccoby & Carol Nagy Jacklin, *The Psychlogy of Sex Differences* (Stanford, 1974).
- Eleanor E. Maccoby, *The Two Sexes: Growing Up Apart, Coming Together* (Harvard, 1998).
- Carol Tavris, *The Mismeasure of Woman* (Simon & Schuster, 1992)

Homosexuality

Is Homosexuality Adaptive?

Homosexuality poses problems for evolutionary psychology, because, like altruism, it seems maladaptive. If evolution favors traits that increase reproductive fitness, how could a trait evolve that doesn't lead to reproduction at all? Over the years, a number of hypotheses have been offered to explain how a genetic basis for homosexuality might have evolved:

- While homosexuals might not produce many children themselves, they may gain an adaptive advantage by serving as guardians of their kin. Because genes are

shared among family members, anything that homosexuals do to increase the reproductive fitness of their heterosexual siblings and cousins will also pass a genetic tendency toward homosexuality into the next generation (a similar argument from *kin-selection* has been offered for altruism).

- Homosexuals may have such strong sex drives that they engage in heterosexual as well as homosexual activity, and thus pass genes for homosexuality to the next generation in the usual way.
- Based on the observation that bonobos, a subspecies of chimpanzees (and thus closely related to humans) engage in homosexual and bisexual behavior in order to form strategic alliances, it has been suggested that homosexuality might enhance fitness in a similar way for humans.
- It may be that homosexuality is determined by not one gene but many, and that the genes for homosexuality are only activated in a particular intrauterine environment (such as low levels of androgens). Thus, some heterosexuals could carry genes for homosexuality the same way some brown-eyed individuals carry genes for blue eyes. Homosexuality would only occur if the person inherited a critical number of homosexuality genes, and if these genes encountered the "right" intrauterine hormonal environment.
-

These hypotheses are all very interesting, but they all appear to be predicated on the same *adaptationist fallacy* -- the notion that traits must be adaptive to evolve, and that traits evolve by virtue of their adaptive value.

The answer to the mystery of homosexuality may be simply that it is a mystery. If you think about it, setting reproductive issues aside, the sexual attraction that two people of the same sex feel for each other may be no different, no more mysterious, than the sexual attraction that two people of opposite sex feel for each other.

Other aspects of personality are probably acquired in much the same way. In other words, the development of gender differences in identity and role (not to mention erotic orientation) serve as models for the development of personality in general.

The Twin-Study Method

Many basic questions of nature and nurture in personality can be addressed by using the techniques of *behavior-genetics* are used to analyze the origins of psychological characteristics. Perhaps the most interesting outcome of these experiments is that, while initially intended to shed light on the role of genetic factors in personality developThese behavior-genetic analyses show the clear role of genetic determinants in personality, but also reveal a clear role for the environment.

The most popular method in behavior genetics is the twin study -- which, as its name implies, compares two kinds of twins in terms of similarity in personality:

- **Monozygotic** (MZ or *identical*) twins are the product of a egg that has been fertilized by a single sperm, but which subsequently split into two embryos -- thus yielding two individuals who are genetically identical.
  - Actually, MZ twins aren't *precisely* identical. Research by Dumanski and Bruder (*Am. J. Hum Gen* 2008) indicates that even MZ twins might differ in the number of genes, or in the number of copies of genes. Moreover, failures to repair breaks in genes can occur, resulting in the emergence of further genetic differences over the individuals' lifetimes. This discovery may have consequences for the determination of environmental contributions to variance, detailed below. But for most practical purposes, the formulas discussed below provide a reasonable first approximation.

- **Dizygotic** (DZ or *fraternal*) twins occur when two different eggs are fertilized by two different sperm -- thus yielding individuals who have only about 50% of their genes in common.

Of course, you could compare triplets, quadruplets, and the like as well, but twins are much more convenient because they occur much more frequently in the population. Regardless of twins or triplets or whatever, the logic of the twin study is simple: To the extent that a trait is inherited, we would expect MZ twins to be more alike on that trait than DZ twins.

The usual technique in twin studies is to administer some personality inventory, like the MMPI or CPI or NEO-PI to a large sample of MZ and DZ twins, thus obtaining scores representing each individual's standing on each personality trait measured by the inventory. Then we measure the similarity of the twins on each trait. The most common measure of similarity is the *correlation coefficient*, which summarizes the direction and strength of the relationship between two variables -- for example, between extraversion in one twin and extraversion in the other.

- The correlation is positive if one individual has a high score and his twin does too.
- The correlation is negative if one individual has a high score and his twin has a low score.
- Correlations close to +1.0 or =1.0 indicate a strong relationship, positive or negative.
- Correlations close to 0.0 indicate little or no similarity between the twins.

If we assume that a personality trait (or a physical trait like eye color, for that matter) is solely determined by the genes, and the environment has no effect, we would expect that following pattern of correlations:

- For MZ twins, r = +1.0: the twins are genetically identical, and thus identical in personality.
- For DZ twins, r = +0.50: because there is some degree of genetic similarity between the twins, we would expect some degree of similarity in personality as well.
- For genetically unrelated individuals, r = 0.0: with no genetic overlap, there should be no similarity in personality.

An alternative measure of similarity is the *concordance rate*. Assuming that a person either has a trait or does not, on the hypothesis of exclusively genetic determination we would expect a concordance rate of 100% for MZ twins, and a concordance rate of about 50% for DZ twins (we will meet up with concordance rates again in the lectures on Personality and Psychopathology, when we discuss the origins of mental illness).

More generally, to the extent that a trait is inherited, we expect that MZ twins will be more similar to

each other than DZ twins -- regardless of whether similarity is measured by the correlation coefficient or the concordance rate.

In fact, a twin study of the "Big Five" personality traits by Loehlin and his colleagues (1992) showed that for each dimension of the Big Five, MZ twins were more alike than DZ twins. Studies using other personality inventories, such as the MMPI or the CPI, have yielded similar sorts of findings. Taken together, this body of research provides *prima facie* evidence for a genetic contribution to individual differences in personality. But genes aren't the only forces determining individual differences in personality. If they were, then:

- the MZ correlations would be a perfect 1.0 and
- the DZ correlations would be 0.50.

Physical characteristics like eye color and hair texture may come close to these values. Height and weight show high MZ correlations, but even these aren't perfectly correlated. The reason is that genotype alone is never sufficient to determine phenotype. Phenotypes always result from the interaction of genotypes with environmental factors. The typical MZ correlations for physical traits range upward from 0.50, suggesting high if not perfect heritabilities. By contrast, the typical MZ correlations for psychological traits range between 0.25 and .50 -- suggesting that genetic influences on personality are relatively weak, and environmental influences are correspondingly strong.

Of course, even perfect MZ correlations of 1.00 wouldn't be enough to clinch the case of exclusive heritability. Twins, especially MZ twins, share more than genes. They also share environments, and it is possible that MZ twins live in environments that are more alike than DZ twins (perhaps because MZ twins are of the same sex, or perhaps simply because they look more alike). This raises the question: How do we tease apart the genetic and environmental contributions to personality?

One way to address this question is to study identical twins who have been separate at birth and reared apart -- meaning that they share genes but not environments. Such cases do exist, and they are interesting, but the fact is that there are not enough of them to make a satisfactory sample. Moreover, many twins ostensibly "reared apart" really aren't. For example, twins might be "separated" for economic reasons, because their parents can't afford to raise both of them, and one of them reared by an aunt and uncle down the road. Even when twins are actually adopted out, adoption agencies often try to place adoptees with foster parents who resemble their biological parents in terms of age, educational levels, occupational status, and the like. Such twins probably share more of their environment than not.

Separated at Birth!

From the time Tamara Rabi began her undergraduate studies at Hofstra University, in New York, people started telling her that they knew someone else who looked just like her. It turned out that the other woman, Adriana Scott, was Tamara's identical twin sister. The two women had been born in Guadalajara, Mexico, and through a series of beurocratic snafus, separated at birth and adopted by different American families.

Adriana was raised as a Roman Catholic, Tamara as Jewish. Neither knew she had a twin (see "Separated at Birth in Mexico, United at Campuses on Long Island" by Elissa Gootman, *New York Times*, 03/03/03).

Identical twins separated at birth, and reared independently of each other, have often been taken as providing interesting evidence regarding the role of heredity and environment in personality and behavior. Naturally, a fair amount of interest lies in the similarities among the twins. Both own a pair of large hoop earrings, both like to dance, and they had similar nightmares when they were children. Both their adoptive fathers died of cancer.

Identical twins raised apart also provide the plot of a Walt Disney-produced movie, *The Parent Trap*, starring Hayley Mills (1961; remade 1998), a television sitcom (*Sister, Sister*), and an episode of *the X-Files* ("Eve"). Other movies involving twins separated at birth include:

- *The Iron Mask* (silent, 1929), remade as *The Corsican Brothers* (1971) and *the Man in the Iron Mask* (1997), all from the Dumas novel
- *Start the Revolution Without Me* (1970)
- *Echo* (1988)
- *Twin Dragons* (1990)
- *Big Business* (1988)
- A Merry Mix-Up (1957), starring the Three Stooges
- *Twice Blessed*
- *Double Impact* (1991)
- *Equinox* (1992)

See also a documentary, *Twin Stories* (1997).

For a review of scientific studies of identical twins reared apart, see:

- *Identical Twins Reared Apart: A Reanalysis* by Susan L. Faber (Basic Books, 1981)

Link to www.twinstuff.com for a complete listing of films about twins -- and lots of other information for and about twins and other "multiples".

Separating Genes and Environment(s)

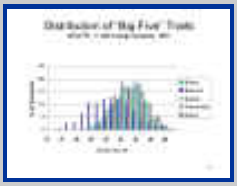
The genetics-versus-environment question can also be approached in the context of standard twin studies. But the issue gets a little complicated, because it turns out that the "environment" comes in two basic forms:

- The **shared environment**, also known as *between-family variance*, includes all the factors

that children raised in the same family share, which differentiate them from children in other families. As a rule, children in the same family are raised by the same parents, share a single racial, ethnic, and cultural heritage, live in the same neighborhood, go to the same schools, and attend the same church, synagogue, or mosque. The shared environment includes all the things that siblings have in common.

- The **nonshared environment**, also known as *within-family variance*, includes all the factors that differentiate among children raised in the same family. Even within a family, children differ in terms of such factors as gender (boy or girl) or birth order (first-born vs. latterborn). Children may have different interactions with their parents (parents treat children differently depending on age and sex), and develop different networks of friends and acquaintances outside the family. Different children within a family are also distinguished by *nonsystematic factors*, which include all the things that happen randomly to one child but not to his or her brothers and sisters -- *chance encounters* that can really make a difference in the individual's life. The nonshared environment is an umbrella term that refers to all the unique experiences that siblings have.

As it happens, the relative strength of both environmental components of personality, as well as the genetic component, can be estimated from the observed pattern of MZ and DZ correlations.



Consider, first the entire distribution of a trait within a population, from those individuals with the lowest scores on Extraversion or Neuroticism to those with the highest scores on these traits. This distribution is typically represented by a more-or-less "normal" distribution -- the famous "bell curve". Each person's score on a trait measure -- Neuroticism, Extraversion, whatever -- is a measure of the person's phenotype -- how he or she "turned out" with respect to that dimension of personality. The entire distribution of individual scores within a population is the **total variance** on the trait(s) in question.

This **total variance** in the trait (100%, or a proportion equal to 1.0) is the sum of **genetic variance** (i.e., variance in the trait that is accounted for by to genetic variability, or individual differences in genotypes) and **environmental variance** (i.e., variance in the trait that is accounted for by environmental variability, or individual differences in environments):

- Total Variance on a Trait (T) = Genetic Variance (G) + Environmental Variance (E)

The **environmental variance**, in turn, is the sum of variance due to the **shared environment** and variance due to the **nonshared environment**:

- E = Variance due to Shared Environment ($E_{\mathbf{S}}$) + Variance due to Nonshared Environment ($E_{\mathbf{NS}}$)

First, consider the comparison between MZ and DZ twins. By definition, MZ and DZ twins are identical with respect to the shared environment -- they are raised by the same parents in the same household. But MZ and DZ twins differ genetically: MZ twins are identical genetically, while DZ twins are no more alike, genetically speaking, than any two nontwin siblings. Thus, any difference in similarity between MZ and DZ twins must be due to genetic differences.

Genetic variance is a function of the *difference* between MZ and DZ correlations: the greater the MZ correlation compared to that of DZ, the more we can attribute similarity to shared genes than to

shared environments (don't worry about where the "2" comes from: this is a technical detail):

$$G = 2 * (MZ - DZ).$$

Next, consider MZ twins raised together. By definition, MZ twins are identical with respect to both genes and the shared environment. They are the product of a single fertilized egg, and they are raised by the same parents in the same household. If the only contributions to variance were from the genes and the shared environment, they ought to be identical in personality. Therefore, any departure from a perfect correlation of 1.00 must reflect the contribution of the *nonshared environment*.

Variance due to the **nonshared environment** is a function of the MZ correlation: MZ twins share both genes and (shared) environment, so any MZ correlation less than a perfect +1.0 must reflect the contribution of the nonshared environment:

$$E_{NS} = 1 - MZ.$$

Once we've estimated the contributions of the genes and the nonshared environment, variance due to the **shared environment** is all that's left, so it can be estimated simply by subtracting G and E_{NS} from 1:

$$E_S = 1 - G - E_{NS}.$$

Here are some illustrative examples:

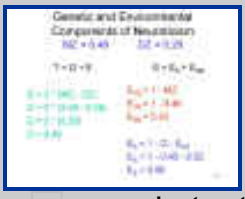
If the correlation for MZ twins is 1.00, and the correlation for DZ twins is .50, we have the situation described earlier: all the variance on the trait is attributable to genetic variance, and no variance is attributable to either sort of environmental factor, shared or nonshared.

If we reduce the MZ correlation substantially, but keep the DZ correlation pretty much the same, most of the variance is now attributed to the environment. There is some genetic effect, and some effect of each sort of environment.

If we increase the MZ correlation, but also increase the DZ correlation, most of the variance is still attributable to the environment, but the strength of the genetic contribution diminishes markedly.

The Big Five

If we use MZ and DZ correlations that roughly approximate those found in Loehlin's study of the Big Five, we find evidence of a substantial genetic component of variance, but also a substantial environmental component. Most important, we find that the contribution of the *nonshared* environment is much greater than that of the *shared* environment. In fact, the effect of the shared environment is minimal.



In fact, if we use Loehlin's data for Neuroticism, that's exactly the pattern we find:

- a substantial genetic component to variance;
- the contribution of the nonshared environment is even greater than that of the genes;
- the contribution of the shared environment is relatively trivial.

Considering all five traits examined in Returning to Loehlin's (1992) study of The Big Five, the results of actual twin studies of personality reveal that genetic factors account for approximately 40% of the variance on the Big Five traits; the nonshared environment accounts for approximately 50% of variance; and the shared environment accounts for less than 10% of variance. Apparently the family environment is not decisive for adult personality, and the nonshared environment is far more important.

Twin studies reveal genetic influences on personality, and these are interesting, but by far the most surprising finding of behavior-genetics research is the evident power of the *nonshared* environment. We've been taught, at least since Freud (though that should have been our first clue that something might be wrong!) that the way children are treated in the family determines how they'll grow up. In fact, this widespread belief appears to be incorrect. There is an extensive literature on child-rearing practices, considering such things as age of weaning and toilet training (the sorts of things that interested Freud a great deal), and these aspects of childhood seem to have little influence on adult personality (Sears, Maccoby, & Levin, 1957).

The fact is that, with respect to the major dimensions of personality, variability *within* a family -- i.e., the variance among children raised in the same family environment -- is almost as great as the variability *between* families -- i.e., the variance between children raised in different families. This result is sometimes misinterpreted as meaning that parents have no influence on their children. But it doesn't mean that at all.

- What it means, first, is that *parents don't have the same effects on each of their children.*

- In addition, it means that there are other forces at work besides the parents, and these become increasingly important as the child begins to move beyond the family (e.g., by going to school or joining the soccer league).

In a psychologically meaningful sense, every child:

- is born to different parents,
- grows up in a different family,
- lives in a different neighborhood,
- attends a different school, and
- worships in a different church.

These differences in the *nonshared environment* are critical for our individual uniqueness. Put another way, the most important environmental determinants of personality are the unique experiences that we have in our lives.

The Environment Outside the Family

One source of the nonshared environment, of course, is the extrafamilial environment. Even if all children within a family are treated precisely alike by their parents, once they begin to interact with the world outside the family they will have experiences that tend to make them different.

As examples of extrafamilial influence, consider a series of studied by David Rowe and his colleagues (e.g., 1992), using behavior-genetic methods, of the sources of various aspects of adolescent behavior.

- In one analysis, Rowe found that parents who smoke tend to have children who smoke, and the behavior-genetic analysis indicated that this influence was mediated by heredity (G), not the shared environment within the family (E_s).
- But it is also true that adolescents who smoke tend to have peers who smoke -- an effect of the nonshared environment outside the family (E_{ns}).

Rowe and his colleagues found similar causal patterns for alcohol consumption, delinquency, sexual behavior, and pregnancy. In each case, the shared environment had relatively little impact on behavior, but peer groups had a powerful effect on whether adolescents experimented with tobacco, alcohol, sex, and misbehavior.

Similarly, a study by Kindermann (1993) of academic motivation among elementary-school children found that students tended to group themselves into cliques such as "brains" and "slackers" -- but also that membership in these cliques tended to be somewhat unstable, with individual children moving back and forth from one group to another. Interestingly, the children's attitudes toward school changed as they changed cliques. "Brains" lost interest in school if they moved to a "slacker" clique, and "slackers" gained interest if they moved to a "brains" clique -- despite the fact that their IQs remained constant, and parental influences presumably did so as well. It was the

peer group that caused the changes to occur.

Based on results such as these, Harris (1995, 1998, 2006) has proposed a theory of *group socialization* which argues that peer groups and peer cultures, not parents, are the most powerful socialization forces impinging on a child. In fact, Harris argues that socialization is context-specific, and that children may behave quite differently depending on whether they are at home or away, and depending on which particular extrafamilial context they're in.

As an example, she points to "code switching" among bilingual and bicultural children:

- Children born to Spanish-speaking parents, for example, may continue to speak Spanish inside the home, even though they will speak English with their peers.
- Similarly, minority children from middle-class families may succumb to pressure from their peer groups to downplay academic achievement and other forms of "acting White" (Fryer, 2006).
- As another example, consider food preferences. If parents are such powerful socialization agents, why do they find it so hard to get their children to eat what they want them to eat? Children want to eat what their friends like, not what their parents like.

Analysis of Within-Family Differences

Even within the family context, however, there are important differences among siblings. Harris (1995, 1999, 2006) has classified these within-family differences into four categories:

- child-driven,
- relationship-driven,
- parent-driven, and
- family context.

In addition to these within-family differences, there are also extrafamilial influences that influence the development of personality and social behavior.

Child-Driven Effects. Child-driven effects, also known as reactive effects, relate to the fact that each child brings certain physical and behavioral characteristics into the family, which in turn affect how he or she is treated by parents and others.

Some reactive effects reflect the environment's response to the **physical appearance** of the child. These reflect the *evocation* mode of the person-by-situation interaction.

- The clearest example, discussed in the lectures on Personality and Social Interaction, concern how the child's biological sex -- male or female -- affects gender-role socialization. Here the physical appearance of the child structures the environment, by evoking differential treatment by others, according to cultural prescriptions for the proper socialization of boys and girls.

There may be other examples, having to do with the child's physical appearance:
- whether the child is conventionally "pretty", or perhaps has some blemish or disfigurement;
- whether the child physically resembles the parents or others in the immediate family.

Other reactive effects are instigated by the **behavior of the child**, not just his or her physical appearance. These reflect the *manipulation* mode of the person-situation interaction: there is something the child *does*, however unwittingly or involuntarily, to alter the environment in which he or she is raised.

- The clearest reactive effects of the child's behavior have to do with individual differences in temperament -- by which we mean the person's speed and strength of emotional arousal. Temperament is usually thought of as a product of genetic endowment and physiology, which combine to give the child a generally "quiet" or "fussy" disposition. The child's temperament-related behaviors then interact with the parents to alter the environment in which the child is raised.
  - In a *positive feedback loop*, a child with a pleasant temperament might elicit positive treatment from the parents, while one with an unpleasant temperament might elicit negative treatment. Of course, the parents' response to the child will elicit subsequent behavior from the child himself. In this way, a vicious cycle can develop that strengthens the child's initial behavioral tendencies -- making a quiet child quieter, and a fussy child fussier.
  - In a negative feedback loop, a child with a quiet temperament might elicit "lower-limit control behaviors" from the parents, intended to increase activity levels, while one with an active temperament might elicit "upper-limit control behaviors" intended to decrease them.

Positive and Negative Feedback

Remember how positive and negative feedback are defined: They don't refer to pleasant or unpleasant consequences, like reward and punishment. Instead:

- Positive feedback refers to any response that strengthens the stimulus that produced it.
- Negative feedback refers to any response that weakens the stimulus that produced it.

Of course, such child-driven effects may extend beyond the child's interactions with his or her parents, as children begin to venture outside the home to school, playgroups, sports programs, and the like. Thus:

- aggressive children may elicit aggressive behavior from other children;
- introverted children may be ignored by their teachers.

In general, child-driven effects are unpredictable, because they greatly depend on the response to

the child by the people who make up the child's environment -- their own personalities, beliefs, attitudes, goals, and the like.

Relationship-Driven Effects. Relationship-driven effects have to do with the "fit" between child and parent in terms of appearance and temperament. For example:

- a quiet child may elicit quite different behaviors from a parent who is also quiet, as opposed to one who is active;
- an introverted parent may react quite differently to a quiet child, as opposed to one who is active.

Relationship-driven effects are related to the *selection* mode of the person-by-situation interaction, in that they involve the degree of "fit" between the child and the other people who make up his or her social environment.

Parent-Driven Effects. Parents don't just react to their children's appearance, behavior, or temperament. To some extent, parental behavior is independent of the physical, mental, and behavioral characteristics of the child. For example:

- Sad as it may be, some parents will reject a child who is the product of an unplanned pregnancy (this doesn't always happen, of course: unplanned pregnancies can be joyful surprises for parents; but to think that they're all blessed events is asking too much. Sometimes the appearance of a child conflicts with the parent's other plans, or makes life difficult for the parent in some way (this is why it is so important that every child be actively wanted by its parents).
- Some parents try to treat identical twins very similarly, with respect to dress, activities, and the like; other parents of identical twins will go out of their way to treat them differently. To the extent that identical twins are deliberately treated differently by their parents, of course, they are raised in different environments despite having identical genetic endowments; they have little by way of shared environment, and a great deal by way of nonshared environment.
- Parents who have more than one child sometimes experience *contrast effects* on their perception of their offspring.
  - If the first child was "difficult", the second may be perceived as "easier" to raise.
  - If the first child was "easy", the second may be perceived as "difficult to raise -- even if there are no objective differences between the two children's behavior.

  These different perceptions will naturally translate into different parenting behaviors, which will exaggerate the differences in home environments between the children.

Family-Context Effects. Family context effects relate to the children's "microenvironments" within a family. For example, in my family, there was a father, a mother, a girl and two boys. Therefore, my family microenvironment consisted of my parents, my sister, and my brother. But my brother's family environment was different -- it consisted of my parents (who of course were also his parents), but it also included my sister and me. Similarly, my sister's family environment consisted of our parents and my brother and me. Different people in each environment. Put bluntly, I grew up in an environment that included a very popular cheerleader and a varsity basketball player; my sister and brother didn't. It's the same for every child in every family.

Serendipity

Aspects of the nonshared environment can be classified in many ways, but one that almost defies classification is *serendipity* -- chance encounters that shape our attitudes and personalities, and almost by definition constitute unique experiences. The word *serendipity* has its origins in a folktale first related in 1754 by Horace Walpole, and English writer, about three princes of Serendip, or Sri Lanka, who "were always making discoveries, by accident and sagacity, of things which they were not in quest of". In *The Travels and Adventures of Serendipity* (Princeton, 2004), the late Robert K. Merton and Elinor Barber trace both the origin of the word and the role that serendipity has played in the history of science -- for example, Alexander Fleming's accidental discovery of penicillin. In much the same way that simple chance will lead a scientist one way as opposed to another, simple chance can profoundly affect our lives and the way we lead them.

Birth-Order Effects?

Among the most controversial family-context effects involve **birth order** -- that is, systematic differences in personality between first-born and latter-born siblings in a family. Because there are no systematic genetic differences between first-borns and latter-borns (all brothers and sisters share a random 50% of their genes in common), any systematic differences between them must be due to their position in the *family constellation*.

But *are there* any such systematic differences owing to family constellation?

Until recently, most researchers held that birth-order effects were weak or inconsistent (Schooler, 1966; Ernst & Young, 1983). To be sure, there were occasional studies that demonstrated personality differences between first-borns and latter-borns, but there were lots of confounding variables that made the studies difficult to interpret:

- By definition, first-borns are older than latter-borns, so any differences between them might be a product of age, not family constellation.
- Also by definition, birth order is correlated with family size. You can't be a latter-born unless there are at least two children in the family, and you can't be the fifth-born unless there are at least five. Family size, in turn, is correlated with parents' education, occupation, and socioeconomic status. As a general rule, in Western countries at any rate, highly educated, wealthy, professional people have fewer children than poorly educated, poorer, working-class people. There are exceptions, of course: for example, members of the Mormon religion (Latter-Day Saints) are encouraged to have as many children as they can afford. But the fact that family size tends to be negatively correlated with socioeconomic status means that, in most populations, subjects who are first-borns will be from wealthier families, on average, than subjects who are latter-borns (it takes a little while to get your head around this, but you can do it). For that reason, differences between early-borns and latter-borns may be an artifact of differences in socioeconomic status.

Birth Order and Personality. None of these problems are intractable, however, provided that your sample sizes are large enough. And there are reasons for being interested in the possibility of birth-order effects on personality. For example, Frank Sulloway (1996), a historian of science who dabbles in evolutionary psychology, has argued that, in Darwinian terms, siblings complete with each other for their place in the family environment -- just like species and organisms compete for their environmental niches in nature.

- At least among males, Sulloway argues that first-borns have first choice, which makes them more traditional and acquiescent to authority.
- By contrast, Sulloway argues, latter-borns have to find other ways of distinguishing themselves, making them more egalitarian and anti-authoritarian. From Sulloway's point of view, laterborns are "born to rebel" (which, not coincidentally, is the title of his book on birth-order effects).

Primogeniture

As an example of the sort of "competition" process that Sulloway has in mind, consider the practice of primogeniture, quite common among the titled lords and landed gentry in England and elsewhere in Europe. In this practice, the first-born son inherited the father's estate, leaving the other sons to fend for themselves. As the saying went (more or less): the first-born got the title, the second-born son went into the military, and the third-born son went into the church. Parents wanted to marry their daughters off to first-born sons, so that they would not have to provide so much of a dowry (see, for example, *Little Women* or almost any 19th-century English novel). Note, too, that in royal successions, the crown passes from the king or queen to his or her eldest child (usually, in fact, the eldest son) -- regardless of his abilities or desire for the job (think about the House of Windsor in England: Charles get to be King when Elizabeth dies, while Andrew went into the Royal Navy and Edward became a filmmaker (not exactly the Church, but you get the picture). If the first-born son was disobedient, he could be disowned, and have to work for a living. No wonder, if Sulloway is right, that first-borns were more conservative and obedient to authority!

Sulloway, trained as a historian of science, found that scientists who made revolutionary contributions to their fields tended to be latter-borns. This led him to become interested in the wider psychological literature on birth-order and personality. In fact, a "meta-analysis" (i.e., a form of quantitative literature review that summarizes and aggregates the outcomes of many studies) performed by Sulloway, revealed systematic birth-order effects on personality:

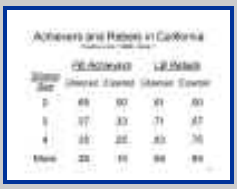
- **Neuroticism**: *firstborns* > *laterborns*: Firstborns tend to be more jealous, more anxious, more neurotic, more fearful, and more likely to affiliate with others under conditions of stress.
- **Extraversion**: *firstborns* > *laterborns*: Firstborns tend to be more extraverted, more assertive, and more likely to exert leadership in groups.
- **Agreeableness**: *laterborns* > *firstborns*: Latterborns tend to be more easygoing, more

cooperative, and more popular with others.
- **Conscientiousness**: *firstborns* > *laterborns*: Firstborns tend to be more responsible, more achievement oriented, more organized, and more planful.
- **Openness**: *laterborns* > *firstborns*: Firstborns are more conforming, more traditional, and more closely identified with their parents' attitudes, beliefs, values, and goals.

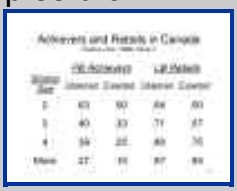
Technically speaking, Sulloway counted the number of comparisons on each dimension that gave positive, negative, or null findings with respect to his Darwinian hypotheses. For each Big Five dimension, he found that far more studies supported his hypothesis than contradicted it. Lots of studies yielded unambiguous findings, though, leading to some controversy over his interpretations.

- Of the total of 196 comparisons, only a minority of the studies (72, or 36.7%) confirmed his hypotheses. However, if you adopt the standard criterion for statistical significance -- $p < .05$, meaning that a result has a 5% probability of occurring randomly, this is more than we'd expect by chance (196 x .05, or 9.8). Conversely, even *fewer* studies (14, or 7.1%) yielded clearly negative results.
- Of the 86 comparisons that yielded definitive findings one way or another, the vast majority (74. or 86.1%) were positive, confirming his hypothesis.

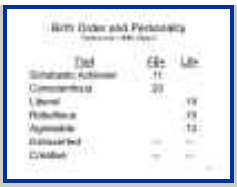
The power of Sulloway's meta-analysis comes from the fact that he made his predictions *in advance*, based on his reading of Darwinian theory. However, his analysis involved a lot of interpretation, and it would be nice to see his findings confirmed in a study expressly designed to test his hypotheses.



Such a study was performed by Paulhus et al. (1999), based on samples drawn from student populations in both California and Canada. Paulhus asked subjects to think about themselves and their siblings, and to nominate who in their family was the "achiever" and who was the "rebel". In both samples, Paulhus found that subjects were more likely to nominate the first-born child in their family as the "achiever", and a laterborn child as the "rebel", than we would expect by chance.



- For example, if there were two children in a family, we would expect 50% (1/2) of firstborns to be nominated as "achievers", and 50% of laterborns (the remaining 1/2) to be nominated as "rebels", just by chance. On the contrary, in the California sample Paulhus 65% of "achiever" nominees were firstborns, and 61% of "rebel" nominees were laterborns.
- If there were three children in a family, we would expect 33% (1/3) of firstborns to be nominated as "achievers", and 67% of laterborns (the remaining 2/3) to be nominated as "rebels", just by chance. On the contrary, in the California sample 37% of the "achiever" nominees were firstborns, and 71% of the "rebel" nominees were laterborns.
- The findings originally obtained in the California sample were subsequently replicated in a Canadian sample.



In two other studies, Paulhus and his colleagues also found other respects in which firstborns differed from laterborns. For example, there were more firstborns nominated as the "scholastic achiever" in the family, and more laterborns nominated as the "liberal" in the family, than we would expect by chance. These departures from statistical expectations are sometimes small, but these small effects accumulate to provide significant support for Sulloway's hypotheses.

Note that Sulloway and Paulhus found significant personality differences between first- and laterborn children, but these differences do not necessarily validate Sulloway's "Darwinian" theory. The personalities of first- and laterborn children may differ in significant ways for reasons that have nothing to do with competition for an environmental niche. There may be other expectations. For example, parents may impose their own expectations more strongly on the firstborn, and give laterborns more freedom. Royal families (like the House of Windsor in England) want to produce "an heir and a spare", but once the heir proves up to his assigned job, his younger sibling may be given a great deal of freedom to pursue his own interests. In England, Edward looks like a rebel only because Charles is doing his duty.

A Continuing Controversy

Like the question of birth order effects itself, Sulloway's work is highly provocative, but it is also highly controversial -- not just for the Darwinian interpretation he puts on his findings, but also with respect to the findings themselves. For critiques of Sulloway's work, see:

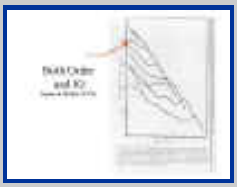
- Harris, J.R. (2002, May 22). The mystery of *Born to Rebel*: Suloway's re-analysis of old birth order data. http://xchar.home.att.net/tna/birthorder/methods.htm.
- Sulloway, F. (Undated). Birth order and the nurture misassumption: A reply to Judith Harris. http://www.edg.org/3rd_culture/sulloway_harris/index.html.

For another view of within-family differences, see *The Pecking Order: Which Siblings Succeed and Why* by Dalton Conley (Pantheon, 2004).

Birth Order and Intelligence. Perhaps the most controversial claim about birth-order is that firstborns are more "intelligent", as measured by standard "IQ" tests, than laterborns. It was this hypothesis that was specifically rejected by the Schooler (1966) and Ernst & Young (1983) studies cited earlier. However, a provocative study by Zajonc and his colleagues has revealed an interesting (if small) effect of birth order on general intelligence. These effects, however small, has led Zajonc to develop a *confluence model* of development that recapitualtes the major themes of these lectures:

- The person is a part of his or her own environment.
- The child is an agent of his or her own development.

The first study involved an analysis of data collected in the Netherlands as part of a study of the effects of the Dutch famine of 1944 (Zajonc & Markus, 1974). As part of routine testing for the military draft, the Dutch government administered a nonverbal IQ test (Ravens Progressive Matrices) to every Dutch male who reached 19 in the years 1963-1966. Zajonc and Markus then plotted mean IQ scores as a function of both family size and birth order.



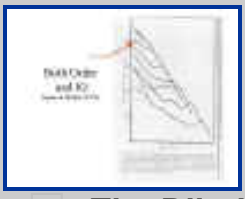
The results revealed a significant interaction of birth order with family size on IQ. Specifically:

- Average IQ declines with family size.
- Within each family size, average IQ declines with birth order.
- The last-born child shows a greater decline in IQ than any other birth rank.
- The rate of decline in IQ diminishes with later birth ranks.
- An only child has a lower average IQ than the firstborn of a two-child family.

Before we go on, please note that the effects just described are *very small*. Note the Y-axis on the accompanying figure: the difference between the top and bottom means amounts to only about 10 IQ points. The differences noted above achieve statistical significance only by virtue of the huge sample size involved.

Given the fact that individual differences in IQ are only weakly related to social outcome in the first place, the differences revealed in Zajonc & Markus's analysis are of no practical significance. However, as we will see, they are of considerable *theoretical* import. Big theories can be built on small effects, and that is as true in psychology as it is in physics.

The Confluence Model

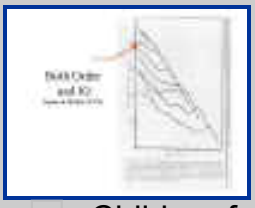


In order to explain the joint effects of family size and birth order on IQ, Zajonc and Markus proposed a *confluence model of intellectual development*. This model traces the mutual intellectual influences among children, and their parents, as they develop. The major features of the model are as follows:

- **The Dilution Effect:** A newborn child effectively diminishes the intellectual resources available within a family. Newborns literally don't know very much, and their lack of declarative and procedural knowledge drags the family down.
- **The Growth Effect:** Each child contributes more intellectual resources to the family as he or she grows up. Over time, this growth brings the family average back up.
- But if more siblings come into the family, each new child is born into a progressively diminished environment. This is an extension of the dilution effect.
- At the same time, each child in the family is growing up. The intellectual grown of earlyborn siblings progressively enhances the intellectual environment for the whole family, and

counteracts the dilution effect created by the laterborns.
- The actual effects of dilution and growth depend on the spacing of the siblings.
  - If siblings are spaced closely together, the dilution effect is increased.
  - If siblings are spaced farther apart, the dilution effect is weakened.

- In large families, some earlyborns are much older than some laterborns. Therefore, the dilution effect is weakened for these laterborn children.
- **The Teaching Effect:** Earlyborns also profit from the presence of laterborns, because they get intellectual stimulation from teaching younger siblings.
- **The Last-Child Handicap:** The lastborn child doesn't get the benefit of the teaching effect, simply because there are no younger siblings for him or her to teach. Therefore, he or she is at a special disadvantage.
- **The Only-Child Handicap:** For the same reason, an only child also doesn't get the benefit of the teaching effect. This puts only children at a disadvantage compared to the firstborns of small families. In a sense, the only child is both a firstborn and a lastborn.



The theory makes the interesting prediction that twins and triplets should be even more disadvantaged than only children, because their birth produces a big dilution effect. This is, in fact the case, but of course the outcome depends on details of birth order, spacing, and the like. Some other implications of the theory:

- Children from single-parent households may be at a special disadvantage, because there is a stronger dilution effect with only one parent in a household. Of course, there may be other adults present, such as grandparents or paramours, who can substitute for the missing parent.
- Children from extended families may be at a special advantage, because there are lots of adults around to counteract the dilution effect.

The confluence theory tells only part of the story of intellectual development . There are lots of other things going on, both genetic and environmental. But the major assumptions of the theory illustrate the basic points made throughout these lectures on personality, social interaction, and psychological development:

- The individual is a part of his or her own environment.
- The environment itself is dynamically changing as different individuals enter and leave it.
- The individual is constantly influenced by these environmental changes.
- The individual reciprocally influences the environment by virtue of his or her own changes, regardless of where these changes come from.

The person is a part of his or her own environment.

The person is an agent of his or her own development.

The nonshared environment is such a powerful force in personality development because everyone creates a unique environment for him- or herself, in interaction with other people, through the

various modes of person-by-situation interaction:

- Evocation;
- Selection;
- Manipulation;
- Transformation.

The uniqueness of the individual's environment is the sum total of many different effects, acting alone and in combination. And the uniqueness of the environment, as it is shaped by the individual him- or herself, in turn contributes to the uniqueness of the individual.

There is a sort of paradox in development, which is that the universal processes of development are universal, but these widely shared processes come together in such a way as to produce a unique individual.

Cultural Development

There is actually a third view of development, the cultural point of view, which is concerned with the effect of social development on the development of the individual's mind. In general, psychology has tended to ignore sociocultural differences in mental life. Psychology is universalistic, in that it assumes that the basic principles of mental functioning are found in all normal adult humans; and it is particularistic, in that it assumes that the course of individual lives reflect individual differences in knowledge and skills. But cognitive anthropology and sociology take on the task of understanding how social and cultural processes affect what we now and how we know it. Cognitive anthropology (also known as anthropological psychology or cultural psychology) arose in the late 19th century, with an interest in characteristic patterns of thought associated with people in so-called "primitive" and "advanced cultures. In the context of late 19th-century European imperialism (and its American counterpart in the drive westward towards "Manifest Destiny"), cognitive anthropology essentially studied the differences between conquerors (e.g., British, American) and the conquered (e.g., Arabs, Africans, and Native Americans). But setting politics aside, there are other aspects of cultural development that might also affect individuals' mental processes:

- literacy, or the proliferation of written language (not to mention, more recently, the proliferation of electronic media such as radio, television, and the Internet);
- economic development, as in the progression of societies from hunter-gatherer through agricultural and industrial to "post-industrial" forms of social organization (this definition of development was especially pursued by psychologists in the Soviet Union, such as Lev Vygotsky, but it has since outgrown its Marxist overtones).
- modernization, typically defined in terms of two dimensions: traditional beliefs versus secular rationalism; and a concern with survival and physical security versus a concern with self-expression (Inglehart & Baker, American Sociological Review, 2000).

The Three- (Maybe Four-) Age System

In cultural terms, *H. (sapiens) sapiens* are "Stone Age" humans:

- they made needles, handles, fishhooks;
- they hunted with harpoons;
- they used mechanical devices to throw spears.
- Perhaps as long as 77,000 years ago, they left pots in Blombos Cave, in what is now South Africa, that display abstract, symmetrical, geometric designs that may represent the earliest known art.
- About 40,000 years ago, they left the wall-art in the caves at Altamira (Spain) and Lascaux (France).

The term "Stone Age" refers to a "three-age" system for organizing human prehistory, based on the use of tools, introduced by C. J. Thomsen, a Danish archeologist, in the early 19th century. The three canonical ages are he Stone Age, Bronze Age, and Iron Age. The Stone Age is further subdivided into early, middle, and late periods. Sometimes a fourth age, the Copper Age, is interpolated between the Stone Age and the Bronze Age.

As their names imply, the prehistoric ages are determined largely by the kinds of tools in use, but in fact the ages also carry broad implications for social organization.

- **The Stone Age.** These humans were hunter-gatherers, living a mobile lifestyle close by sources of water. They made tools by hand from sharpened stones, bones, reeds, branches, and other objects found in nature.
  - Paleolithic (Early Stone Age) peoples lived in small bands of up to 100 people.
  - Mesolithic (Epipaleolithic, or Middle Stone Age) peoples divided into tribes and bands as their population increased.
  - Neolithic (Late Stone Age) peoples domesticated animals and otherwise began the transition to agriculture on stable farmsteads, and a hierarchical social organization based on the tribal chief.

- **The Bronze Age.** These humans fashioned tools from copper and then bronze alloys, and used a potter's wheel (as opposed to their hands) to make pottery. Bronze age agriculture involved the deliberate breeding of livestock, as well as the beginnings of trade.
- **The Iron Age.** These humans used -- well, duh! -- iron. Social development included the emergence of cities and city-states.

The three-age system was developed to organize our understanding of European history, though a similar progression, with some glitches, can be found outside Europe as well. Although we know little about the mental lives of prehistoric people, the general thrust of evolutionary psychology is that the heuristics, errors, and biases that litter modern thought processes are, in fact, evolutionary holdovers from prehistoric times. In other words, these patterns of thought evolved precisely because they aided survival in the Environment of Early Adaptation.

Paleolithic Cave Art

The meaning of paleolithic cave art remains a mystery. The most common

interpretation is that it has a spiritual or supernatural nature. Other authorities suggest that much of it, especially the paintings of genitalia and other sexual anatomy, is the work of adolescent boys with too much time on their hands.

Two recent books that review the controversy are:

- *The Cave Painters: Probing the Mysteries of the World's First Artists* by Gregory Curtis (Knopf, 2006), which tends toward the conventional view;
- *The Nature of Paleolithic Art* by R. Dale Guthrie (Chicago, 2006), which argues for the revisionist view.

For succinct coverage of the controversy, see "Secrets of the Cave Paintings" by William H. McNeill (*New York Review of Books*, October 19, 2006).

Epochs in Human History

Just as it seems likely that human mental life changed with progress from the Stone Age to the Bronze age, it is also a reasonable hypothesis that patterns of thought continued to change with further economics, political, and social development.

Some of the milestones of historical development have already been listed -- literacy, industrial capitalism, and modernism.

Here are some other possibilities:

- the Ancient Era (roughly up to the sack of Rome in the 4th century CE)
- The Middle Ages (4th-15th c.)
- Early Modern Period (14th-18th c.)
- Modern Era (18th-20th c.)
- Post-Modern Era (since World War II)

Again, these epochs were developed with reference to Europe, but analogs can be found outside of European culture.

From Cultural Development to Cultural Psychology

In addition to the new evolutionary psychology, a new cultural psychology is emerging that addresses cultural differences in thought processes without necessarily implying that one culture is more or less "developed" than another

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