

The Evolution of Adolescence and the Adolescence of Evolution: The Coming of Age of Humans and the Theory About the Forces That Made Them

Patricia H. Hawley
University of Kansas

Adolescence is a period characterized by well-documented growth and change, including reproductive, social, and cognitive development. Though not unheard of, modern evolutionary approaches to adolescence are still relatively uncommon. Recent treatises in developmental biology, however, have yielded new tools through which to explore human physiological and behavioral growth, highlighted the role of the environment, and provided new avenues of thought for amelioration. Life history, the integration of form with function, and the concept of evolutionary mismatch are discussed.

It is an exciting time to be both an evolutionist and a developmentalist. Allied fields are in the midst of a considerable paradigm shift (a growth spurt, one might say), giving rise to exciting developments in evolutionary circles that well stand to benefit the study of adolescence. Of course, evolutionary approaches to human development are not new; some weighty evolutionary insights into human development are seamlessly integrated (e.g., Bowlby, 1969/1982; Hinde, 1974; Maslow, 1937). Yet, at the time of this writing, Google Scholar located only four articles with the word “evolution” or “evolutionary” in the title from all the English language journals on adolescence. This gap is extraordinary in light of the reproductive maturity of the average 15-year-old and evolutionists’ interest in reproduction.

I will begin by introducing modern evolutionary approaches to development and applying this thinking to adolescent pubertal changes and power (social dominance) relationships. Second, I will revisit how these bodies of work challenge us to reconsider the concept of “risk.” Third, I will introduce evolutionary mismatch and how it may specially apply to adolescents’ health and well-being. In the end, my hope is to offer the reader new lenses through which to view adolescent behavior and the unique problems that arise in this critical developmental stage.

Many thanks to David Sloan Wilson and Jerry Lieberman, founders of the Evolution Institute, for energizing, organizing, and stimulating evolutionary scholars to action. Thanks are also extended to Mark Osman, Jacklyn Ratliff, Luke McCune, and Kathryn Stump for helpful commentary on earlier drafts.

Requests for reprints should be sent to Patricia H. Hawley, Department of Psychology, University of Kansas, 1415 Jayhawk Blvd., Lawrence, KS 66045. E-mail: phawley@ku.edu

MODERN EVOLUTIONARY APPROACHES TO HUMAN DEVELOPMENT

The application of “biological thinking” to human behavior has its roots in ethology. Four foci defined this field (Tinbergen, 1963): (a) the adaptive function of behavior (its design, purpose, and role it plays in reproductive success), (b) its evolutionary history (phylogeny), (c) its proximal causation (e.g., sensory, neural, hormonal underpinnings) and environmental releasers, and (d) the behavior’s development within the individual (i.e., its ontogeny). Fellow ethologists thus were urged to focus rigorously on the integration of the four categories of question (e.g., Zeifman, 2001). Yet, even still, the levels are all too often conflated by the uninitiated. For example, when secure attachment is associated with optimal coping and therefore deemed “adaptive,” what is presumably meant is “adaptation” in the strictly proximal (i.e., psychological adjustment; e.g., Seiffge-Krenke, 2006). It is easy to erroneously conclude that secure attachment is the evolutionary adaptation, with insecure attachment being the maladaptation that must somehow be accounted for. In reality, the attachment system is the evolutionary adaptation, while the attachment styles are different solutions to the problems faced by the organism after birth. The latter reflects points “c” and “d” above, the former point “a.” Most attachment work is not evolutionary at all despite the fact that attachment theory is a sound mid-level evolutionary theory.

Nearly half a century after Tinbergen’s classic treatise, modern evolutionary approaches to human behavior incorporate elements from several fields (e.g., ethology, behavioral ecology, anthropology,

economics, and evolutionary psychology), all of which have their own theoretical lineage, favored methods and questions, and unique contributions. Yet, evolutionary approaches of all flavors share a concern for integrating a behavior's "form" (phenomenological manifestation) with its ultimate "function" (what is a feature designed to do?). As Williams (1966) described, the function of an apple is to produce and disperse apple trees. Reproduction and dissemination are the apple's functions, fruit is its form. In the above example on attachment, the different qualities of attachment are different forms reflecting the same function (maintaining proximity to the caregiver). This latter point illustrates the openness of developmental programs to environmental input, a point that is often well overlooked when evolutionary arguments come into play.

DEVELOPMENTAL PLASTICITY AND ENVIRONMENTAL SENSITIVITY: A VIEW FROM LIFE HISTORY THEORY

In fact, evolutionists are still often naively accused of genetic determinism (Winegard, Winegard, & Deaner, 2009). Quite to the contrary, we have learned from developmental biology that genetically similar organisms characteristically develop vastly different phenotypes (physical and behavioral characteristics) in response to environmental factors (West-Eberhard, 2003). This environmental sensitivity is called "phenotypic plasticity." Not only does the environment play a key role in the sex determination of many reptiles (Bull, 1983), but members from the same species can take on different physical characteristics and behavioral habits dependent on the conditions (e.g., seasonal) under which they are raised. Specifically, key environmental inputs calibrate the system toward a favorably competitive strategy (strategic differentiation) for the prevailing local environmental conditions. As one example from many, a *Schistocerca gregaria* nymph hatched under low population densities will become a harmless form, that of a solitary grasshopper. But if hatched under densely populated conditions and resource scarcity, its form will be a "social" locust, prepared to live life on the move searching for new food sources. These so-called "condition dependent adaptations" may be quantitative variations on a single dimension, or in extreme cases they may be so qualitatively distinct that they are mistaken for different species (as was long the case with *S. gregaria*). The two very different forms of *S. gregaria* serve the same function: survival and reproduction under the prevailing ecology. It is important to note that though

this latter form imposes a cost on humans, "harm" is not the locust's function. It has merely been designed by natural selection to do the best job it can in light of the conditions under which it was born.

All species have a phylogenetic history that shaped the modal course of their life trajectories. Many species live a season or two and breed early and often. Humans and elephants take time to develop, and reproduce relatively late and infrequently. Life history theory (e.g., Roff, 1992) is the metatheoretical framework that describes physical growth, development, and reproduction (timing of sexual maturation, parental investment, quantity of offspring, etc.) as a lifelong stream of adaptive trade-offs for allocating finite resources toward competing life functions. Generally speaking, these trade-offs between growth and reproduction have been described on a fast-slow continuum (early reproduction, briefer gestation vs. protracted development, later reproduction, longer gestation). Overall, humans tend to be positioned on the "slow" end of the continuum (formerly referred to as "K" strategists) because of our prolonged maturation, delayed reproduction, and bias toward bearing few, large-brained, slow-developing offspring that require a good deal of careful and costly investment. In contrast, faster strategists (formerly known as "r") come to reproductive age more quickly, and bear sometimes hundreds of offspring that, at the extreme, require little or no parental care, but accordingly suffer a high mortality rate (e.g., the ants in your kitchen).

What makes the above evolutionary theoretical perspective particularly powerful for our present purposes is threefold. First, it is inherently developmental and as such illustrates how individual differences are as much a part of evolution as are universals (Buss & Hawley, 2010). That is, the course of a "life history strategy" not only varies across species, but also across individuals within a species, as these individuals are differentially triggered by their physical (e.g., temperature, resource scarcity) and social environments (e.g., quality of parental investment, population density: Burton, 1990; Ellis, Figueredo, Brumbach, & Schlomer, 2009). Second, it makes clear that different forms (qualitative or quantitative) of behavior can serve the same function, even if the "morphs" look very different. Third, any harm to human society that may result from variegated forms is probably not the function per se, but rather a side effect of the organism attempting to thrive given the hand it was dealt. I will incorporate these three points into my discussion of pubertal timing and social dominance.

Pubertal Timing and Adolescent Sexual Behavior

Socioenvironmental conditions can turn a grasshopper nymph into a locust. Similar responses in many species make this phenomenon uncontroversial in biological circles. Are there analogous effects in humans? Can a child born under conditions A “do well” to develop a set of behavioral and physiological characteristics distinct from a child born into condition B, even if those children are genetically similar? Bowlby advanced similar claims about behavior with attachment theory. Stronger claims about behavior and physiology emerged in the 1980s (e.g., Draper & Harpending, 1982) and have garnered increasing theoretical elaboration and empirical support over the last 20 years (Belsky, Steinberg, & Draper, 1991; Del Giudice, 2009; Ellis, 2004). These authors collectively suggest that human children, especially girls, may be sensitive to their early socioecological conditions in ways that entrain development toward either a faster (earlier pubertal maturation, more sexual partners, less stable relationships) or slower (later pubertal maturation, fewer sexual partners, more stable relationships) life history strategy. These early environmental conditions (e.g., harshness, unpredictability, family disruption, and father absence; Ellis, 2004; Ellis et al., 2009) cue the developing system as to the socioecological conditions she is likely to find herself in when she comes of reproductive age. For example, girls who find themselves in a fractious early environment with low investment from their fathers “encode” that resources are scarce and men are unnecessary for reproduction. Over evolutionary time, the reproductive success of these girls was enhanced via early pubertal maturation and an accompanying suite of motivational orientations and behaviors connoting precocious sexual debut, early reproduction, and multiple, unstable relationships, all characteristics of a “fast strategy” in humans. In contrast, girls who enjoy reliable investment from committed fathers postpone puberty, and instead develop a life history pattern of stable pair bonding involving fewer partners and sexual restraint (Ellis et al., 2009).

Here we see divergence in approaches that focus on either form or function of behavior. Accelerated pubertal development, sexual precociousness, and an orientation favorable to multiple partners are seen as predominantly noxious from most (form focused) developmental perspectives. Evolutionists, however, see this suite of behaviors and orientations as an adaptation to the local environmental conditions. As such, each life history strategy is viewed as having distinct costs and benefits. Delaying reproduction until early adulthood yields healthier, more robust

infants (e.g., Mirowsky, 2005). The cost, however, manifests in reduced lifetime reproductive success for the female. Though a childbearing adolescent has a longer reproductive lifetime (a benefit), her infants are less likely to be healthy and of full weight (e.g., Geronimus & Korenman, 1993). These trade-offs between current and future reproduction and offspring quantity versus quality lie at the heart of life history theory.

Though traditional developmental perspectives view slow strategies as vastly preferable (presumably because they bear little cost to society), evolutionary approaches like life history theory recognize that some behaviors typically considered proximally maladaptive by psychologists may actually reflect the organism (here, adolescent) adaptively adjusting to the environment in which he or she finds him- or herself.

Social Dominance, Aggression, and Cooperation

As with the above example, focusing on the phenomenological manifestation of the behavior (form) may lead one to conclude that early pubertal development and accompanying behaviors are indications of maladaptive processes in the adolescent. The picture becomes multisided when function is taken into account. As detailed above, morphological manifestations that look quite distinct can in fact be functionally similar. This is the case, I believe (and have argued at length elsewhere; see Hawley, 1999), with cooperative behavior and aggression, the reformulation of which is evidence for the value added from evolutionary theory as it casts some aspects of human behavior in quite a different light and in ways that are not easily explained by predominant models in non-evolutionary developmental psychology.

Power relations are inherent to group living species. Traditionally (and even still), the bulk of this work on social dominance in humans and animals focuses on the form of behavior and the function only secondarily. One sees this focus in the emphasis on agonistic contests, fighting ability, and submissive gestures, which in general are predicted by size, pugnacity, and sex. Research on chicken peck orders initially gave rise to this aggression-based view of social dominance (Schjelderup-Ebbe, 1922), and it was quickly applied to social groups of children (e.g., Bühler, 1927). As a consequence of this focus on the *form over function*, socially dominant individuals—typically thought to be males (Pellegrini, 1995; Weisfeld, 1995)—are believed to play central roles in their social groups (e.g., ally selection, priority access to females; Dunbar, 1988).

There are several issues that are ill addressed by this approach. Foremost, humans who “win in agonistic contests” do not reap the social rewards evident in their animal counterparts. Indeed, a good deal of developmental work has shown that individuals who favor agonism are to some degree socially repellant (Coie & Dodge, 1998). Moreover, work in biology has clearly shown that there is rarely only one solution to a problem. To claim otherwise would be to suggest that the only way to be a successful *S. gregaria* is to be a swarming locust.

Does resource competition (function) take different forms? The proposition that cooperative behavior can serve as an effective competitive strategy that enhances reproductive success in fact has long theoretical roots (e.g., Charlesworth, 1996; Kropotkin, 1902; Trivers, 1971). One can meet one’s material needs in the social group by theft or threatening harm (i.e., aggression) or by proposing friendly cooperation or reciprocation (I help you now, you help me later). Thus, prosociality and aggression are two very different forms of behavior that can serve the same function of maximizing access to resources, or “two sides of the same coin.”

This simple shift from form to function has both theoretical and methodological implications. The two-strategy approach implies that prosocial and coercive strategies can be measured on independent scales and then used to identify types of individuals based on their employment of the strategies relative to other social group members (i.e., high–high, low–low, high–low, low–high, etc.). This *person-centered approach* is known to uncover aspects of functioning unavailable to more commonly employed variable-centered approaches characterized by regressions and correlations (see Hawley, Johnson, Mize, & McNamara, 2007, for extended discussion). Thus, adolescents (and children and adults) tend to use one strategy over another (e.g., prosocial controllers, coercive controllers), both strategies to an average degree (i.e., typical controllers), neither strategy (noncontrollers), or both strategies frequently relative to other group members (bistrategic controllers). The modal pattern of humans is to use both strategies to some degree.

The types differ in ways that show that aggression does not necessarily earn the social censure it is believed to in developmental circles. For example, two groups are very high on aggression: coercive controllers and bistrategic controllers. Yet, these groups differ markedly in terms of social skills, moral cognition, regulatory ability, and social reception (e.g., Hawley, 2003). Bistrategic controllers (who are highly effective at goal attainment) do not seem to suffer the

deficits of coercive controllers and accordingly are not only well received by peers (liked), but are also high status (i.e., popular; e.g., Hawley, Card, & Little, 2007). In short, bistrategic controllers do not appear to bear the same costs for their aggression as do the coercive controllers. I will return to the issue of costs associated with “high risk” behavior below. Until then, it is interesting to note that this revised view of power engenders a group heretofore undocumented; specifically, prosocial controllers who control resources without resorting to aggression. Their mere existence demonstrates that dominance (resource control) need not entail agonism and that prosociality need not be altruistic. Finally, this function-based view brings females firmly into the fold; females nearly outnumber males in the aggregate of bistrategic and prosocial controlling groups. This pattern, documented across multiple age groups, highlights the role of competition in the half of the population that has been nearly ignored for a century of evolutionary literature on power and dominance (Hawley, Little, & Card, 2008).

REDEFINING RISK AND BALANCING COSTS WITH BENEFITS

Bistrategic resource controllers confront predominant developmental psychopathology models that construe aggressive behavior as a *risk factor* in development through its associations with negative developmental outcomes such as peer rejection (Coie et al., 1998), delinquency (Hämäläinen & Pulkkinen, 1995), and low educational achievement (Brook & Newcomb, 1995). In developmental circles, our understanding of “risk” has been largely influenced by epidemiological disease models which attempt to “locate agents or conditions that are associated with an increased probability of outcomes that compromise health, quality of life, or life itself” (Jessor, 1991, p. 597). These medical-model-inspired approaches have been fruitfully applied to youth aggression. Yet, even Jessor himself cautioned that when reformulating epidemiological approaches to apply to psycho-social phenomena, the concept of risk requires modification from its medical counterpart; namely, many adolescent “risk behaviors” have positive outcomes, and the goals that adolescents formulate for such behaviors are neither “perverse, irrational, or psychopathological” (Jessor, 1991, p. 598). Benefits associated with alcohol use, for example, include the foundational human need of social connectedness (e.g., Shim & Maggs, 2005). Thus, when evaluating risk, both the costs and the benefits to such behaviors should be considered.

In contrast to models derived from medicine, behavioral ecology models—with roots in economics, not epidemiology—define risk in terms of the *variance of outcomes* distributed about an expected outcome average (Figueredo & Jacobs, 2010). Behaviors with a wide array of outcomes—both beneficial and costly—are high risk. When such behaviors are performed, they may result in a net cost or benefit. Therein resides the risk. Their average payoff is less important for risk assessment, even if the average is below zero (i.e., cost bearing). This is like saying an investment that is doomed to fail (i.e., bear nothing but cost) is actually low risk because there is no variance in outcomes. At the same time, such investment would indeed be a poor choice (perhaps ironically, especially because it is low risk).

The point at which a behavior becomes “ill advised” is where the behavioral ecology and developmental approaches to risk part ways (Figueredo et al., 2010). If a behavioral outcome is high risk from the former perspective, it simply has high variance around a mean payoff. If that mean payoff is 0, however, the behavioral ecologist would not see that behavior *a priori* as “ill-advised” (nor does that behavior have a strong selection pressure against it). A developmental psychologist, however, might focus on “loss” (i.e., the portion of the distribution below 0) while underrating the power of potential “gain.” The behavior would be thusly deemed proximally maladaptive. That is, because the probability of loss is significant, it is “risky” from the developmental perspective. Traditional perspectives may emphasize costs unduly. “Risk” need not be taken to mean “bad” (see also Sutton, Swettenham, & Smith, 1999).

What does the risk distribution look like for aggressive behavior? Developmental psychopathology models have traditionally assumed that aggression sports an average payoff well below zero; that is, the social costs associated with aggression have traditionally assumed to be great. At the same time, scholars of both evolutionary and nonevolutionary ilk have recently documented sizable social advantages associated with some forms of aggression, such as status attainment (Hawley, 2003; Pellegrini, 2001; Rodkin, Farmer, Pearl, & van Acker, 2000). Aggressive behavior appears to be a strategy that can pay handsome dividends, especially if it is balanced with other strategies connoting social skills and prosociality.

THE MISMATCH OF ADOLESCENCE TO MODERN REARING ENVIRONMENTS

Thus far I have cast behavior patterns that are typically considered to be unilaterally maladaptive from

traditional perspectives in terms of their (ultimate) functional value with a focus on benefit. At the same time, reformulating risk in economical terms will hardly console educators, parents, and practitioners who are deeply committed to improving the lives of adolescents. Clearly, behavioral problems, health threats, psychiatric vulnerabilities, drug and alcohol use, unprotected sex and pregnancy, academic underachievement and drop out, delinquency and violence, bullying and Internet predation are all among the difficulties besetting our youth. Do all evolutionary approaches cast these issues as “adaptations”? No.

In the case of biological systems, structure takes a form that is determined by the kind of environment in which the system has in fact been operating during its evolution. . . . In each case, therefore, there is a particular sort of environment to which the system . . . is adapted. . . . Only within its environment of adaptedness can it be expected that a system will work efficiently. In any other environment it cannot be expected to do so. In some cases a system may in fact work reasonably well; in others it does not work at all; and in others again it gives rise to behaviour that is at best unusual and at worst positively unfavorable. (Bowlby, 1969, p. 47)

For his time, Bowlby had several truly inspirational insights, including his recognition of “mismatch” to the “environment of evolutionary adaptedness” (EEA). In more modern terms, the EEA refers to the composite of selection pressures underlying an adaptation’s development, rather than to a specific time or place (Buss, 2004). The EEA for bipedalism, for example, is most certainly different from the EEA for language. That being said, it is generally held that humans were hunter–gatherers for most of human history (more than 2 million years) up until the advent of the agricultural revolution approximately 10,000 years ago (e.g., Tooby & DeVore, 1987), and the EEA for many of our psychological adaptations is presumed to be during that extended period. Some influential authors in evolutionary psychology circles have gone so far as to claim that humans possess “stone age minds” with which we grapple with modern environments (e.g., Tooby & Cosmides, 2010).

Though not all authors adopt the “stone age mind” assertion uncritically (see, e.g., Cochran & Harpending, 2009; Foley, 1996), many evolutionists would agree that a number of our physical and psychological vulnerabilities find their source in a

“mismatch” between our biological and psychological adaptations and modern environments. Take, for example, the current American scourge of obesity and diabetes afflicting our youth (Steele, Nelson, & Jelalian, 2008). In hunter-gatherer societies, a good deal of time and energy is spent securing and preparing food. Not only do we no longer expend energy to fulfill our dietary needs, we now also have ready access to highly calorific foods that satisfy our evolved taste preferences for fat, salt, and sugar. In the EEA, these elements were rare and presumably yielded selective advantage when they became available. In modern Western environments, these foods are more readily available and less expensive than healthy counterparts. Couple this dietary supply and demand with a sedentary lifestyle (also not characteristic of traditional societies), and you have a plethora of illness bourn of mismatch (Nesse & Williams, 1994).

A number of mismatch concerns apply equally well to adolescents as they do to adults. Poor diet deficient of fiber and omega-3 fatty acid but rich in refined sugars, lack of exercise associated with a sedentary lifestyle, reduced contact with both immediate and extended family, and disrupted sleep cycles all can undermine physical and psychological well-being (Ilardi, 2009). A number of these issues, however, can be elaborated to highlight the special risks to adolescents of recent generations. For example, it is quite the norm for youth to have both parents working outside the home even if the family is intact. Thus, there is a sharp reduction in time spent with immediate kin. Computer-based entertainments and television not only dip into time better spent sleeping, but also draw otherwise active youth indoors away from other people, natural light, and physical activity. Indeed, targeting diet, sleep, exercise, light exposure, and social connectedness are central features to an evolutionary treatment for depression (Ilardi, 2009).

At the same time, the conditions of modern living have put adolescents into an unforeseen and unprecedented quandary in Western nations; they are achieving puberty earlier than they had in previous generations (menses beginning on average between 12 and 13; Gluckman & Hanson, 2006; Herman-Giddens et al., 1997). This accelerated development thus places them well ahead of youths in modern hunter-gatherer societies (Worthman, 1987, 1999). What has led to this acceleration? Conditions not present in the EEA including highly calorific diets, exposure to toxins (Cromer & Gordon, 2009; Kembra, Howdeshell, Hotchkiss, Thayer Vandenberg, & vom Saal, 1999), and cow milk consumption (Bogin,

1999; Hoppe, Mølgaard, & Michaelsen, 2006), to name a few. The effects of the hormones and traces of prescription medications found in drinking water are yet unknown (Dean, 2007; Tabak, Bloomhuff, & Bunch, 1981).

Aside from the fact that early pubertal maturation has health (Stoll, 1998) and psychosocial consequences of its own (Ge, Conger, & Elder, 1996), this secular trend results in an unprecedented gap between psychosocial and reproductive maturity (Gluckman et al., 2006). From a nonevolutionary perspective, this chasm has been famously referred to as the “maturity gap,” a time when adolescents are “chronological hostages of a time warp between biological age and social age” (Moffitt, 1993, p. 687).

Because of this gap, the lives of modern, Western adolescents differ from those in traditional societies in important ways (Weisfeld, 1999). First, for example, the labor performed by modern adolescents tends not to earn respect from adults or adult privileges (in “maturity gap” parlance, they are relatively “role-less”; Piquero & Moffitt, 2008). Moreover, because they generally do not contribute to household income in significant ways, adolescents are economic liabilities (often well into their 20s). Second, we segregate our children by age. Thus, there is little opportunity to interact meaningfully with either older or younger youth, which obstructs benefits of instructing and being instructed by others.

This extended limbo consequent to being neither child nor adult in society’s eyes together with age segregation has contributed to the enhancement of the youth subculture in the latter half of the 19th century (Weisfeld, 1999; but see Mintz, 2004, for an alternate view). Within this subculture, as with any group identity, group norms are cultivated replete with negative out-group attitudes. As highlighted by Harris (1995), adolescents look to peers for fashion, trends, habits, values, morality, etc. instead of modeling the adult world that stands apart from them. Finally, the prosperity enjoyed by recent generations allows them to benefit from modern material trappings, such as iPods, video games, cars, cell phones, and Facebook, all of which distance them further from the family and pull them deeper into the youth culture where norms and innovations are constantly shifting.

Age segregation and its concomitant ingroup identity and outgroup opposition may be especially unsettling when it comes to sexual socialization. Common in traditional societies are adult-supervised adolescent initiation ceremonies (Schlegel & Barry, 1980) that are designed to commemorate the

transition from childhood to adulthood and inculcate the adolescent with adult values, duties, behaviors, and sex roles associated with the culture (Schlegel, 1973). That is, these adolescents are taught adult sex roles by *adults*. We now appear to have a complete turnaround.¹ In modern, Western cultures, adolescents derive sexual relationship expectations from television, cable, music, purveyors of racy lingerie (who target teenage girls), and pornography that they can now access on the Internet and thereby carry around on their cell phones. At the same time, we ask them to delay sexual activity and, in some districts, teach them that intercourse in a heterosexual marriage is the only acceptable standard.

Nonevolutionary perspectives in fact have long recognized the dangers associated with a mismatch between adolescents' needs and opportunities (Eccles et al., 1993), the stress associated with person-environment misfit (Hunt, 1975), the potential costs of large schools over small schools (Barker & Gump, 1964), the importance of giving youth meaningful work (Steinberg, Greenberger, Jacobi, & Garduque, 1981), the negative effects of geographic mobility (Pulkkinen, 1982), and the psychosocial risks associated with early puberty (Ge et al., 1996). Thus, evolutionists should not claim to "discover" these relationships. At the same time, however, an evolutionary outlook that considers how humans *are adapted* to live while evaluating how we organize our communities, nutritional guidelines, and social and educational policies can bring our failures into sharper wide-angle focus and help guide us to more meaningful and effective solutions.

THE NEXT CHALLENGES

Applying What We Know

Evolution is morally neutral, but we are not. What can we do? As of this writing, the newly founded Evolution Institute (<http://evolution-institute.org/>) has sponsored three workshops with the express goal of challenging researchers and child development practitioners to formulate strategies to improve the human condition by scrutinizing what evolutionary viewpoints have to offer. As with any ambitious integration, clear consensus is not likely to immediately emerge. Moreover, the sloppy application of "evolutionary thinking" to problems of

human improvement has a rather dark history (e.g., the eugenics movement). Nonetheless, overemphasizing errors of the past generates more heat than light; it perpetuates misunderstandings and myths about modern evolutionary approaches and risks diverting attention away from an enlightening paradigm that stands to improve the lives of children.

It is easy to forget that some of our founding fathers of developmental psychology were evolutionists, in part because applications roll freely from their theoretical contributions: Bowlby's work, for example, drew attention to the perils of maternal separation and Piaget inspired discovery-based educational contexts. At present, the neighborhood conditions implicated in the development of "fast" strategies are being discovered (e.g., Nettle, 2010), where such behaviors "are not mistakes or negligence, so much as coherent strategic responses to the context in which people have to live" (Nettle, 2010, p. 8). Accordingly, interventions might fruitfully focus on structural inequalities in economic conditions. Similarly, it would be useful to identify the conditions under which depression is an adaptive cue indicating when one's goals should be adjusted (Wrosch & Miller, 2009) versus a maladaptive response to environmental mismatch (Ilardi, 2009). These are just a few examples.

CONCLUSIONS

The present article does not claim to exhaustively cover topics relevant to the period of adolescence (see, e.g., hormone response and stress: Flinn, 2006; the role of immaturity: Bjorklund, 1997; brain development: Dahl, 2004; sexual segregation: Pellegrini & Long, 2003). Most glaringly, I have said nothing about mate selection and sexuality outside of mismatch. Indeed, very little evolutionary work has been conducted on these topics in adolescents (but see Pellegrini, 2001). More generally, developmental psychology and evolutionary psychology have tended toward distinct historical trajectories with some notable points of contact. Despite the fact that the developmental perspective has been evolutionary since its inception (e.g., Baldwin, 1902), the two disciplines have not thoroughly cross-fertilized. At present, the landscape is wide open.

Persistent misconceptions about evolutionary approaches may have obstructed the synthesis of many developmental perspectives with their evolutionary counterparts. The present article's goals were to expose the reader to some of the original ideas concerning evolution and the period of adolescence, a collection of the work currently being undertaken

¹African elephants also experience problem behavior among "unsupervised" and unsocialized adolescents. These management problems arise in the absence of older males whose presence is known to socialize younger males and suppress their reproduction (Slotow, van Dyk, Poole, Page, & Klocke, 2000).

and fertile directions for advancement. In the end, it appears that the evolutionary paradigm is poised for a growth spurt, ready to move confidently into the earlier stages of the life span with its implications for the evolution of individual differences and the environments that engender them.

REFERENCES

- Baldwin, J. M. (1902). *Development and evolution*. New York, NY: Macmillan.
- Barker, R. G., & Gump, P. V. (1964). *Big school, small school: High school size and student behavior*. Stanford, CA: Stanford University Press.
- Belsky, J., Steinberg, L., & Draper, P. (1991). Childhood experience, interpersonal development, and reproductive strategy: An evolutionary theory of socialization. *Child Development, 62*, 647–670.
- Bjorklund, D. F. (1997). The role of immaturity in human development. *Psychological Bulletin, 122*, 153–169.
- Bogin, B. (1999). *Patterns of human growth*. New York, NY: Cambridge University Press.
- Bowlby, J. (1982). *Attachment and loss. Vol. 1. Attachment (2e)*. New York, NY: Basic Books. (Original work published 1969).
- Brook, J. S., & Newcomb, M. D. (1995). Childhood aggression and unconventionality: Impact on later academic achievement, drug use, and workforce involvement. *The Journal of Genetic Psychology, 156*, 393–410.
- Bühler, C. (1927). Die ersten sozialen Verhaltensweisen des Kindes. In *Soziologische und psychologische Studien über das erste Lebensjahr. Quellen und Studien zur Jugendkunde, 5* (pp. 1–102). Jena, Germany: G. Fischer.
- Bull, J. J. (1983). *Evolution of sex determining mechanisms*. Menlo Park, CA: Benjamin/Cummings.
- Burton, L. M. (1990). Teenage childbearing as an alternative life-course strategy in multi-generation black families. *Human Nature, 1*, 123–143.
- Buss, D. M. (2004). *Evolutionary psychology: The new science of the mind (2e)*. Boston: Pearson.
- Buss, D. M., & Hawley, P. H. (2010). *The evolution of personality and individual differences*. New York, NY: Oxford University Press.
- Charlesworth, W. R. (1996). Co-operation and competition: Contributions to an evolutionary and developmental model. *International Journal of Behavioral Development, 19*, 25–38.
- Cochran, G., & Harpending, H. (2009). *The 10,000 year explosion: How civilization accelerated human evolution*. New York: Basic Books.
- Coie, J. D., & Dodge, K. A. (1998). Aggression and antisocial behavior. In W. Damon & N. Eisenberg (Eds.), *Handbook of child psychology. Vol. 3. Social, emotional and personality development* (5th ed., pp. 779–862). New York: Wiley.
- Cromer, B., & Gordon, C. M. (2009). Early pubertal development in Chinese girls. *Pediatrics, 124*, 799–801.
- Dahl, R. E. (2004). Adolescent brain development: A period of vulnerabilities and opportunities. Keynote address. *Annals of the New York Academy of Sciences, 1021*, 1–22.
- Dean, C. (2007, April 3). Thousands of chemical traces found in drinking water. *New York Times*.
- Del Giudice, M. (2009). Sex, attachment, and the development of reproductive strategies. *Behavioral and Brain Sciences, 32*, 1–67.
- Draper, P., & Harpending, H. (1982). Father absence and reproductive strategy: An evolutionary perspective. *Journal of Anthropological Research, 38*, 255–273.
- Dunbar, R. I. M. (1988). *Primate social systems*. Ithaca, NY: Cornell University Press.
- Eccles, J. S., Midgley, C., Wigfield, A., Buchanan, C. M., Reuman, D., Flanagan, C., et al. (1993). Development during adolescence: The impact of stage-environment fit on young adolescents' experiences in schools and in families. *American Psychologist, 48*, 90–101.
- Ellis, B. J. (2004). Timing of pubertal maturation in girls: An integrated life history approach. *Psychological Bulletin, 130*, 920–958.
- Ellis, B. J., Figueredo, A. J., Brumbach, B. H., & Schlomer, G. L. (2009). Fundamental dimensions of environmental risk: The impact of harsh versus unpredictable environments on the evolution of life history strategies. *Human Nature, 20*, 204–268.
- Figueredo, A. J., & Jacobs, W. J. (2010). Aggression, risk-taking, and alternative life history strategies: The behavioral ecology of social deviance. In M. Frias-Armenta & V. Corral-Verdugo (Eds.), *Biopsychosocial perspectives on interpersonal violence* (pp. 3–27). Hauppauge, NY: Nova Science Publishers.
- Flinn, M. V. (2006). Evolution and ontogeny of stress response to social challenges in the human child. *Developmental Review, 26*, 138–174.
- Foley, R. (1996). The adaptive legacy of human evolution: A search for the environment of evolutionary adaptedness. *Evolutionary Anthropology, 4*, 194–203.
- Ge, X., Conger, R. D., & Elder, G. H. (1996). Coming of age too early: Pubertal influences on girls' vulnerability to psychological distress. *Child Development, 67*, 3386–3400.
- Geronimus, A. T., & Korenman, S. (1993). Maternal youth or family background? On the health disadvantages of infants with teenage mothers. *American Journal of Epidemiology, 137*, 213–225.
- Gluckman, P. D., & Hanson, M. A. (2006). Evolution, development and timing of puberty. *Trends in Endocrinology and Metabolism, 17*, 7–12.
- Hämäläinen, M., & Pulkkinen, L. (1995). Aggressive and non-prosocial behaviors as precursors of criminality. *Studies on Crime and Crime Prevention, 4*, 6–21.
- Harris, J. R. (1995). Where is the child's environment? A group socialization theory of development. *Psychological Review, 102*, 458–489.
- Hawley, P. H. (1999). The ontogenesis of social dominance: A strategy-based evolutionary perspective. *Developmental Review, 19*, 97–132.

- Hawley, P. H. (2003). Prosocial and coercive configurations of resource control in early adolescence: A case for the well-adapted Machiavellian. *Merrill-Palmer Quarterly*, *49*, 279–309.
- Hawley, P. H., Card, N. A., & Little, T. D. (2007). The allure of a mean friend: Relationship quality and processes of aggressive adolescents with prosocial skills. *International Journal of Behavioral Development*, *31*, 22–32.
- Hawley, P. H., Johnson, S. E., Mize, J. A., & McNamara, K. A. (2007). Physical attractiveness in preschoolers: Relationships with power, status, aggression and social skills. *Journal of School Psychology*, *45*, 499–521.
- Hawley, P. H., Little, T. D., & Card, N. A. (2008). The myth of the alpha male: A new look at dominance-related beliefs and behaviors among adolescent males and females. *International Journal of Behavioral Development*, *32*, 76–88.
- Herman-Giddens, M. E., Slora, E. J., Wasserman, R. C., Bourdony, C. J., Bhapkar, M. V., Koch, G. G., et al. (1997). Secondary sexual characteristics and menses in young girls seen in office practice: A study from the Pediatric Research in Office Settings Network. *Pediatrics*, *99*, 505–512.
- Hinde, R. A. (1974). *Biological bases of human social behaviour*. New York, NY: McGraw Hill.
- Hoppe, C., Mølgaard, C., & Michaelsen, K. F. (2006). Cow's milk and linear growth in industrialized and developing countries. *Annual Review of Nutrition*, *26*, 131–173.
- Hunt, D. E. (1975). Person-environment interaction: A challenge found wanting before it was tried. *Review of Educational Research*, *45*, 209–230.
- Ilardi, S. S. (2009). *The depression cure: The 6-step program to beat depression without drugs*. Cambridge, MA: Da Capo.
- Jessor, R. (1991). Risk behavior in adolescence: A psychosocial framework for understanding and action. *Journal of Adolescent Health*, *12*, 597–605.
- Kembra, L., Howdeshell, K. L., Hotchkiss, A. K., Thayer, K. A., Vandenberg, J. G., & vom Saal, F. S. (1999). Environmental toxins: Exposure to bisphenol advances puberty. *Nature*, *401*, 763–764.
- Kropotkin, P. A. (1902). *Mutual aid: A factor of evolution*. London, U.K.: William Heinemann.
- Maslow, A. (1937). Dominance-feeling, behavior, and status. *Psychological Review*, *44*, 404–429.
- Mintz, S. (2004). *Huck's raft: A history of American childhood*. Cambridge, MA: Harvard University Press.
- Mirowsky, J. (2005). Age at first birth, health, and mortality. *Journal of Health and Social Behavior*, *46*, 32–50.
- Moffitt, T. E. (1993). Adolescence-limited and life-course-persistent antisocial behavior: A developmental taxonomy. *Psychological Review*, *100*, 674–701.
- Nesse, R. M., & Williams, G. C. (1994). *Why we get sick: The new science of Darwinian medicine*. New York, NY: Times Books.
- Nettle, D. (2010). Dying young and living fast: Variation in life history across English neighborhoods. *Behavioral Ecology*, *21*, 387–395.
- Pellegrini, A. D. (1995). A longitudinal study of boys' rough-and-tumble play and dominance during early adolescence. *Journal of Applied Developmental Psychology*, *16*, 77–93.
- Pellegrini, A. D. (2001). The roles of dominance and bullying in the development of early heterosexual relationships. *Journal of Emotional Abuse*, *2*, 63–73.
- Pellegrini, A. D., & Long, J. D. (2003). A sexual selection theory longitudinal analysis of sexual segregation and integration in early adolescence. *Journal of Experimental Child Psychology*, *85*, 257–278.
- Piquero, A. R., & Moffitt, T. E. (2008). Explaining the facts of crime: How the developmental taxonomy replies to Farrington's invitation. In D. P. Farrington (Ed.), *Integrated developmental & life-course theories of offending* (pp. 51–72). New Brunswick, NJ: Transaction.
- Pulkkinen, L. (1982). Self-control and continuity in childhood-delayed adolescence. In P. Baltes & O. Brim (Eds.), *Life span development and behavior* (pp. 63–105). New York, NY: Academic Press.
- Rodkin, P. C., Farmer, T. W., Pearl, R., & Van Acker, R. (2000). Heterogeneity of popular boys: Antisocial and prosocial configurations. *Developmental Psychology*, *36*, 14–24.
- Roff, D. A. (1992). *The evolution of life histories*. New York, NY: Chapman & Hall.
- Schjelderup-Ebbe, T. (1922). Beiträge zur Sozialpsychologie des Haushuhns. *Zeitschrift für Psychologie*, *88*, 225–252.
- Schlegel, A. (1973). The adolescent socialization of the Hopi girl. *Ethnology*, *12*, 449–462.
- Schlegel, A., & Barry, H. (1980). The evolutionary significance of adolescent initiation ceremonies. *American Ethnologist*, *7*, 696–715.
- Seiffge-Krenke, I. (2006). Coping with relationship stressors: The impact of different working models of attachment and links to adaptation. *Journal of Youth and Adolescence*, *35*, 25–39.
- Shim, S., & Maggs, J. L. (2005). A psychographic analysis of college students' alcohol consumption: Implications for prevention and consumer education. *Family and Consumer Sciences Research Journal*, *33*, 255–273.
- Slotow, R., van Dyk, G., Poole, J., Page, B., & Klocke, A. (2000). Older bull elephants control young males. *Nature*, *408*, 425–426.
- Steele, R. G., Nelson, T. D., & Jelalian, E. (2008). Child and adolescent obesity in context: Trends and epidemiology. In E. Jelalian & R. G. Steele (Eds.), *Handbook of childhood and adolescent obesity* (pp. 3–10). New York, NY: Springer.
- Steinberg, L. D., Greenberger, E., Jacobi, M., & Garduque, L. (1981). Early work experience: A partial antidote for adolescent egocentrism. *Journal of Youth and Adolescence*, *10*, 141–157.
- Stoll, B. A. (1998). Western diet, early puberty, and breast cancer risk. *Breast Cancer Research and Treatment*, *49*, 187–193.
- Sutton, J., Smith, P. K., & Swettenham, J. (1999). Socially undesirable need not be incompetent: A response to Crick and Dodge. *Social Development*, *8*, 132–134.
- Tabak, H. H., Bloomhuff, R. N., & Bunch, R. L. (1981). Steroid hormones as water pollutants. II. Studies on the

- persistence and stability of natural urinary and synthetic ovulation-inhibiting hormones in untreated and treated wastewaters. *Developments in Industrial Microbiology*, 22, 497–519.
- Tinbergen, N. (1963). On aims and methods of ethology. *Zeitschrift für Tierpsychologie*, 20, 410–433.
- Tooby, J., & Cosmides, L. (2010). *Evolutionary psychology: A primer*. Santa Barbara, CA: University of California. Retrieved from <http://www.psych.ucsb.edu/research/cep/primer.html>
- Tooby, J., & DeVore, I. (1987). The reconstruction of the hominid behavioral evolution through strategic modeling. In W. G. Kinzey (Ed.), *The evolution of human behavior* (pp. 183–237). New York, NY: SUNY Press.
- Trivers, R. L. (1971). The evolution of reciprocal altruism. *The Quarterly Review of Biology*, 46, 35–57.
- Weisfeld, G. E. (1995). Aggression and dominance in the social world of boys. In J. Archer (Ed.), *Male violence* (pp. 42–69). London, U.K.: Routledge.
- Weisfeld, G. E. (1999). *Evolutionary principles of human adolescence*. New York, NY: Basic Books.
- West-Eberhard, M. J. (2003). *Developmental plasticity in evolution*. Oxford, U.K.: Oxford University Press.
- Williams, G. C. (1966). *Adaptation and natural selection*. Princeton, NJ: Princeton University Press.
- Winegard, B. M., Winegard, B. M., & Deaner, W. O. (2009). *Misrepresentations of evolutionary theory in social science textbooks*. Poster presented at HBES, Fullerton, CA.
- Worthman, C. M. (1987). Interactions of physical maturation and cultural practice in ontogeny: Kikuyu adolescents. *Cultural Anthropology*, 2, 29–38.
- Worthman, C. M. (1999). Epidemiology of human development. In C. Panter-Brick & C. M. Worthman (Eds.), *Hormones, health, and behavior: A socio-ecological and lifespan perspective* (pp. 47–104). New York, NY: Cambridge University Press.
- Wrosch, C., & Miller, G. E. (2009). Depressive symptoms can be useful: Self-regulatory and emotional benefits of dysphoric mood in adolescence. *Journal of Personality and Social Psychology*, 96, 1181–1190.
- Zeifman, D. M. (2001). An ethological analysis of human infant crying: Answering Tinbergen's four questions. *Developmental Psychobiology*, 39, 265–285.