Middle Childhood: An Evolutionary-Developmental Synthesis

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ABSTRACT—***Middle childhood is a crucial phase of human development characterized by a global shift in cognition, motivation, and social behavior. In this article, I review recent work on middle childhood from an evolutionary-developmental perspective and show how contributions from a range of disciplines can be synthesized into an integrated model of this life stage. I begin by reviewing the main evolved functions of middle childhood and the underlying hormonal mechanism of adrenarche. Then, I introduce the idea that the transition to middle childhood works as a switch point in the development of life history strategies. Finally, I discuss three insights into the nature of middle childhood that arise from an integrated approach.***

KEYWORDS—*adrenarche; evolution; middle childhood*

Middle childhood—conventionally from about 6 to 11 years—is a crucial yet underappreciated phase of human development. On the surface, middle childhood may appear like a slow-motion interlude between the transformations of infancy and early childhood and those of adolescence. In reality, this life stage is anything but static: The transition from early to middle childhood heralds a global shift in cognition, motivation, and social behavior, with profound and wide-ranging implications for the development of personality, sex differences, and even psychopathology (see Table 1).

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In the last two decades, converging theories and findings from anthropology, primatology, evolutionary psychology, endocrinology, and behavior genetics have revolutionized our understanding of middle childhood. In this article, I show how these diverse contributions can be synthesized into an integrated evolutionary-developmental model of middle childhood. I begin by reviewing the main evolved functions of middle childhood and the cognitive, behavioral, and hormonal processes that characterize this life stage. Then, I introduce the idea that the transition to middle childhood works as a switch point in the development of life history strategies (Del Giudice, Angeleri, & Manera, 2009, 2012; Del Giudice & Belsky, 2011). Finally, I discuss three insights into the nature of middle childhood that arise from an integrated approach.

WHAT IS MIDDLE CHILDHOOD?

Middle childhood is one of the main stages of human development, marked by the eruption of the first permanent molars around 6 years and androgen secretion by the adrenal glands at about 6–8 years (Bogin, 1997). In middle childhood, body growth slows considerably, usually following a small mid-growth spurt. At the same time, muscularity increases and the body starts accumulating fat (the *adiposity rebound*; Hochberg, 2008), while sex differences in body composition become more pronounced (Del Giudice et al., 2009; Wells, 2007). Figure 1 places middle childhood in the broader context of human growth from conception to adolescence.

In biological terms, middle childhood corresponds to human *juvenility*—a stage in which the individual is still sexually immature but no longer depends on parents for survival. In social mammals and primates, juvenility is a phase of intense learning—often accomplished through play—in which youngsters practice adult behavioral patterns and acquire social and foraging skills. Indeed, the duration of juvenility in primates correlates strongly with the size and complexity of social groups, as well as with cortical brain volume (Joffe, 1997). Social learning in juvenility can be understood as investment in *embodied*

Table 1
Development in Middle Childhood

Body growth	Eruption of permanent molars Mid-growth spurt, followed by decelerating skeletal growth Increased muscle mass Increased adiposity and BMI (adiposity rebound) Initial development of axillary hair and body odor Increased sex differences in adiposity (F > M), bone strength, and muscularity (M > F) Emergence of sex differences in vocal characteristics
Brain growth	Approaching peak of overall brain volume Peak of gray matter volume Continuing increase in white matter volume/integrity
Motor and perceptual skills	Increased gross motor skills (e.g., walking) Increased fine motor skills Local–global shift in visual processing preferences
Cognitive skills	Increased reasoning and problem-solving skills (e.g., concrete operations) Increased self-regulation and executive functions (inhibition, attention, planning, etc.) Increased mentalizing skills (multiple perspectives, conflicting goals) Increased navigational skills (working memory, ability to understand maps)
Motivation and social behavior	Acquisition of cultural norms (e.g., prosociality) Complex moral reasoning (conflicting points of view) Increased pragmatic abilities (gossiping, storytelling, verbal competition, etc.) Consolidation of status/dominance hierarchies Changes in aggression levels (individual trajectories) Development of disgust Changes in food preferences (e.g., spicy foods) Onset of sexual/romantic attraction Increased frequency of sexual play Increased sense of gender identity Peak of sex segregation Peak of sex differences in social play (including play fighting vs. play parenting) Increased sex differences in physical aggression (M > F) Emergence of sex differences in attachment styles
Psychopathology	Early peak of psychopathology onset (externalizing, anxiety, phobias, ADHD) Peak onset of fetishistic attractions Emergence of sex differences in conduct disorders (M > F)
Social context	Active involvement in caretaking, foraging, domestic tasks, helping Expectations of responsible behavior Attribution of individuality and personhood (“getting noticed”)
Behavior genetics	Increased heritability of general intelligence and language skills New genetic influences on general intelligence, language, aggression, prosociality

Note. See the main text for supporting references. BMI = body mass index; M = male; F = female; ADHD = attention deficit hyperactivity disorder.

capital—skills and knowledge that cost time and effort to acquire, but increase an individual’s performance and reproductive success (Kaplan, Hill, Lancaster, & Hurtado, 2000).

Human children are no exception to this pattern. Social learning is universally recognized as a key evolved function of middle childhood and is enabled by a global reorganization of cognitive

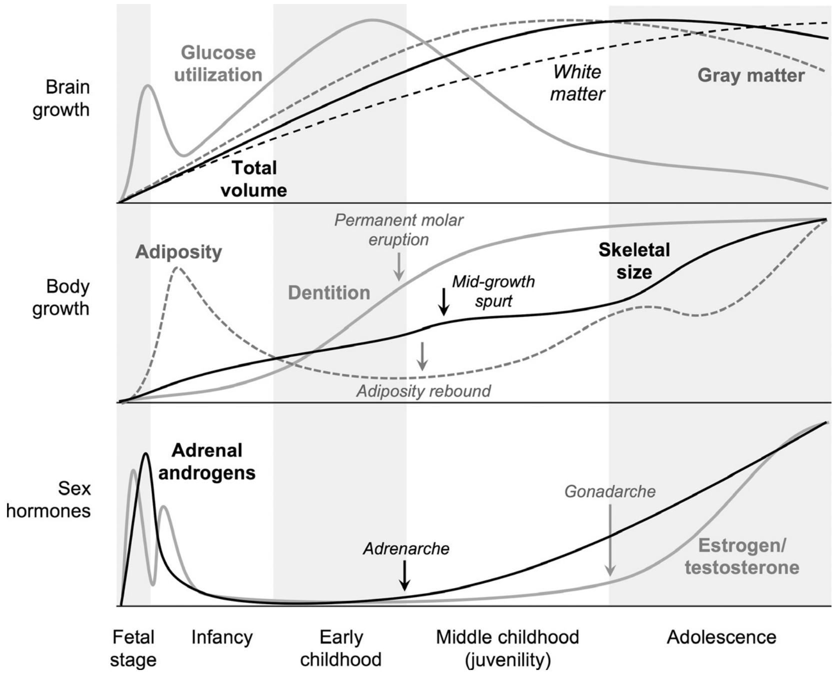

Figure 1. Developmental trajectories of human growth and sex hormones production, from conception to adolescence. Arrows show the landmark events that characterize middle childhood.
Sources: Auchus and Rainey (2004), Bogin (1997), Giedd and Rapoport (2010), Hochberg (2008), Kuzawa et al. (in press), Ober, Loisel, and Gilad (2008), and Wells (2007).

functioning known as the *five-to-seven shift* (Weisner, 1996). By age 6, the brain has almost reached its maximum size and receives a decreasing share of the body's glucose after the consumption peak of early childhood (see Figure 1; Giedd & Rapoport, 2010; Kuzawa et al., in press). However, brain development proceeds at a sustained pace, with intensive synaptogenesis in cortical areas (gray matter) and rapid maturation of axonal connections (white matter; Lebel, Walker, Leemans, Phillips, & Beaulieu, 2008). The transition to middle childhood is marked by a simultaneous increase in perceptual abilities (including a transition from local to global visual processing), motor control (including the emergence of adult-like walking), and complex reasoning skills (Bjorklund, 2011; Poirel et al., 2011; Weisner, 1996). The most dramatic changes probably occur in the domain of self-regulation and executive functions: Children become much more capable of inhibiting unwanted behavior, maintaining sustained attention, making and following plans, and so forth (Best, Miller, & Jones, 2009; Weisner, 1996). Parallel improvements take place in mentalizing (the ability to understand and represent mental states) and moral reasoning, as children become able to consider multiple perspectives and conflicting goals (Jambon & Smetana, 2014; Lagattuta, Sayfan, & Blattman, 2009).

In traditional societies, older relatives—especially parents and grandparents—are the main sources of knowledge for juveniles, supplemented by peers and—where available—professional teachers. Storytelling—both fictional and based in real events—transmits knowledge about foraging and social skills, avoidance of dangers, topography, finding one's way, and social roles and norms (Scalise Sugiyama, 2011). Storytelling mimics the format of episodic memories, providing children with a rich source of indirect experience (Scalise Sugiyama, 2011). Intriguingly, episodic memory improves dramatically and in a sustained manner across middle childhood (Ghetti & Bunge, 2012).

However, children at this age are not just learning and playing. Cross-culturally, middle childhood is the time when children are expected to start helping with domestic tasks—such as caring for younger siblings, collecting food and water, tending animals, and helping adults prepare food (Bogin, 1997; Lancy & Grove, 2011; Scalise Sugiyama, 2011; Weisner, 1996). In favorable ecologies, juveniles can contribute substantially to families' subsistence (Kramer, 2011). Thanks to marked increases in spatial cognition (reflected in the emerging ability to understand maps) and navigational skills, children can memorize complex routes and find their way without an adult's supervision (Bjorklund, 2011; Piccardi, Leonzi, D'Amico, Marano, & Guariglia, 2014). The important role of juveniles in collecting and preparing food may explain why the emotion of disgust does not fully develop until middle childhood (Rozin, 1990a).

The transition to middle childhood is typically associated with a strong separation in gender roles, even in societies where tasks are not assigned rigidly by sex. Spontaneous sex segregation of boys and girls peaks during these years, as does the frequency of sexually differentiated play (Del Giudice et al., 2009). On a broader social level, cross-cultural evidence shows that juveniles start "getting noticed" (Lancy & Grove, 2011, p. 282) by adults—that is, they begin to be viewed fully as people with their own individuality, personality, and social responsibility.

In summary, the life stage of juvenility/middle childhood has two major interlocking functions: *social learning* and *social integration* in a system of roles, norms, activities, and shared knowledge. While children are still receiving sustained investment from parents and other relatives—in the form of food, protection, knowledge, and so forth—they also start to contribute actively to the family economy. By providing resources and sharing the burden of child care, juveniles can boost their parents' reproductive potential. The dual nature of juveniles as both *receivers* and *providers* explains many psychological features of middle childhood and has likely played a major role in the evolution of human history (Kramer, 2011).

Adrenarche

The transition to middle childhood is coordinated by a remarkable endocrinological event: the awakening of the adrenal glands, or *adrenarche* (Auchus & Rainey, 2004; Hochberg, 2008). Starting at about 6–8 years—with much individual variation but only minor differences between males and females—adrenal glands begin to secrete increasing amounts of androgens (see Figure 1), mainly dehydroepiandrosterone (DHEA) and its sulfate form. Adrenal androgens have only minor effects on physical development, but they have powerful effects on brain functioning. Dehydroepiandrosterone and its sulfate form promote neurogenesis and modulate γ-aminobutyric acid and glutamate receptors; moreover, DHEA can act directly on androgen and estrogen receptors. Even more important, adrenal androgens can be converted to estrogen or testosterone in the brain (Campbell, 2006; Del Giudice et al., 2009). As sex hormones, adrenal androgens play a twofold role: They *activate* sexually differentiated brain pathways that had been previously organized by the hormonal surges of prenatal development and infancy (Figure 1) and they further *organize* brain development along sexually differentiated trajectories (Del Giudice et al., 2009).

Adrenal androgens likely provide a major impulse for many of the psychological changes of middle childhood (Campbell, 2006, 2011; Del Giudice et al., 2009), including the emergence and intensification of sex differences across domains (see Table 1). Since the age of adrenarche correlates strongly with that of *gonadarche* (the awakening of the testes/ovaries that marks the beginning of puberty; Hochberg, 2008), human development shows a peculiar pattern in which sexually differentiated brain pathways are activated several years *before* the development of secondary sexual characteristics. This developmental pattern (shared by chimpanzees and, to a lesser extent, gorillas; Bernstein, Sterner, & Wildman, 2012) results in a temporary decoupling between physical and behavioral development, consistent with the idea of middle childhood as a sexually differentiated phase of social learning and experimentation (Geary, 2010). Moreover, adrenal androgens promote extended brain plasticity through synaptogenesis, and may play an important role in shifting the allocation of the body's energetic resources away from brain development and toward the accumulation of muscle and fat in preparation for puberty (Campbell, 2006, 2011; see also Kuzawa et al., in press).

THE TRANSITION TO MIDDLE CHILDHOOD AS A DEVELOPMENTAL SWITCH POINT

The evolutionary model of middle childhood sketched in the previous section can be enriched and extended by considering the role of adrenarche as a *developmental switch* (Del Giudice et al., 2009). The concept of a developmental switch was introduced by West-Eberhard (2003); a switch is a regulatory mechanism that activates at a specific point in development, collects input from the external environment or the state of the organism, and shifts the individual along alternative pathways—ultimately resulting in the development of alternative phenotypes (morphological, physiological, or behavioral traits of an organism). For example, a switch may regulate the development of aggressive behavior so that safe conditions entrain the development of low levels of aggression, whereas threatening environments trigger high levels of aggression. Developmental switches enable *adaptive plasticity*—the ability of an organism to adjust its phenotype to match the local environment in a way that promotes biological fitness (West-Eberhard, 2003). In other words, plastic organisms track the state of the environment—usually through indirect cues—and use this information to develop alternative phenotypes that tend to promote survival or reproduction under different conditions.

Developmental switches work in a *modular* fashion (see Figure 2). Activation of a switch leads to the coordinated expression of different genes—both those involved in the regulatory mechanism itself and those involved in the production of the new phenotype. Moreover, alternative phenotypes (A and B in Figure 2) involve the expression of modular packages of genes specific to each phenotype. Another key aspect of developmental switches is that they integrate variation in the environment with individual differences in the genes that regulate the switch. For example, different individuals may have genetically different thresholds for switching between aggressive and nonaggressive phenotypes. Finally, the embodied effects of past experiences and conditions (e.g., an individual's previous exposure to stress or nutritional conditions early in life) may also modulate how the switch functions, allowing the organism to integrate information over time and across different life stages (Ellis, 2013). In many instances, the effects of past experience on developmental switches may be mediated by epigenetic mechanisms (see Meaney, 2010).

The concept of a developmental switch point resembles that of a *sensitive period*, in that the organism is maximally responsive to some environmental input. The crucial difference is that

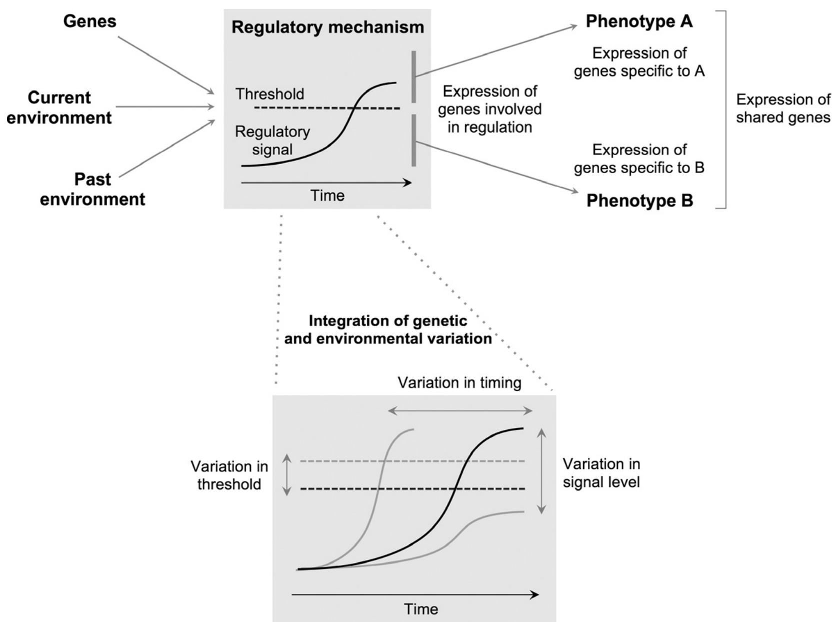

Figure 2. The concept of a developmental switch. A regulatory mechanism (which may operate through hormonal signals) integrates current and past information from the environment with the individual's genotype. As a result, the individual's developmental trajectory is shifted along alternative pathways—here, A and B—depending on whether a threshold is reached within the mechanism. The location of the threshold, the intensity of the signal, and the timing of the switch point all depend on the joint action of the current state of the environment, the embodied effect of past environmental conditions, and individual variation in the genes involved in the regulatory mechanism. Each alternative pathway involves the modular expression of a set of specific genes, in addition to the shared genes expressed in the new developmental stage. A developmental switch may integrate many sources of input from the environment or produce graded phenotypes rather than discrete alternatives such as A and B.

because genetic and environmental inputs converge in the regulatory mechanism, a developmental switch amplifies both environmental *and* genetic effects on the phenotype (West-Eberhard, 2003). Indeed, the activation of a developmental switch exposes many potential sources of genetic variation, including the genes involved in the regulatory mechanism and in the expression of the new phenotypes (Figure 2).

A Switch Point in Life History Development

The role of adrenarche as a developmental switch is not limited to a single trait; in fact, the transition to middle childhood (or *juvenile transition*; Del Giudice et al., 2009) encompasses all the major domains of behavior—from learning and self-regulation to attachment and sexuality (see Table 1). My colleagues and I (Del Giudice & Belsky, 2011; Del Giudice et al., 2009, 2012) have argued that the transition to middle childhood is a switch point in the development of *life history strategies*, which are coordinate suites of morphological, physiological, and behavioral traits that determine how organisms allocate their resources to key biological activities such as growth, reproduction, mating, and parenting. At the level of behavior, individual differences in life history strategy are reflected in patterns of self-regulation, aggression, cooperation and prosociality, attachment, sexuality, and so forth (Del Giudice & Belsky, 2011; Del Giudice, Ellis, & Shirtcliff, 2011; Del Giudice et al., 2009; Ellis, Figueredo, Brumbach, & Schlomer, 2009; Kaplan & Gangestad, 2005). Although life history strategies are partly heritable, they also show a degree of plasticity in response to the quality of the environment, including the level of danger and unpredictability (embodied in the experience of early stress) and the availability of adequate nutritional resources. In a nutshell, dangerous and unpredictable environments tend to favor fast strategies characterized by early reproduction, sexual promiscuity, unstable relationships, impulsivity, risk taking, aggression, and exploitative tendencies, whereas safe and predictable environments tend to entrain slow strategies characterized by late reproduction, stable relationships, high self-control, aversion to risk, and prosociality. Slow strategies are also favored by nutritional scarcity when danger is low (Ellis et al., 2009).

Our argument is that adrenarche coordinates the expression of individual differences in life history strategy by integrating individual genetic variation with information about the child's social and physical environment collected throughout infancy and early childhood (Belsky, Steinberg, & Draper, 1991). The stress response system plays a major role in gathering and storing information about environmental safety, predictability, and availability of resources; adrenarche contributes by translating that information into adaptive, sexually differentiated patterns of behavior (Del Giudice et al., 2011). Consistent with this view, both early relational stress and early nutrition modulate the timing of adrenarche (Ellis & Essex, 2007; Hochberg, 2008). It is no coincidence that the first sexual and romantic attractions

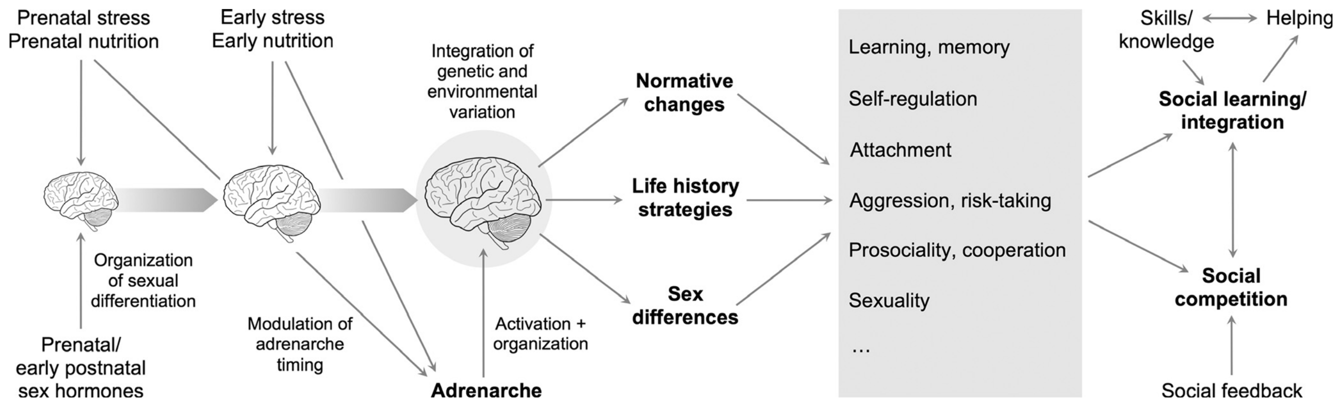

Figure 3. An integrated evolutionary-developmental model of middle childhood. Adrenarche is shown as a switch in the development of life history strategies, as well as a key mechanism underlying the normative changes of middle childhood and the emergence and intensification of sex differences. At a broader level, development in middle childhood serves two complementary functions, social *integration* and social *competition*.

typically develop in middle childhood, in tandem with the intensification of sexual play (Bancroft, 2003; Herdt & McClintock, 2000). By interacting with peers and adults, juveniles receive feedback about the effectiveness of their nascent behavioral strategies. The information collected during middle childhood feeds into the next developmental switch point, that of gonadarche (Ellis, 2013); the transition to adolescence offers an opportunity for youth to adjust or revise their initial strategy before attaining sexual and reproductive maturity (Del Giudice & Belsky, 2011).

The role of adrenarche as a switch point in life history development adds another level of complexity to the biological profile of juvenility. Figure 3 outlines an integrated evolutionary-developmental model that brings together the various strands of theory and evidence reviewed in this article.

THREE INSIGHTS INTO THE NATURE OF MIDDLE CHILDHOOD

Insight #1: Social Integration and Social Competition Are Complementary Functions of Middle Childhood

Evolutionary accounts of middle childhood typically focus on learning, helping, and other forms of social integration. A life history approach emphasizes the need to consider *social competition* as a crucial, complementary function of human juvenility. In the peer group, children compete for vital social resources—status, reputation, allies, and friends. While learning and play are relatively risk free, they are not without consequences. The social position achieved in middle childhood is a springboard for adolescence and adulthood; popularity and centrality within the peer network put a child at a considerable advantage, with potentially long-term effects on reproductive success (Del Giudice et al., 2009).

Physical and relational aggression are obvious tactics for gaining influence, but social competition also occurs through prosocial behaviors such as forming alliances, doing favors, and displaying valuable skills. Indeed, managing the balance between prosocial and coercive tactics is an important part of developing social skills (Hawley, 2014). More broadly, competition shapes many aspects of cognitive and behavioral development in middle childhood; for example, increased pragmatic abilities allow children to gossip, joke, tease, and engage in verbal duels—all forms of social competition mediated by language (Locke & Bogin, 2006). Intensifying social competition also contributes to explain the early peak of psychopathology onset observed in middle childhood, characterized by increasing rates of externalizing disorders (e.g., conduct disorder), anxiety disorders (including social phobia), and attention deficit hyperactivity disorder (Del Giudice et al., 2009).

Insight #2: Sexual Selection Contributes to the Emergence and Intensification of Sex Differences in Middle Childhood

By determining children's initial place in social networks and hierarchies, competition in middle childhood indirectly affects their ability to attract sexual and romantic partners later. In other words, middle childhood is a likely target for *sexual selection*—that is, natural selection arising from the processes of choosing mates (*mate choice*) and competing for mates (*mating competition*). My colleagues and I (Del Giudice et al., 2009) argued that sexual selection is one reason why sex differences emerge and intensify in middle childhood. In particular, sex differences in physical aggression increase markedly, in tandem with sex differences in muscularity and play fighting. At the same time, attachment styles begin to diverge between males and females, with insecurely attached boys becoming more avoidant and insecure girls becoming more preoccupied/ambivalent (Del Giudice, 2009; Del Giudice & Belsky, 2010). Different attachment styles are conducive to different social strategies, and may be adaptive in regulating children's nascent relationships with peers (Del Giudice, 2009). Sexual selection also has indirect implications for the development of psychopathology; for example, marked sex differences in the prevalence of conduct disorders appear at the beginning of middle childhood (Del Giudice et al., 2009).

Insight #3: In Middle Childhood, Heightened Sensitivity to the Environment Goes Hand in Hand With the Expression of New Genetic Factors

When an organism goes through a developmental switch point, inputs from the environment combine with the individual's genotype to determine the resulting phenotype. For example, when adrenal androgens begin to increase during the transition to middle childhood, they activate many hormone-sensitive brain pathways that have been dormant since infancy. In doing so, they release previously hidden genetic variation (Del Giudice et al., 2009). Thus, middle childhood should be characterized by a mixture of heightened sensitivity to the environment (possibly mediated by newly activated epigenetic mechanisms; Meaney, 2010) and expression of new genetic factors.

Evidence of increased sensitivity to the environment in middle childhood is not hard to find. Two intriguing and little-known examples concern the development of food preferences and erotic fetishes. In cultures where chili pepper is an essential part of the diet, children tend to dislike spicy food until middle childhood then increase rapidly their preference for the flavor of chili as a result of social learning (Rozin, 1990b). Fetishistic attractions also tend to form in middle childhood, with the onset of pleasurable sensations toward the object of the fetish (e.g., rubber, shoes) that later become fully eroticized (Lawrence, 2009). The onset of fetishistic attractions is part of a generalized awakening of sexuality in middle childhood (see Table 1) and illustrates the potential for rapid plasticity with long-lasting outcomes. Enhanced sensitivity to the environment extends beyond individual learning to acquiring social norms: for example, cross-cultural differences in prosocial behavior are absent in young children but emerge clearly during middle childhood (House et al., 2013).

On the genetic side of the equation, general intelligence and language skills increase markedly in heritability from early to middle childhood. In both cases, new genetic factors come into play around age 7 (Davis, Haworth, & Plomin, 2009; Hayiou-Thomas, Dale, & Plomin, 2012). Studies of prosociality and aggression follow the same pattern, with new genetic influences on behavior emerging during the transition to middle childhood (Knafo & Plomin, 2006; van Beijsterveldt, Bartels, Hudziak, & Boomsma, 2003). These genetic findings dovetail with converging evidence that individual changes in levels of aggression are especially frequent during the transition to juvenility (Del Giudice et al., 2009).

CONCLUSIONS

We cannot make sense of human development without understanding middle childhood and its many apparent paradoxes. An evolutionary-developmental approach illuminates the complexity of this life stage and shows how different levels of analysis—from genes to society—can be tied together in a coherent synthesis. This emerging view of middle childhood can help developmental scientists appreciate its centrality in the human life history, and stimulate ideas for research and intervention. The study of middle childhood may finally be ready to come of age.

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