

Evolutionary developmental psychology

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The field of evolutionary developmental psychology can potentially broaden the horizons of mainstream evolutionary psychology by combining the principles of Darwinian evolution by natural selection with the study of human development, focusing on the epigenetic effects that occur between humans and their environment in a way that attempts to explain how evolved psychological mechanisms become expressed in the phenotypes of adults. An evolutionary developmental perspective includes an appreciation of comparative research and we, among others, argue that contrasting the cognition of humans with that of nonhuman primates can provide a framework with which to understand how human cognitive abilities and intelligence evolved. Furthermore, we argue that several «immature» aspects of childhood (e.g., play and immature cognition) serve both as deferred adaptations as well as imparting immediate benefits. Intense selection pressure was surely exerted on childhood over human evolutionary history and, as a result, neglecting to consider the early developmental period of children when studying their later adulthood produces an incomplete picture of the evolved adaptations expressed through human behavior and cognition.

Psicología evolucionista del desarrollo. El campo de la psicología evolucionista del desarrollo puede ampliar potencialmente los horizontes de la psicología evolucionista, combinando los principios darwinistas de la evolución por selección natural con el estudio del desarrollo humano, centrándose en los efectos epigenéticos entre los seres humanos y su entorno, de manera que explique cómo los mecanismos psicológicos evolucionados se acaban expresando en el fenotipo de los sujetos adultos. Una perspectiva evolucionista del desarrollo incluye una consideración de la investigación comparada, y, como otros muchos especialistas, sostenemos que la comparación de la cognición humana con la de primates no humanos puede proporcionar un marco adecuado para comprender mejor cómo la inteligencia y otras habilidades cognitivas humanas evolucionaron. Además, se sostiene que varios aspectos «inmaduros» de la infancia (e.g., el juego y la cognición inmadura) sirven a la vez como adaptaciones diferidas y adaptaciones que tienen beneficios a corto plazo. Probablemente una intensa presión selectiva ha sido ejercida sobre la infancia a lo largo de la historia evolutiva humana, y, como resultado, negarse a considerar la relevancia del período temprano de desarrollo infantil cuando se estudia el comportamiento adulto, puede generar una visión incompleta de las adaptaciones evolutivas expresadas en la cognición y el comportamiento humanos.

The field of *evolutionary developmental psychology* stems from combining the principles of Darwinian evolution by natural selection with the study of human development in a way that focuses on the epigenetic effects (bidirectional gene-environment interactions) that occur between all living things and their environments. While mainstream evolutionary psychology theories focus primarily on adult behavior, especially in regard to mating and social interactions, evolutionary developmental psychology provides a broader framework for viewing the evolution of human behavior, attempting to explain how evolved, psychological mechanisms become expressed over the course of development in the phenotypes of adults.

We begin this article with a brief introduction to evolutionary psychology and evolutionary developmental psychology, focusing on the differences between the two perspectives. Next, we discuss animal comparative research that contrasts human social cognition with that of nonhuman primates. Because of our shared roots, looking at primate behavior and cognition can help bridge the gap between the more “primitive” behavior of our ancestors and that of modern humans. This is followed by a discussion of the benefits of cognitive immaturity and humans’ extended childhood and a brief examination of an evolutionary developmental approach to socialization and the adaptive nature of childhood and play, in particular.

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Integrating evolutionary theories with developmental psychology

A basic tenet of evolutionary psychology is that humans have evolved domain-specific abilities in response to recurring conditions in the *environment of evolutionary adaptedness*. While

these abilities may not always be well suited for modern conditions (e.g., humans' penchant for sweet and fatty foods was adaptive for our nomadic ancestors living in resource-scarce environments, but is associated in modern times with a host of health problems for many people living in developed countries), they would have served to solve recurrent problems in the lives of our ancestors. As such, they have been genetically transmitted over generations as evolved *domain-specific mechanisms*. Evolutionary psychologists assume that the human mind does not function like a general-purpose problem solver, but rather is *modular*, analogous to a Swiss-army knife, with a different evolved brain-based adaptation for each specific problem (Tooby & Cosmides, 2005). The goal of evolutionary psychology is to identify human psychological or behavioral adaptations that have evolved by natural selection and have conferred some fitness advantage to individuals possessing the traits relative to those without them.

A common example of such an adaptation is that of mate-retention. Because our ancestors who were able to gain access to and retain mates were undeniably more likely to reproduce than their conspecifics who were unable to find and retain mates, mate-retention tactics (such as displaying resources, derogating rivals, or monopolizing a mate's time) would have evolved as an adaptation and would have been passed along to offspring (Buss & Shackelford, 1997). Although this example is primarily behavioral, adaptations can also be structural (e.g., the shape of horse's teeth are well suited for grinding grass) or physiological (e.g., temperature regulation allows humans as well as other animals to maintain homeostasis).

Similar to evolutionary psychology, the goals of evolutionary developmental psychology "are to identify the social, psychological, cognitive, and neural phenotypes that are common to human beings, and to other species, and to identify the genetic and ecological mechanisms that shape the development of these phenotypes and ensure their adaptation to local conditions" (Geary & Bjorklund, 2000, p. 57). A central premise for this view is that throughout human evolutionary history there were (and continue to be) different adaptive pressures that emerged at varying points in time throughout ontogeny and have yielded predictable, adaptive responses to environmental pressures (see Bjorklund & Pellegrini, 2002; Burgess & MacDonald, 2005; Ellis & Bjorklund, 2005). Our ancestors had to survive infancy and childhood before becoming reproductive adults, and natural selection surely operated with special vigor on the early stages of the lifespan. In fact, given that nearly one-quarter of infants in the past died before their first birthdays, while nearly half died before puberty (Volk & Atkinson, 2008), infancy and childhood should be intense periods of natural selection. From this perspective, evolution can be viewed as a progression of ontogenies, with the accumulation of adaptations over the course of the lifespan eventually producing new species. Adopting an evolutionary developmental view can broaden the horizons of evolutionary psychology by providing a framework of the conditions in which children are reared and how those conditions can impact later (adaptive) development.

Of particular importance to an evolutionary developmental approach is the concept of *epigenesis*, "the sum of the genetic and non-genetic factors acting on cells to selectively control the gene expression that produces increasing phenotypic complexity during development. The genotype is the starting point and the phenotype is the endpoint of epigenetic control" (Hall, 1992, p. 215). In

contrast to the gene's-eye view of mainstream evolutionary psychology, which hints of genetic determinism (Lickliter & Honeycutt, 2003), evolutionary developmental theories focus on the evolved adaptive characteristics that become manifest over the course of ontogeny in response to environmental factors (Bjorklund & Hernández Blasi, 2005). Such a theory, focusing on bidirectional epigenetic effects that take place between an individual and its environment, is by definition a contradiction of genetic determinism because of the importance placed on environmental factors in shaping the phenotype (see Bjorklund & Pellegrini, 2002).

Although evolutionary developmental psychologists usually agree that there are domain-specific mechanisms that have evolved over time in response to recurring problems, they also argue that *domain-general mechanisms* exist for the purpose of solving novel, general problems (Geary, 2005; Bjorklund & Pellegrini, 2002). The human mind is noted for its flexibility, both early in development and throughout the lifespan, and our fluid intelligence and working memory suggest the existence of domain-general mechanisms. Thus, evolutionary developmental psychologists assume that children are highly plastic and especially responsive to conditions in their early environments, which are the best predictors of what future environments will be like (Bjorklund & Pellegrini, 2002).

Another assumption made by most evolutionary developmental psychologists is that children's prolonged period of development is associated with high risks as well as high benefits, and that there are specific adaptations associated with childhood. Moreover, some adaptations of childhood serve as preparations for adulthood (*deferred adaptations*), whereas others serve to adapt individuals to the niche of childhood and not as preparation for adulthood (*ontogenetic adaptations*; Hernández Blasi & Bjorklund, 2003). We will revisit some of these assumptions in more detail in the following sections.

Human social cognition contrasted with that of nonhuman primates

Since Darwin's time (1871), evolutionary biologists have believed in the continuity of mental functioning across phylogeny. An implication of this is that humans should share some cognitive features with the nonhuman primate species that recently shared a common ancestor with *Homo sapiens* (Bjorklund & Pellegrini, 2002). It is because of this that animal comparative research has become so entrenched in evolutionary developmental psychology, among other disciplines (i.e., biology, psychology, ethology, medicine, etc.), as a way to study human behavioral and psychological adaptations in terms of possible homologies (biological inheritance from a shared ancestor) and analogies (similar functions that evolved independently in different species; Maestriperieri & Roney, 2006).

Based on fossil evidence, the length of the developmental period in humans has nearly doubled relative to that of *Australopithecus afarensis*, a close genetic relative of modern chimpanzees (*Pan troglodyte*) that lived in Africa about 3 million years ago (see Bjorklund & Pellegrini, 2002). Humans take longer to reach sexual maturity than any other primate. However, *Homo sapiens* not only take longer to reach maturity than other primates, but, according to Bogin (2003), evolved two new life stages. The first is *childhood*, between infancy and the juvenile period, when

children are weaned but still cannot care for themselves. The second is *adolescence*, between the juvenile period and adulthood, with its characteristic growth spurt and low levels of fertility (see Figure 1). Some have interpreted humans' prolonged journey to adulthood as affording children more time with which to engage in social play and exploration, which enables superior physical, social, and cognitive competencies relative to that of our nonhuman ancestors (Geary & Bjorklund, 2000). Comparative research provides further support for this hypothesis, showing that longer developmental periods across primate species are associated with a larger neocortex and more complex social systems (Joffe, 1997).

A prolonged period of immaturity was (and continues to be) important for learning the complexities associated with group living. This makes humans uniquely susceptible to variations in parenting behavior (for a review of maternal effects on development see Bjorklund, Grotuss, & Csinady, 2009; for a review of paternal effects see Geary, 2000). These social interactions are particularly significant because it has been argued that the confluence of an enlarged brain, socially complex group living, and an extended juvenile period account, in part, for the evolution of human intelligence (Bjorklund, Grotuss et al., 2009).

Because humans and chimpanzees last shared a common ancestor sometime between 5 and 7 million years ago, there have been ample opportunities for divergence between the species, and one major area of such divergence is social cognition. Although some accounts of chimpanzees suggest that they have sophisticated social cognition, including the ability to inhibit behavior, at least a rudimentary theory of mind (the ability to attribute mental states to oneself and others), and substantial social-learning abilities (e.g., de Waal, 2005), their social-cognitive skills remain substantially limited compared to those of humans (see Bjorklund, Causey, & Periss, 2009; Tomasello, Call, & Hare, 2005).

Such findings suggest that our last shared ancestor with chimpanzees may have possessed enough neurological plasticity to allow it to adapt its behavior and cognition to changes in its environment, particularly early in life. An increase in overall brain size, coupled with an extended developmental period, has been

suggested to account for many of the species' differences in social-cognitive competencies, including self-awareness, prospective memory, maintenance of attention, and episodic memory (see Causey & Bjorklund, in press). The origins of these competencies, therefore, are rooted in the plasticity of the human mind, particularly early in life, and our ability to solve problems in a diverse variety of contexts and situations (Geary, 2005). We discuss this development in humans below.

Human cognitive development

The adaptive nature of cognitive immaturity

As we have mentioned, a central tenet of evolutionary developmental psychology is that while some periods of childhood may serve as preparations for later adulthood, other adaptations of childhood were selected because they served an adaptive purpose at that specific time in development (Bjorklund, 1997; 2007; Bjorklund, Causey, et al., 2009). This is true of some immature cognition characteristic of young children. For example, infants' immature sensory systems may prevent competition for neurons in the developing brain (Turkewitz & Kenny, 1982). Other studies have shown that children's poor ability to judge the competency of their own performance may be adaptive because it encourages them to attempt a wide range of activities and to learn from their less-than-perfect performance rather than considering it a failure (see Bjorklund, 2007). Furthermore, a limited working-memory capacity may actually aid children in acquiring a language because it simplifies the task of language acquisition (see Newport, 1990). We will revisit the adaptive nature of childhood and "immaturity" when we discuss the benefits of childhood and play.

Biologically primary and secondary abilities

Geary (1995) coined the term *biologically primary abilities* to refer to abilities that have evolved over the course of human evolution in response to various social and ecological pressures. These abilities will become manifest at some point in the development of all humans reared in a species-typical environment.

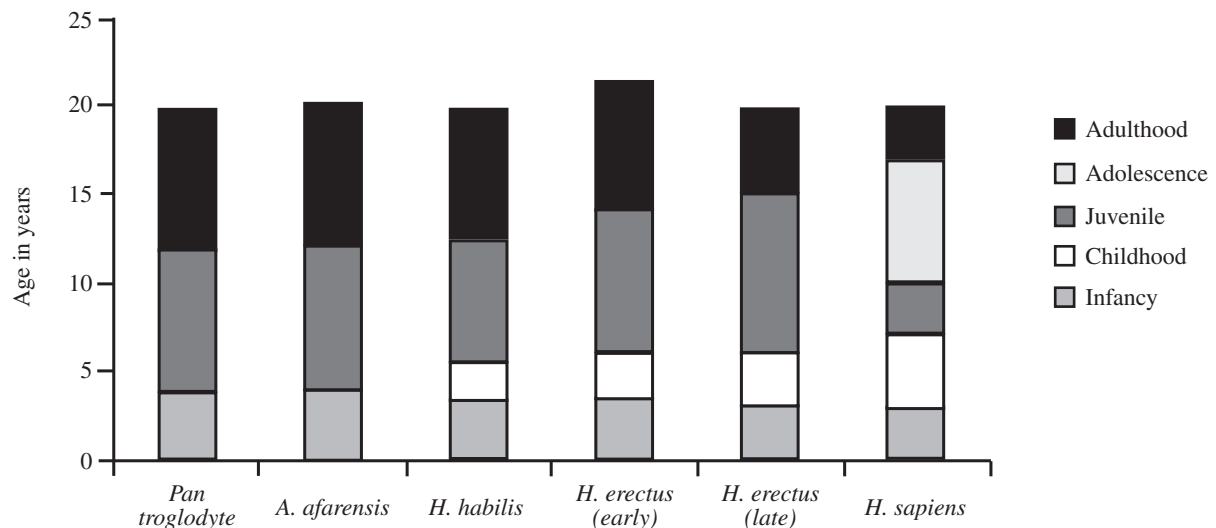


Figure 1. The evolution of human developmental stages

An often-cited example of such an ability is language. *Biologically secondary abilities*, in contrast, are culturally determined, built upon primary abilities, and are often acquired through formal education. An example is reading. While children typically display high motivation to learn biologically primary abilities and, indeed, universally acquire such abilities in all species-typical environments, children lack the same intrinsic motivation to learn biologically secondary abilities and, instead, rely heavily upon formal education to acquire such skills (Geary, 2007).

In addition to biologically primary abilities, all children seem to possess “intuitive” knowledge of their physical, biological, and social/psychological worlds, what Spelke and Kinzler (2007) refer to as *core knowledge* (see also Geary, 2005). For example, infants develop an early understanding of the nature of physical objects (e.g., *continuity*, the idea that objects move from one location to another in a continuous path and cannot be in the same place as another object), are able to distinguish between living and nonliving things during their first year of life (see Cohen & Cashon, 2006), and develop a *theory of mind* over the course of infancy and early childhood (Wellman, Cross, & Watson, 2001). Such abilities are important because, as Geary (2005) has argued, they likely serve as the basis upon which a child’s developing cognitive competencies are built, making them a central component of the evolution of intelligence.

An appreciation of children’s evolved information-processing abilities, learning styles, and intuitive knowledge of their physical, biological, and social worlds can be applied to education in modern cultures. For example, educators can take advantage of the fact that young children learn in play-oriented contexts and have some intuitive understanding of their physical and biological worlds. Additionally, understanding children’s developmental limitations (i.e., culturally important technological skills, such as reading and mathematics, require extrinsic motivation to learn; furthermore some of children’s intuitions are unscientific and must be “taught around”) can facilitate the development of curricula to most effectively foster learning (see Geary, 2007).

Socialization: An evolutionary developmental perspective

Conditional adaptations and children’s responses to early environments

The substantial degree of plasticity characteristic of children, afforded in part by humans’ extended childhood, permits them to adjust to variations in social environments and anticipate future ones. To capture this ability, Boyce and Ellis (2005) proposed the concept of *conditional adaptations*, defined as “evolved mechanisms that detect and respond to specific features of childhood environments – features that have proven reliable over evolutionary time in predicting the nature of the social and physical world into which children will mature – and entrain developmental pathways that reliably matched those features during a species’ natural selective history” (Boyce & Ellis, 2005, p. 290). This is perhaps most readily seen in girls’ rate of pubertal development as a function of their early family environment (e.g., Belsky, Steinberg, & Draper, 1991). Girls growing up in homes with economic and psychological stress, marital discord (or father absence), and unreliable social relationships, attain puberty sooner, become sexually active earlier, and invest less in their own offspring than girls reared in more supportive environments (see Belsky et al.,

2007; Ellis, 2004). These different patterns reflect adaptive responses to girls’ early environments. Although the “early-puberty/early sexual activity” pattern may seem maladaptive, it may represent a “good” strategy (from a Darwinian perspective) for a girl living in a harsh environment where social support is unreliable. By having many children in a resource-poor environment, parents can increase their chance that at least one of their offspring will be successful. Such “strategies” are not necessarily conscious, of course, but are based on children’s sensitivity to early environments and their physical and psychological responses to those environments in anticipation of future ones.

Girls have typically been the focus of these studies because research on the effects of the environment on pubertal timing has shown that girls tend to be more easily influenced by environmental conditions than are boys (Bjorklund & Pellegrini, 2002). Moreover, the consequences of sexual activity are greater for females than males given the disparity in obligatory investment in offspring that would occur should a female become pregnant (Trivers, 1972), making it reasonable that they would be more sensitive to factors that influence reproductive strategies. Once conception occurs, gestation and post-partum suckling require that the female be present in the early life of the offspring while males, in contrast, need only invest the time required for attracting a mate and engaging in copulation. Because this is the case for most mammals (in fact, fewer than five percent of mammalian species engage in male parenting), females should have necessarily evolved to respond differently to environmental cues than should males, and we should see the origins of this sex difference in childhood.

The development of socialization in Homo sapiens

While much research has been done on mothers’ role in the socialization of infants through shared attention, social learning, imitative play, and high-quality care, other environmental factors also play a role in human socialization (Bjorklund, Causey, & Periss, 2009). Fathers, as well as other extended family members (usually women), play a major role in the development of social competencies. Hrdy (2009), in fact, has described humans as *cooperative breeders*, in which mothers share the responsibility for childcare with others in the family and the larger social group. In traditional societies, and certainly for our ancestors, children were quickly integrated into the larger social group, mainly of other children. Importantly, Harris (1995) has posited that the most effective way for children to become socialized is to become members of, and identify with, a social group. Because social skills are so vital for adults to possess, it is reasonable to expect that these skills would be acquired primarily during childhood, so they have a chance to be learned and perfected. Many of these social-cognitive competencies are acquired through play.

The adaptive nature of play

We have already discussed how some aspects of childhood have been selected throughout evolution to serve an adaptive function at that particular time in development (i.e., immature cognition can be adaptive by reducing the cognitive load of learning a new language, thus aiding in comprehension). Now we turn our attention to an aspect of childhood that natural selection would have favored, in part, both for its immediate benefits and as preparation for later adulthood - play.

Geary and Bjorklund (2000) argued that child-initiated play and exploration are pivotal for the development of cognitive and social competencies. This is because child-initiated play (in contrast to “organized” play) is often person-centered and focuses on “developing social competencies, learning about other living things, and learning how the physical world is organized” (p. 62). These skills, examples of what Geary (1995) refers to as biologically primary abilities, serve as the foundation for later adult social competencies.

Evidence supporting these proposals is easily observed in sex differences that occur naturally in children’s play. For example, boys’ play is often more rough than girls’ play. For boys, there is a focus on social dominance and group-level competition that serve as preparation for physically aggressive male-on-male competition that would have served to increase social status and the acquisition of mates for our male ancestors, and still exists in many pre-industrial societies (Pellegrini, in press). Girls’ play, however, is more apt to be focused on developing and maintaining social relationships with other girls (i.e., fantasy play emphasizing social relationships; Pellegrini, in press; Pellegrini & Bjorklund, 2004). These behaviors serve as preparations for adulthood by helping girls learn how to form and maintain a social support system that can provide them some stability, a skill that was surely vital for the survival and reproductive fitness of ancestral women from hunter-gatherer societies (Bjorklund & Pellegrini, 2002). Although girls also display aggression, theirs is far less likely to be physical and, instead, is often in the form of *relational aggression*, a more covert form of aggression characterized by malicious gossip, ostracizing peers, and other forms of indirect bullying

(Crick & Grotpeter, 1995). Furthermore, relational aggression may provide practice for later competition over resources or mates.

Play is important for both boys and girls because it can serve as the foundation upon which later innovations and creativity may take root, which are certainly beneficial in adulthood (Bjorklund & Pellegrini, 2002). In addition to these preparations for later life, play also imparts immediate benefits such as those gained through exercise and the establishment and maintenance of social relationships during childhood.

Concluding remarks

An evolutionary perspective can contribute significantly to the study of human development, but a developmental perspective can also add to evolutionary psychology. While most evolutionary psychologists acknowledge that the environment plays a role in development, they rarely address this in depth and fail to fully explore the implications this has on adult social behavior and cognition.

Ultimately, adopting a developmental perspective in evolutionary psychology has the potential to broaden the horizons of mainstream evolutionary psychology by providing a more thorough description of the environmental variations that account for the development and expression of evolved human behaviors. Failing to do so can potentially limit the influence of evolutionary theory. After all, all humans who successfully survive into adulthood passed through the same developmental stages that significantly contribute to their adult behavior. Separating an adult’s behavior from his or her developmental history produces an incomplete picture, as the two cannot be separated in the natural world.

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