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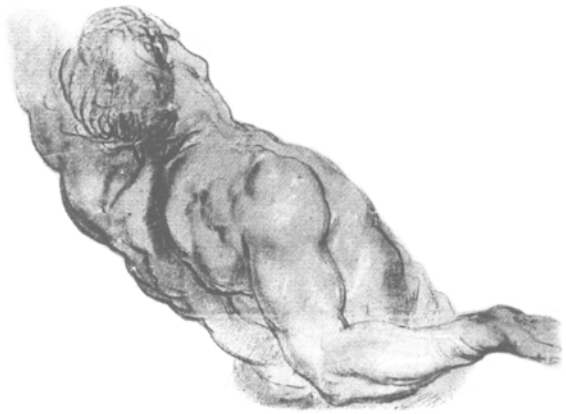

USABP Mission Statement

The USABP believes that integration of the body and the mind is essential to effective psychotherapy, and to that end its mission is to develop and advance the art, science, and practice of body psychotherapy in a professional, ethical, and caring manner in order to promote the health and welfare of humanity.

Part II - The Adolescent Brain: Clinical Applications

Deborah Harkin, PhD

Abstract

A fundamental assumption of somatic psychology is that the mind and body are not separate but function as one (Reich, 1973). Contemporary theory and research in various scientific disciplines have contributed to our understanding of how the mind and body develop and function together within the evolving self. In particular, principles and findings in the field of neuroscience are increasingly being incorporated into psychology and inform clinical work. Until recently, little was known about the adolescent brain. However, a decade of research now suggests adolescence as a critical period for brain maturation and associated capacities. Part 1 of this article presented an overview of recent research on the adolescent brain and its significance for understanding adolescence as a critical period (Harkin, 2009). Part 2 will provide a brief review of the findings and discuss the implications for clinical practice.

Keywords

Neuroscience – Adolescent Brain – Adolescent Development – Clinical Applications

The prenatal period and infacy are generally recognized as *the* critical period for brain development (Cozolino, 2002; Schore 1994, 2003; Siegel, 1999). Until recently, it was assumed that by adolescence brain development was essentially complete. Over the last decade, however, the discovery of complex patterns of growth and change in the adolescent brain provide evidence that adolescence may be a second such critical period (Giedd 2004, Giedd et al., 1999). These findings are significant because they suggest that the structure and function of the brain continue to be shaped by interactions with the environment during adolescence. It is thought that during critical periods the brain is particularly receptive to new learning as well as susceptible to the impact of adverse stimuli (Schore, 1994). As a result, the quality of experience during critical periods is essential to the future development and well-being of the individual. A hallmark of critical periods is that they represent a time of both increased vulnerabilities and opportunities (Dahl, 2004; Schore, 1994; Siegel, 1999; Steinberg, 2005). Recent discoveries in neuroscience may provide new insights into adolescent behavior as well as some of the risks and opportunities unique to this developmental stage. Part 1 of this article (Harkin, 2009), provided an overview of a decade of research on the adolescent brain. Part 2 will provide a brief review of the findings followed by a discussion of the implications for clinical practice.

A Brief Review of Neuroscience Findings

Recent research in neuroscience suggests that adolescent brain development is far from complete. Structural changes have been discovered in almost every area of the brain that has been examined. White matter changes reflecting progressive myelination have been identified in a number of important structures and circuits including the superior medullary lamina (Benes, Turtle, Khan, & Farol, 1994), amygdala (Durston et al., 2001; Giedd, Shaw, & Wallace, 2006), hippocampus (Day, Chiu, & Hendren, 2006; Giedd et al, 1996; Suzuki et al. 2005), basal ganglia (Barnea-Goraly, Menon, & Eckert, 2005), corpus callosum (Thompson et al., 2000), and the cerebellum (Giedd quoted in Frontline PBS, 2002). Most importantly, increases in gray matter have been identified in multiple areas of the neocortex, with the greatest changes occurring in the frontal lobes (Giedd, 2008; Paus, 2005; Sowell, Thompson, Holmes, Batth, et al., 1999; Sowell, Thompson, Holmes, Jernigan, et al., 1999; Sowell, Trauner, Gamst, & Jernigan, 2002).

The findings reviewed above highlight two key aspects of adolescent brain maturation. First, white matter changes allow for faster, more efficient processing and increased connectivity between different areas of the brain (Benes et al., 1994; Keating, 2004; Luna et al., 2001, Paus, 2005, Paus et al., 1999; Sowell, Thompson, Holmes, Batth, et al., 1999; Sowell, Thompson, Holmes, Jernigan, et al., 1999; Thompson et al., 2000). Secondly, substantial and previously unrecognized development occurs within the frontal lobes. Changes in the prefrontal cortex are of particular interest because of its executive role in integrating and regulating various brain functions. In addition, the frontal lobes are associated with many of the capacities that make us most human. Most higher order cognitive capacities such as language, abstract thinking, logical reasoning and the abilities to organize, prioritize and plan have been linked to the prefrontal cortex (Frontline PBS, 2002; Keating, 2004; Pearce, 2002; Steinberg, 2005). Taken together, greater interregional connectivity reflected in white matter changes and the development of prefrontal executive functions appear to allow for more efficient, complex and integrated processing that likely underlies the emergence of new capacities during adolescence.

Development of the prefrontal cortex has received considerable attention in the literature in part because of its inhibitory functions—in short, its role in impulse control. The prefrontal cortex is understood to play a role in the integration of thought and emotion, the capacity for self-regulation, the evaluation of potential risks and rewards, response inhibition and the ability to produce socially appropriate behavior (Casey, Giedd, & Thomas, 2000; Damasio, 1999; Giedd, 2004; Keating, 2004; Schore, 1994, 2001; Siegel, 1999). Certain characteristics commonly associated with adolescence such as emotional volatility, impulsivity, difficulty planning or envisioning consequences, as well as increased risk taking may be due in part to incomplete maturation of the frontal lobes (Dahl, 2004; Steinberg, 2005).

While some adolescent behaviors may be explained in part by limitations of an immature prefrontal cortex, neurophysiological changes associated with the onset of puberty likely contribute as well. Research suggests that an influx of gonadal and adrenal hormones appear to impact the balance of neurotransmitters in the brain, and in turn, emotional, motivational and reward systems (Cameron, 2004; Spear, 2000, 2008). Neurophysiological changes have been implicated in a number of adolescent behaviors including mood fluctuations, changes in drives (including romantic and sexual interest), sleep patterns, increased novelty seeking, sensation-seeking and risk taking, as well as gender differences in behavior (Carskadon, Acebo, & Oskar, 2004; Compas, 2004; Dahl, 2004; Spear, 2000; Steinberg, 2004, 2005; Strauch, 2003; Wallis, 2004; Walsh, 2004).

Research on the adolescent brain is relatively recent and much remains speculative. Nevertheless, several themes have emerged that are of particular relevance to clinicians. Research suggests that while many of the neurophysiological changes associated with puberty appear to "fire-up" the system for intense feeling, exploration, and risk-taking—the development of prefrontal executive functions responsible for impulse control, planning and envisioning the consequences of actions, occurs gradually over the course of adolescence and continues into the twenties (Dahl, 2004; Giedd et al. 1999; Keating, 2004; Steinberg, 2004; 2005). As Steinberg (2005) observes, changes in arousal and motivation systems appear to precede the development of regulatory competence, creating a potential gap between an adolescent's emotional experience and his or her ability to regulate thoughts, feelings, drives and behavior. This gap may be further exacerbated by a recent trend towards earlier puberty. A number of studies have documented a decline over the past century in the average age of pubertal onset within Western industrialized societies, particularly for girls (Dahl, 2004; Papalia, Olds, & Feldman, 2007; Pearce, 2002). While changes in motivational and emotional processes are occurring at earlier ages, there appears to be no concomitant change in cognitive development. The gap between emotional processes and cognitive controls during adolescence has been likened to having a foot on the accelerator without adequate brakes, or starting an engine without having a skilled driver at the wheel (Dahl, 2004; Nelson et al., 2002; Steinberg, 2005; Walsh, 2004). The potential disjunction between emotional and cognitive processes suggests increased risks for a broad range of emotional and behavioral problems during adolescence.

Clinical Applications

Risky Business

Dahl (2004) notes a central paradox of adolescence. At a time when adolescents are becoming stronger, faster and more resilient than before, and cognitive abilities are undergoing significant advances—there is an overall 200% increase in morbidity and mortality rates over the same period (p. 3). While the majority of adolescents navigate the adolescent transition without major difficulties, a significant number struggle with considerable distress (Dahl, 2004; Offer & Offer, 1975; Steinberg & Morris, 2001). Adolescence is understood to be a period of increased risk for a wide range of emotional and behavioral problems including schizophrenia, affective disorders, violent delinquency and substance abuse (Giedd et al., 2006; Steinberg, 2002, 2005). Adolescence is indeed a time of both accelerated development and increased vulnerability. Recent research on the adolescent brain may provide new insights into both the risks and opportunities inherent during this period.

The Integration of Multiple Lines of Development

Changes in the adolescent brain can best be understood within the context of broader developmental processes. Adolescence involves dramatic physical, emotional and cognitive changes that must be integrated within a shifting sense of self. In addition, adolescents must navigate important developmental tasks including the incorporation of maturing sexuality (Freud, 1905/1975), the integration of growing cognitive capacities and new ways of thinking and experiencing the world (Inhelder & Piaget, 1958; Keating, 2004), the renegotiation of relationships which are becoming more intimate, reciprocal and egalitarian in nature (Allen & Land, 1999; Steinberg & Morris, 2001), as well as the development of a more differentiated, integrated, and consistent sense of self—what Erikson (1968) refers to as *identity* and Blos (1978) refers to as *character*. These developmental tasks are undertaken in the face of changing expectations, new social roles and growing responsibilities within an increasingly complex world. Adolescence serves as the bridge to adulthood, and as such, the establishment of an independent identity and greater autonomy are widely recognized as central developmental tasks (Allen & Hauser, 1996; Allen & Land, 1999; Blos, 1962, 1967; Erikson 1968; Gemelli, 1996; Hill & Holmbeck, 1986).

During adolescence, physical, emotional, cognitive, social and behavioral systems undergo major reorganization. The changes within these various systems can be understood to involve different neural mechanisms. For example, signals from the hypothalamus trigger the pituitary to release hormones that lead to the development of secondary sexual characteristics that are associated with puberty (Dahl, 2004; Sussman & Rogol, 2004). Changes to emotional and motivational systems appear to involve neurophysiological changes that impact limbic and reward systems in the brain (Spear, 2000, 2008), while cognitive advances are associated with development of the prefrontal cortex (Giedd, 2004; Keating, 2004, Steinberg, 2005). Changes in social behavior likely involve complex interactions between all of the systems as well as direct experience with the environment. The various systems can develop somewhat independently from one another, yet remain intricately intertwined (Dahl, 2004; Keating, 2004; Steinberg, 2004, 2005).

An understanding of the different lines of development and their neural underpinnings can help us to appreciate the magnitude of change that must be integrated during adolescence, as well as better understand individual differences that are so

prevalent at this time. Different systems can develop along different timetables and at very different rates. Therefore, integration is not necessarily a smooth and seamless process. One teen may appear physically well developed yet be emotionally and cognitively immature, while another may be physically undeveloped yet cognitively and academically advanced (but has yet to integrate the physical, emotional and social changes associated with puberty). Developing out of sync with one's peers is recognized as a source of increased risk for emotional and behavioral problems during adolescence (Resnick et al., 1997; Steinberg & Morris, 2001). An understanding of the various lines of development can help clinicians to identify an individual's particular strengths as well as areas in which they may need support.

Integration is a process. Both cognitive science and neuroscience suggest that a period of disequilibrium (Inhelder & Piaget, 1958; Wadsworth, 1989) and disorganization (Schore, 1994) precedes reorganization. Not surprisingly, adolescents are often described as going through an "awkward stage" as they attempt to grow into their changing bodies and minds. The nose doesn't quite seem to fit the face and hands and feet don't quite fit the limbs. During this time, even the brightest, most articulate child may respond to questions with a grunt or a yes or no answer, or lash out at a parent who is "only trying to help." An understanding of the complexity of developmental processes and the challenges adolescents face can foster patience and more realistic expectations on the part of adults, including parents, teachers, employers and clinicians.

Theory and research in a number of areas such as neuroscience, cognitive science, and attachment, suggest that integration within and between the various lines of development happens much later than we might think (Blakemore & Choudhury, 2006; Fraley & Davis, 1997; Giedd et al. 1999, Harter, 1999). As previously noted, evidence suggests that changes within the prefrontal cortex proceed gradually over the course of adolescence and continue long after puberty is complete (Dahl, 2004; Giedd et al., 1999; Keating, 2004; Paus, 2005). Integration takes time and it is important to remember that even when an adolescent appears grown up, they are not.

Normalizing Behavior

The transition from childhood to adulthood involves intrinsic risks. Neuroscience findings suggest that adolescents are primed for growth, exploration and new learning (Dahl, 2004; Spear, 2000; Steinberg 2004). It appears that there is a natural inclination (perhaps a biological imperative) to move farther afield, experiment and seek novel experiences—for adolescents to test themselves (and perhaps others). Spear (2000) notes that behaviors such as novelty-seeking, risk-taking, increased social investigation and interaction with peers can be observed in adolescents of many species. Such behaviors create certain vulnerabilities, however, from an evolutionary perspective, they can be understood as adaptive. Increased exploration and risk-taking support the acquisition of new skills necessary for survival, as well as the opportunity to gain experiences necessary for future adult functioning. Spear observes that research suggests adolescents who engage in moderate risk-taking tend to be more socially competent than adolescents who take few risks or those who are frequent risk takers. In short, some exploration and risk-taking is normal, healthy and necessary during adolescence.

Greater understanding of changes in the adolescent brain can help to normalize other behaviors as well. In addition to increased novelty seeking and risk-taking, the neurophysiological changes associated with puberty have been linked with emotional intensity and volatility (Dahl, 2004; Spear, 2000; Steinberg, 2004, 2005). Research suggests that adolescents may be more susceptible to stressors (Spear, 2000) during a time when the challenges of adolescence may be understood as naturally stressful. Irritability and reactivity are common responses to stress at any age. With an added sensitivity to stress during adolescence, even an apparently minor stressor may evoke a big response.

Functional MRI research further suggests that adolescents process emotion differently than adults (Baird et al., 1999; Guyer et al., 2008; Yurgelen-Todd interviewed in Strauch, 2003). Several studies that examine processing of facial expressions suggest that children and adolescents may be more likely to act from parts of the brain primed for automatic survival responses such as fight, flight and freeze, while adults have the benefit of prefrontal functions that allow for more complex processing (including the reevaluation of stimuli), subtler distinctions between emotions, and a more deliberate, considered response (Baird et al., 1999; Guyer et al., 2008). The research also showed that children and adolescents were more likely to make errors when identifying emotions, mistaking fearful expressions for other emotions such as shock, anger or confusion (Baird et al., 1999). These findings may help to explain some of the misunderstandings so common in adolescent relationships (and feelings of not being understood), as well as some of the emotionally charged conflicts that can erupt between adolescents and their parents or peers.

Brain changes have also been linked with other "typical" adolescent behaviors such as increased appetite and the tendency to stay up late and have difficulty getting up in the morning. Studies have shown that melatonin (the neurochemical that signals the body to prepare for sleep) is secreted up to two hours later in adolescents than in children or adults, and, that adolescents need more hours of sleep (Carskadon et al., 2004; Carskadon interview in Strauch, 2003; Wolfson & Carskadon, 1998). Building new brain and body systems is energy-consuming work. In some cases, what adolescents need may conflict with what is required of them (such as very early start times in some school districts). It is important to note that sleep deprivation has been linked with excessive daytime sleepiness, depressed mood, difficulties with mood regulation, learning problems, impaired academic performance, school tardiness and absenteeism, as well as greater risk for accidents and injuries (Carskadon et al., 2004; Wolfson & Carskadon, 1998).

Adolescents are often depicted in a negative light—as moody, lazy, uncontrollable, irresponsible, sex-crazed, hostile or rebellious. An understanding of adolescent brain changes within the context of broader developmental processes can help us to

reinterpret and depathologize a number of adolescent behaviors. Many behaviors that are perceived as difficult during the teen years reflect natural biopsychosocial changes that are shaped by a major reorganization of systems and serve important adaptive functions.

While some developmental processes increase risks and create challenges for both teens and their families, critical capacities are being developed that impact the future functioning and well-being of the individual. Increased connectivity and development of the prefrontal cortex allow for better integration of thought and emotion and as a result, the ability to think rather than simply react. Growing cognitive capacities allow adolescents to reflect on and evaluate their experiences, at the same time an expanding social world may challenge old ways of thinking, feeling and being. New abilities and experiences naturally cause teens to question and to begin exercising their own judgments and sensibilities in order to make choices and decisions. Further development of abstract thinking allows adolescents to envision new possibilities and to generate creative solutions to problems. Perhaps most importantly, the growing capacity for self-reflection allows for a more coherent sense of self, and at the same time underlies the ongoing capacity for adaptation and change. Supporting self-reflection as an agent of change is central to many forms of psychotherapy and it is interesting to note that adolescence may very well be a critical period for the development of this capacity.

Many of the issues and developmental tasks that emerge during adolescence—such as negotiating autonomy and connectedness, growing the capacity for intimacy, the desire for fulfilling sexual relationships, the search for meaningful work, and navigation of changing social roles—remain important themes throughout adult life. The way in which these developmental tasks are negotiated during adolescence sets the stage for future adult functioning.

What's Needed?

Adolescence represents a time of both increased risks and developing potential. The question remains, how can we best protect teens while supporting development? As Jay Giedd, the neuroscientist who pioneered recent research on the adolescent brain states, "The more technical and more advanced the science becomes, often the more it leads us back to some very basic tenets of spending loving, quality time with our children" (Frontline PBS interview, 2002).

A large-scale national longitudinal study of risk and resilience factors during adolescence, found that parent-family connectedness and perceived school connectedness were protective against almost every health risk examined, including: emotional distress and suicidality; involvement in violence; substance use; and sexual behaviors by delaying sexual debut (Resnick et al., 1997). At first glance, these finding seem to suggest that what is needed during adolescence is good parenting and good education. However, it is important to note that the unifying theme here is *connection*. A sense of connection may very well be the key to developing potential as well as to preventing harm.

Maintaining Relationship

The greatest protective factor during adolescence may be *maintaining relationship*. This can be challenging during a period when teens naturally begin to spend more time away from their families and more time with peers. Recognizing the central developmental tasks of creating an independent identity and increasing autonomy may be key to staying in contact with teens. A person who understands development will respond differently than one who does not. When a two year-old pushes away and becomes enamored with the word "No!" it may be perceived as noncompliance ("bad") or a challenge to parental authority—when in fact it is likely a healthy expression of emerging preferences and desires, and a growing sense of a separate self. The same can be said of adolescents—although the pushing may take a different form. Awareness that some distancing, opposition and challenge is normal and necessary during adolescence can take some of the sting out of what can feel like rejection, and help parents to take these behaviors less personally.

Supporting Emotional and Cognitive Autonomy

In practical terms, most adolescents remain functionally dependent on their families during the teen years. However, a central role for parents and others who work with adolescents is to support the growth of emotional and cognitive autonomy (Allen et al., 2003; Steinberg & Silverberg, 1986). There is a common attitude within society that adolescents must be controlled and that certain ideas and values need to be instilled into them. However, a more effective way of staying *in connection* with adolescents may be to *listen first.*

Emotional and cognitive autonomy are fostered by encouraging the exploration of thoughts, feelings, ideas, preferences and options. In order to function successfully as adults, adolescents need to learn *how* to think—not what to think. This approach can feel threatening to many adults, particularly around emotionally charged issues such as sexuality and experimentation with drugs or alcohol. However, by participating in the exploratory process, parents or other responsible adults have a better chance of asking the right questions, sharing information and supporting reflection in adolescents. When teens are given the opportunity to fully express and explore their thoughts and feelings, they may be less likely to simply act upon them. In addition, self-discovery within safe and supportive relationships may provide some of the emotional excitement that teens

naturally seek, as well as support the task of identity formation. At a time when relationships with parents can be problematic, other adults such as extended family members, teachers, mentors or therapists can support this process.

Achieving autonomy can be more challenging in some situations than others. For example, Daniels (1990) suggests that separation-individuation may be complicated for adolescents in non-traditional family settings such as being in a home where parents are in the process of a divorce, single parent homes, or blended families. She observes that in single parent homes there is a risk of the child becoming the caretaker of the parent (*parentification*), or, difficulty individuating from a parent who is absent. In addition, the goal of family unification (blended families) or reunification (parental separation) may be contrary to the adolescent's need to separate and individuate. Family trauma, such as the loss or serious illness of a family member may similarly complicate an adolescent's quest for autonomy. In such cases, teens may need additional support in getting their needs met. War and poverty can dramatically limit the desirability or possibility of autonomy, or force premature independence.

It is important to note that autonomy and independence are values that tend to be emphasized in western industrialized societies where young people are expected to eventually leave home, set up separate households and function on their own. This is not the case in all groups or cultures. Independence and autonomy may be actively discouraged in some social contexts, particularly for girls. In these circumstances, adolescents may find themselves caught in a conflict between traditional group or cultural norms and those of the prevailing society. In broader terms, the task of adolescence is to find one's place within the family, culture and larger social world (Erikson, 1968). What is needed during adolescence will vary depending on the specific realities and unique circumstances of each individual.

Psychoeducation

Psychoeducation can be useful for both parents and teens during adolescence. An understanding of developmental processes can help parents to better assess what limits and boundaries may be appropriate to their teen's level of maturity. In addition, greater awareness of the developing brain and the gap between emotional and cognitive processes during adolescence may help parents feel more comfortable setting and maintaining boundaries in the face of pressure from teens. The challenge is to find a balance between protection and growing needs for autonomy. Either too much or too little structure may undermine development. When decisions are made based on communication and shared information, teens may not like the limits that are set for them, but may be more likely to respect and appreciate them.

During adolescence, capacities for judgment are not fully developed and social and emotional processes can override logic and reason (Dahl, 2004; Steinberg, 2005; Walsh, 2004). Research suggests that adolescents are more likely to take risks in the presence of peers than when they are alone (Gardner & Steinberg, 2005), and risky behaviors often occur in group situations that create intense excitement and euphoria (Steinberg, 2004). Walsh (2004) suggests that teaching teens about how the emotional brain can hijack the thinking brain can promote a sense of responsibility for managing impulses. (This may also be a welcome alternative to repeated lectures on the dangers of peer pressure.) In addition, learning to recognize the signs of emotional over-arousal and the use of self-regulation skills can provide teens with a sense of mastery.

Both teens and their parents can benefit from learning self-regulation skills. In highly charged situations, lower areas of the brain associated with automatic emotional responses normally become engaged while prefrontal executive functions that allow for more reflective responses become less active (Levine, 1997; Schore, 1994; Siegel, 1999). In situations involving high excitement (either positive or negative), it is easy to imagine how adolescents may become involved in risky behaviors, or how a highly charged conflict between parent and teen might escalate.

Parents and teens can learn self-regulation skills by increasing awareness of bodily reactions associated with over-excitement and sympathetic nervous system hyper arousal. Creating a pause in the action and making the cognitive shift to attend to somatic cues may in and of itself help to slow things down enough for the thinking part of the brain to come back online. However, in addition to somatic awareness, grounding exercises and the use of conscious breathing techniques can be taught as tools to calm the nervous system and promote reflection. Learning and practicing self-regulation skills in unstressful or moderately stressful situations (such as a therapy session) may help teens to utilize these techniques to cope with the stresses of daily life, or in highly activating circumstances when no parent or responsible adult is present to intervene. When passions override rationality and adolescents exercise poor judgments, they need to be supported in learning to think about what happened, take responsibility, consider what other actions they might have taken, and what they might do in similar situations in the future (Walsh, 2004). In this way capacities for self-refection are developed and adolescents have the opportunity to learn from their experiences.

The principles and skills of self-regulation are important at any age but may be particularly relevant during adolescence, at a time when the emotional system is being reorganized (Spear, 2000, 2008, Walsh, 2004) and teens experience a host of physical, emotional and social changes that may be inherently stressful. Parents, too, may face challenges, in addition to parenting, that are rooted in their own circumstances (such as an impending empty nest, marital difficulties, job stress, financial concerns, health issues, or the care of an aging parent). Adolescence can be a stressful period for both teens and their families. Adolescents need adults who model self-care, good communication skills and self-regulation. Conflicts that arise between parents and teens can provide a catalyst for developing and improving these capacities.

Developing the Whole Person

A superficial understanding of adolescent brain changes and critical periods as a time for optimizing development can lead to an over-emphasis on cognitive skills, academic performance and achievement during the teen years. Adolescence is indeed a time of major cognitive advances; however this is only part of the story. The central theme of adolescent brain development is *integration* (Harkin, 2007, 2009). It is the integration of thought and emotion, different modes of information processing, as well as the development of prefrontal executive functions that appear to underlie emerging capacities during adolescence. A broader understanding of adolescence as a critical period for brain maturation and the integration of multiple lines of development suggests the importance of focusing on *process* rather than product. Integration is achieved by emphasizing development of the whole person.

From a neuroscience perspective, relationships and activities that promote brain integration will enhance development during adolescence. The arts, music, dance, recreational, and sports activities may be especially valuable for teens. For example, some aspects of music making involve the analytic capacities of the left-brain (such as reading music or structuring a composition), while other aspects utilize the more holistic, emotional and intuitive capacities of the right brain. Activities that promote development of each hemisphere and their integration may support adolescent brain development. In more general terms, art, education and recreational activities when focused on development of the whole person can serve to support emotional and cognitive development, as well as the development of interpersonal and social skills. Such activities also provide a means of self-expression and identity formation at a time when teens may not always have the words to describe what they are experiencing. It is unfortunate that the arts, recreation and sports programs are viewed as luxuries rather than as essential, and are often among the first to go when budget cuts are deemed necessary.

Channeling the Energies of Youth

Perhaps one of the most effective ways to support development and minimize risks during adolescence is to channel the energies of youth. As Dahl (2004) notes, adolescent processes appear to create high levels of arousal and excitement that create "both a great deal of vulnerability among the young as well as a great opportunity to harness these emotions in service of positive goals" (p. 20). Adolescence is an ideal time for developing interests, skills, and the unique gifts and talents of each individual, as well as the desire for contribution (for example through extracurricular activities or volunteer work).

Within many traditional societies tutelage by village elders and *rites of passage* guide the transition from childhood to adulthood and ensure ongoing connection with the larger community. These ceremonial rituals transmit values and traditions from one generation to the next and serve to redefine the individual's role within the group (Frankel, 1998; van Gennep, 1961). In contrast, within contemporary American society, adolescents tend to be isolated together with less supervision or participation by responsible adults (Hersch, 1998; Hine, 1999). The complexities of modern life have moved us further and further away from formal demarcations of adult status or clearly defined roles. This creates added challenges for adolescents trying to find a sense of identity and belonging. Adolescents can benefit from positive structures that provide some of the functions served by those lost rites of passage (or that create new ones). Adolescents need relationships and activities that provide support and guidance, create salient emotional experiences, generate deep meaning, and offer substantive challenges that help to develop the skills necessary for adulthood.

Psychopathology

Recent research on the adolescent brain was originally pioneered to study the relationship between brain development and psychopathology (Giedd, 2004). As previously noted, adolescence is recognized as a period of increased risk for the onset or exacerbation of a number of emotional and behavioral problems including anxiety, depression, eating disorders, schizophrenia, violent delinquency and substance abuse (Giedd et al., 2006; Rosentein & Horowitz, 1996; Steinberg, 2002, 2005). The unexpected discovery of structural changes during adolescence suggests that the genetic blueprint for brain development continues to unfold during this period, and as a result, both genetic and environmental factors may create additional vulnerabilities.

Research on structural and neurophysiological changes during adolescence has generated new hypotheses about the origins and progression of various mental disorders. Significant work is being done in this arena and psychopathology will continue to be an important focus of study. A detailed examination of the research on psychopathology is beyond the scope of this article. For an overview of the literature see Giedd et al. (2006) or Toga, Thompson, & Sowell (2006).

One area of particular interest to clinicians is the work being done on addiction. Spear (2000, 2008) and others note that changes in limbic circuits and the dopamine system, along with social factors, may make teens particularly susceptible to the addictive effects of nicotine, alcohol or drugs (Chambers, Taylor, & Potenza, 2003; Jackson, 2005; Strauch, 2003; Walsh, 2004). The dopamine system functions as a natural part of the learning process. As Spear (2000) describes, dopamine acts upon pleasure and reward centers of the brain, and the positive feelings generated by increased dopamine levels tend to reinforce behavior and therefore learning. Addictive substances act by triggering an initial release of dopamine into synapses or prolonging its stay. However, over-stimulation of the brain with dopamine can cause a cut back in the number of dopamine

receptors, resulting in an overall decline of dopamine naturally circulating in the body. This decrease may lead to feelings of depression that can cause an individual to seek increasing levels of stimulation through substances or behaviors that jump-start the release of dopamine—potentially leading to a vicious cycle of addiction (Spear 2000, 2008).

Research suggests that teens may be more sensitive to stressors than adults, and that elevated stress responsivity may contribute to the tendency to initiate drug and alcohol use in adolescence, given that stress has been shown to increase alcohol consumption and facilitate the onset of drug use (Spear, 2000, 2008). Substance abuse during the teen years is of particular concern, as there is a growing body of research that suggests the adolescent brain is more vulnerable to the damaging effects of addictive substances than the adult brain, with potentially long-term consequences (Chambers et al., 2003; Jackson, 2005).

Research on addiction highlights the fact that the developing brain may respond differently to substances than the mature brain. This issue is relevant to the use of psychopharmacological interventions in the treatment of children and adolescents. Until recently, the majority of drug testing was conducted primarily on adult subjects. However, new clinical trials using pediatric and adolescent populations have resulted in product warnings for some medications that include potentially dangerous side effects for children, adolescents and young adults. It is not known whether or how the use of different psychopharmacological drugs may permanently alter the developing brain—or which of these alterations may be beneficial or detrimental to future health and functioning. The full risks and benefits are not yet known (Benedetto, 2006). Until some of these questions are answered, when possible, it may be advisable to try non-psychopharmacological treatments first. When medication is necessary, it is important that side effects are carefully monitored.

Conclusion

A growing body of evidence implicates adolescence as a critical period for brain maturation and associated capacities (Dahl, 2004; Giedd, 2008; Giedd et al., 1999; Keating, 2004; Steinberg, 2005). Central to the concept of critical periods is that they create particular vulnerabilities when developmental needs are not met, as well as unique opportunities to optimize development. Many of the capacities developing during adolescence (such as greater impulse control, significant cognitive advancement, and the abilities to reflect, evaluate and choose) are essential to successful adult functioning and an individual's capacity for ongoing adaptation and change. An understanding of adolescent brain changes within the context of broader developmental processes can help to create greater compassion for the challenges adolescents face, normalize certain behaviors, as well as provide direction for how to best support growth and development.

The transition from childhood to adulthood naturally involves dramatic physical, emotional, cognitive and social changes. The major disorganization and reorganization of systems that occurs during the teen years, coupled with growing reflective capacities make adolescence an ideal time to influence the change process—to proactively provide experiences that support development, or to implement prevention and intervention strategies where needed. Historically there has been an emphasis on the problems of adolescence; however, shifting the focus to adolescence as a critical period highlights its tremendous potential.

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Biography

Deborah Harkin, PhD earned a doctorate in Clinical Psychology with a specialty in Somatic Psychology at Santa Barbara Graduate Institute (SBGI) in 2007. Her dissertation synthesized traditional theories of adolescent development, attachment theory and recent discoveries in neuroscience on the adolescent brain (Harkin, 2007). She currently serves as an academic administrator at SBGI and can be reached at dharkin@sbgi.edu.

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