# Adolescent Brain Development: Current Research and the Impact on Secondary School Counseling Programs

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## Abstract

Brain growth and change is a key factor in adolescent development, influencing cognitions, emotions, and behavior. As technology has improved, so has the research on the adolescent brain. School counselors working with adolescents need to be familiar with recent literature to be more effective in their work with middle and high school students. Understanding changes in teens' brains and the impact it has on cognitive and personal/social development may assist school counselors in building a developmentally appropriate secondary school counseling program that better meets the needs of adolescent student populations.


*Keywords*: adolescents, brain development, comprehensive developmental school counseling program, secondary students

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Adolescents need guidance from adults in creating environments that foster supportive opportunities for optimal brain development if they are to be successful in academics, become well-adjusted socially and emotionally, and be prepared developmentally to make essential career decisions. School counselors, engaged in the implementation of the American School Counselor Association (ASCA) National Model (ASCA, 2005), may utilize recent research on adolescent brain development in advocating for systemic change directed toward attainment of developmentally appropriate ASCA National Standards (ASCA, 2005), building a more “brain friendly” comprehensive developmental program.

Adolescence is time of important changes in the structure and function of the brain; other than the first three years of life, no other developmental stage is characterized by more dramatic changes (Steinberg, 2011). For years, the “roller coaster” of adolescence was blamed on hormones. Recent advances in technology and research have led to the ability to “see inside” the adolescent brain; these studies indicate that the brain, not hormones, is responsible for teens’ thoughts, feelings, and behaviors. Brain research is a new frontier, and studies show that neuroscience has had little impact on the institution of education (Blakemore & Frith, 2005). The current educational system, created in the 19$^{th}$ century, is trying to serve a population that no longer exists (Jones, 1999). Information regarding current research on adolescent brains is imperative for school counselors. Professional school counselors (PSC) must

use this information in providing a comprehensive developmental counseling program; it is also important that PSCs help other school personnel understand teen development.

## Brain Research

### Brief History

For years, scientists could only speculate about the workings of the teen brain. Recently there has been an explosion in research on adolescent brain development (Steinberg, 2011), most of which is the result of improved technologies including magnetic resonance imaging (MRI) and diffusion tensor imaging (DTI). In the 1960s and 1970s, scientists solely relied upon examining human brains post-mortem; such studies over the next twenty years indicated that the prefrontal cortex continued to undergo significant changes in puberty (Blakemore & Choudhury, 2006). More recently, a number of MRI studies began to provide further evidence of both structural and functional changes in teen brains. Increases in both white matter (linear pattern) and decreased density of grey matter (non-linear pattern) due to synaptic pruning were demonstrated (Barnea-Goraly et al., 2005; Giedd et al., 1996, 1999). In the area known as the corpus callosum, it was found that the neural fibers connecting the two hemispheres of the brain underwent significant growth during adolescence and into the mid-twenties (Barnea-Goraly et al., 2005; Giedd et al., 1999). Most recently, the Functional MRI (fMRI) has been used to study not only the structure of the brain, but also its function. These studies indicate significant synaptic reorganization takes place during adolescence; this leads to a sensitive period akin to the sensorimotor period of development during infancy. During this sensitive period, research indicates that

experiential input is critical to the development of both executive function and social cognition (Blakemore & Choudhury, 2006).

A new neurobiological model has emerged. The brain undergoes dynamic changes throughout adolescence, and the interplay between structural and behavioral changes has become more evident (Casey, Jones, & Somerville, 2011). Siegel calls this neurobiological period a “reconstruction zone” (Codrington, 2010). School counselors have the opportunity to assist students during this period of reconstruction through both program services and consultation with other school personnel.

**The Adolescent Brain**

The brain is perhaps the body’s most complex organ. While 95 percent of brain development takes place before age 5 or 6, a second wave of development takes place during adolescence, typically from age 11 or 12 through approximately 24 (Spinks, 2000; Jensen, 2010; Yurgelun-Todd, Killgore, & Young, 2002). The human brain contains approximately 100 billion neurons. Neurons, the only cells in the body that do not touch, must rely on chemicals called neurotransmitters to relay messages from cell to cell. The spaces between cells, or synapses, are formed early on. Some of these are formed genetically, but vast numbers are formed due to the child’s engagement in experiential activities. Children are born with many more synapses than needed; those that are unused will die off in a process known as synaptic pruning. A second overproduction of neurons, dendrites, and synapses takes place in teen years. As overproduction takes place, the brain selectively strengthens neuron pathways, while the others that are unused are eliminated. This pruning process is based on activity and stimulation. Synaptic pruning enhances the brain’s functioning and makes the brain

more efficient….the process “transforms an unwieldy network of small pathways into a better organized system of superhighways” (Steinberg, 2011, p 42).

Following the pruning process, synapses are generated and myelin begins to insulate and cover the neurons and pathways. Myelin, a white fatty substance made of glial, is released in stages, and is dependent upon age, environment, and genetics. One of the last places to receive myelin is the prefrontal cortex, the area responsible for abstract thinking, language and decision-making (Feinstein, 2009). The more extensive the myelination, the faster information flows. This also makes the brain efficient; it allows the brain to organize circuitry.

This period of brain “reconstruction” exists for teens. This “use it or lose it” period is critical; thoughts, beliefs, interests, abilities, and skills developed now with endure a lifetime….or may be lost forever. Overproduction provides teens with the opportunity to learn and excel in a variety of areas as synapses are “spawned all over the brain” through experience (Feinstein, 2009). The synaptic pruning is just as important, and the neural pathways that teens make endure a lifetime; unused connections will be lost. Feinstein (2009) states “If they aren’t reading, doing science, or solving problems, the synapses for those activities will be pruned and lost forever” (p. 11). In a Public Broadcasting System (PBS) interview, Giedd elaborates on the importance of experience in the process of pruning in his statement

> So if a teen is doing music or sports or academics, those are the cells and connections that will be hard-wired. If they’re lying on the couch or playing video games or watching MTV, those are the cells and connections that are going to survive… Are the schools doing a good job?...Are we as parents doing a good

> job?... What can we do to help the teen optimize the development of their own brain? (PBS, 2002)

Fuller (2005) reinforces the point, “This is why the experiences we give children and young people between their 9th and 18th year are so important” (p. 16). While adolescents’ experiences cannot be completely controlled by adults, it is important for counselors, teachers, and even parents to employ more adolescent-centered counseling and educational approaches in schools.

**Prefrontal cortex.** The prefrontal cortex, the section of the brain that controls planning, organization, insight, reasoning, and serves as mood modulator, does not fully mature until age twenty four or twenty five. Appearing sluggish, the prefrontal cortex is the last section of the brain to receive myelin. As this area receives myelin, teens develop the ability to hypothesize, reason, think about and plan for the future, use logic, weigh risks and rewards, and control mood. This happens at different rates for teens, and depends upon genetics and stimulating opportunities. Recent fMRI studies focusing on brain function indicate that adolescents are actually less likely than children to activate prefrontal regions that are not relevant to performing a task well (Steinberg, 2011, p. 45). While adults rely on their prefrontal cortex to react logically to input, adolescents often rely more on the amygdala when confronted with a decision; they will revert to emotions and instinct (Yurgelun-Todd et al., 2002). Often emotions get “first say” about what teens will do when making a decision; this explains poor decisions and emotional responses (e.g., having unprotected sex, spur of the moment activities, and making statements such as “I hate you.”). Jensen (2010) aptly states, “It’s not that they don’t have a frontal lobe. And, they can use it, but they are going to access it much

more slowly" (p. 1). Insight requires a fully connected prefrontal cortex; thinking about the impact of one's behavior on others requires insight. Thus, teens often do not think before they do, or, consider the impact of their actions on others.

Synaptic reorganization in the frontal lobes also has implications for social cognitive processes. Neuro-imaging again reveals what is happening in the teen brain. Choudhury, Blakemore, & Charman (2006) found that perspective taking decreased significantly with age; adults have the highest proficiency and pre-adolescents inefficient skills (p. 170). Pre and early adolescents find it difficult to "step into another person's mental shoes" (Choudhoury et al., 2006, p. 170). Young teens will often appear to others as being self-centered (Jensen, 2010), but this is a developmental difference linked to social experience. Due to developmental differences in prefrontal lobes, adolescents may also misread others' emotions. Yurgelon-Todd et al. (2002) showed pictures of people with fearful facial expressions to teens ages 11 to 17 while scanning their brains. The researchers found that compared to adults, the teens' frontal lobes were less active and their amygdalas were much more active. The adolescents in the study actually misread facial expressions, with those under the age of 14 more often seeing sadness or anger instead of anxiety or fear. Older teens were more likely to read the correct emotions, indicating a shift in activity from the amygdala to the prefrontal cortex.

Interestingly, a new type of brain cells named mirror neurons, were discovered early this century. Neuroscientists engaged in advanced neuroimaging discovered a network of neurons in the frontal cortex that "fired" when they vicariously experienced something (Iaconboni, 2008; Sylwester, 2007). They discovered that the same part of

the brain was activated in an observer as the neurons of the teen actually engaged in the activity. That means that adolescents experience other's feelings, pain, joy, etc., and develop the ability to empathize with a friend who fails a test or is rejected by his girlfriend. School counselors, teachers, and parents can be confounded with adolescent responses to their reactions and changing emotions.

The prefrontal cortex plays a major role in adolescent affect. The right side may be activated by negative feelings, while the left side controls positive feelings; most of the time the two work in sync. The left side of the prefrontal cortex receives and filters information from the amygdala. If the amygdala sends a message of danger, the left prefrontal cortex processes this and sends a message back to the amygdala either reinforcing the danger signal or instructing the amygdala to calm down. If the left side decreases in activity, the amygdala may "run wild" (Feinstein, 2009, p. 105). The inactivity of the left prefrontal cortex leads to dominance by the right side, thus the teen becomes overwhelmed with negative feelings. Adolescents often "get stuck" in negative emotions; this phenomena may lead to the development of depression. There does seem to be a link between the workings of the left and right prefrontal cortex in depression; there is no cause and effect implication (Feinstein, 2009). Depression does impact other parts of the brain, especially the hippocampus. Through MRIs, researchers have found that the hippocampus decreases in volume during a long-term depression, primarily due to death of neurons (Thomas & Peterson, 2003). Malfunctioning of the hippocampus impacts short-term memory and the adolescent's ability to process emotion and information. Due to the brain's plasticity, when depression lifts, the hippocampus grows new synaptic connections (Thomas & Peterson, 2003).

The prefrontal cortex is also the province for language, and language production in adolescence is difficult. Language production shifts in function as the frontal lobe develops, and young adolescents have more difficulty generating words and expressing themselves than do their older counterparts (Sowell, Thompson, Holmes, Jernigan, & Toga, 1999). This explains youthful answers such as “I don’t know,” “Whatever,” and other vague mumblings (Woolfolk, 2006). These types of comments can be frustrating for school counselors when attempting to use talk therapy. They can also frustrate teachers and parents when trying to communicate with teens.

**Mid-brain limbic region.** The mid-brain, or limbic, area of the brain is centered in the head cavity. Two important structures here are the amygdale and the hippocampus. The amygdala, which sits atop the brain stem, interprets input and regulates emotions; it readies the body for action when it perceives a negative stressor. The hippocampus, located behind the amygdala, classifies memory input; it selects, classifies, and stores experiences and learning into memory (long and short-term). The hippocampus is also active in the stress-response system. All new sensory input must first travel through the limbic region. Environments that are threatening activate the stress-responses system, providing a quick short-term, high energy response (Greenleaf, 2003, p. 17). Stress-response systems activate the adrenal gland to produce both adrenalin and cortisol. Once the hippocampus perceives that danger has passed, it signals the adrenal gland to decrease the output of stress hormones. When students feel unsafe physically or emotionally, the stress-response system is activated. Anxiety, stress due to language barriers and cultural differences, bullying, infatuation and attraction, fear, embarrassment are examples of “emotional landmines” that can

trigger the stress-response system and production of stress hormones. These stress hormones can override rational thought and lead the amygdala to very instinctual, emotional responses. Implications of this stress-response system are huge. Greenleaf (2003, p. 17) states “Emotions, then, might be characterized as the vehicle upon which meaning becomes attached, the canvas upon which the painting is developed and to which it adheres.” This process can actually impede cognition; it can also lend itself to enhance student learning if used appropriately (Greenleaf, 2003). Today’s society is fast-paced; students are exposed to vast amount of information and violence; this high stress state may kick in the stress-response system virtually during all waking hours. Some researchers speculate this might be one reason for decreased academic performance in many American children in recent years (Jones, 1999, p. 37). School counselors must collaborate with other educators in providing safe environments for students. Through a comprehensive developmental program that provides guidance curriculum aimed at improving school climate, school counselors can positively impact both the emotional and academic well-being of students.

**Neurotransmitters.** During this period of vast brain development, synapses increase in complexity. While adolescents become more capable of abstract reasoning, brain changes also may make them engage in risky behaviors. Chemical neurotransmitters including dopamine, epinephrine, noradrenalin, and numerous others, become more excitable in adolescence. These excitatory neurotransmitters react more strongly to stressors; neurons are actually seen in brain imaging to spark and fire as messages sprint across teen synapses. Jensen (2010) states, “Nature made the brains of adolescents excitable. Their brain chemistry is tuned to be responsive to everything

in the environment. That's what makes them susceptible to thrill-seeking" (p. 1). Steinberg (2011) states, "When something enjoyable happens, teens experience what some scientists call a 'dopamine squirt,' which leads to the sensation of pleasure" (p. 43). A rapid increase in dopamine activity in early adolescence leads to teens feeling good when involved in intense experiences; these experiences feel really good. This good feeling leads to young adolescents engaging in risky behaviors. In fact, dopamine seems to be the major culprit in risk-taking Research reveals there is a rapid increase in dopamine activity in the brain's reward center (Steinberg, 2011). Risky behaviors, such as experimenting with drugs and having unsafe sex appear to be driven by dopamine and other excitory neurotransmitters (Cohen, Asarnow, Saab, Bilder, Bookheimer, Knowlton, & Poldrack, 2010). Researchers in this particular study found that the dopamine system appears to be the final pathway to all addictions, and begins in the adolescent brain; what was once thought to be choice now appears to be teen "hard-wiring" (Cohen et al., 2010). Stress can also impact the production of dopamine, actually rerouting this neurotransmitter (Begley, 1996). The amygdala and hippocampus go into overdrive and reduces the activity of dopamine in the prefrontal cortex. In fact, the prefrontal cortex does not show normal activation in fMRIs, thus limiting the brain's cognitive processing and memory storage areas (Willis, 2007; Begley, 1996).

Dopamine release increases with pleasurable and positive experiences (Willis, 2007). Studies have found that neuron circuits from the limbic area move to prefrontal cortex and other areas of the cerebrum in response to this dopamine release (Wunderlich, Bell, & Ford, 2005). Additional research indicates that there is increased release of dopamine when adolescents anticipate pleasurable experiences (Nader et

al., 2002). Willis (2007) states, “Because dopamine is the neurotransmitter associated with attention, memory, learning, and executive function, it follows that when the brain releases dopamine in expectation of pleasurable experience, this dopamine will be available to increase the processing of new information” (p. 71). Huge implications for educators lie in this information. If education, and curriculum more specifically, do not induce pleasurable states in the brain, students’ intrinsic interest in subject matter may be diminished (Willis, 2007). School counselors who understand this will employ guidance curriculum that is pleasurable. Acting as a student advocate, counselors may consult and collaborate with other school personnel to help them understand the importance of varied, engaging experiential activities and the importance of more pleasurable classroom experiences.

Serotonin, another important neurotransmitter, seems to be present in lower levels during adolescence (Feinstein, 2009). In addition to regulating numerous bodily functions (temperature, blood pressure, digestion, etc.), serotonin is also a “feel good” substance. When functioning properly, serotonin inhibits the firing of some other neurotransmitters, making teens feel relaxed and counteracting the emotions emitted from the amygdala (Feinstein, 2009, p. 104). Researchers speculate that the lower levels of serotonin may also contribute to depression during teen years for two reasons: either their brains are not able to utilize serotonin present, or, their levels of serotonin are so low that the brain is unable to run smoothly (Feinstein, 2009). Reduced levels of serotonin may lead to depression, but the causes of teen depression are complex. Serotonin does not act alone. The prefrontal cortex, biology, genetics, and environment all influence the development of depression. Contextual factors such as abuse, unreal

expectations, rejection, peer pressure, and stress during adolescence may lead to negative feelings; negative feelings running unchecked may lead to the hopelessness of depression. Recent research shows that when a teen is anxious, has self-doubt, or is not confident, neurotransmitters flow into the synapse, basically shutting them down (Reyna & Farley, 2006). Conversely, when the teen feels confident, has self confidence, and generally anticipate challenges, dopamine, serotonin, and other neurotransmitters flow into the synapse causing the message to fire through quickly and smoothly. This new insight suggests how negative emotions impact teen affect and behavior, and the findings have huge implications for counseling and education. Better understanding the heart of teen depression is critical for school counselors working with secondary populations in both intervention and the referral process.

The structure and function of the brain undergo tremendous change during adolescence. While most adolescents perform as well as adults in basic abilities such as memory, attention, inhibition and other mental strategies, more sophisticated cognitive abilities such as thinking ahead, envisioning consequences of a decision, balancing risks and rewards, and controlling impulses and emotions are still developing (Steinberg, 2011, p. 46). The brain is plastic, or malleable, and its development is dependent on genetics as well as experience. The good news about plasticity is the hope that teens can acquire and improve abilities into adulthood. School counselors working with adolescent populations need to be aware of this recent research on the brain and how brain development impacts affect, cognition, and behavior. School counselors need to provide a “brain-appropriate” comprehensive developmental guidance and counseling program aimed at both prevention and intervention.

## Comprehensive Developmental Guidance and Counseling Programs

Contemporary comprehensive developmental guidance and counseling programs are grounded in human development theories. The notion that developmental changes occur over the lifespan and address numerous life domains including cognitive, social/emotional, personality, moral, and career development are foundational to school counseling programs. School counselors, through a fully implemented comprehensive developmental guidance and counseling program such as the ASCA National Model (ASCA, 2005), need to address developmental changes in a sequential and orderly manner in their curriculum and services (Erford, 2011). Myrick (2003) defines a developmental program as one that identifies skills and experiences that students need to have as part of their educational experience that lead to success. ASCA has identified specific student outcomes in the form of the ASCA National Standards (ASCA, 2005); embedded within the standards are numerous developmental theories and developmentally appropriate tasks. Using a developmental approach in a comprehensive program provides a proactive approach, enabling students to learn about themselves and others, as well as equipping them with the awareness, knowledge, and skills needed to be successful. Wittmer and Clark (2007) suggest that "Today's new secondary school counselors realize they work with young persons experiencing adolescence – a unique developmental stage which includes biological, cognitive, and social/emotional aspects. They realize that 'special approaches' are needed to be effective counselors with this age group" (p. 66). By incorporating recent brain research, school counselors can design student-oriented developmentally appropriate counseling programs. Numerous components of the American School

Counselor Association (ASCA) National Model (ASCA, 2005) must be addressed in secondary schools with the brain needs of the adolescent in mind.

**Guidance**

Classroom guidance is one of the most effective means to reach the most students. Classroom guidance must be collaborative, and school counselors need to work with teachers to most effectively achieve the goals of a developmental program (Wittmer & Clark, 2007). Topics based on developmental goals should be infused appropriately into the regular school curriculum (Wittmer & Clark, 2007). Regular guidance topics, such as educational and career planning, drug education, relationships, conflict resolution, decision-making, etc., can be enhanced by bringing in facts from recent brain research. Opportunities for students to use and stretch their developing brains are encouraged; this would include higher order thinking skills and employing the affective domain. Learning is an emotional experience based on brain studies; incorporating the unusual and unique will enhance students' motivation and increase chances for retention. Jones (1999) suggests the use of experiential and hands-on activities incorporating props, movement, and music. Sylwester (2007) suggests providing adolescents the opportunity to brain-storm and make decisions. Citing the fact that teens spend much time and energy with friends brainstorming activities, Sylwester (2007) suggests that this social exploration helps develop cognitive and negotiation skills, later incorporating these skills in problem-solving activities (p. 31). Research on brain maturation indicates that the more sophisticated cognitive abilities such as thinking ahead, understanding the consequences of a decision, balancing risk and reward, and controlling impulses are still developing during adolescence (Steinberg,

2011). Many scientists believe the maturation of the areas of the brain that control these functions improve and strengthen with practice. Guidance lessons should provide teens with opportunities to practice skills such as planning, anticipating consequences, and regulating their own behavior (Steinberg, 2011). Guidance lessons using scare tactics, lecturing, and other traditional tactics are discouraged by many; these methods disregard effective strategies based on brain research.

Jensen (2010) suggests that adults raise awareness among adolescents with regard to their developing brains; she suggests that teens be educated in brain research. Hutchings and Ojalvo (2009) have developed an excellent lesson for teens which incorporates students reviewing recent scientific research and then hold a symposium to discuss the implications. The lesson incorporates many of the suggested strategies to engage adolescents more effectively.

**Responsive Services**

Individual and group counseling are critical program components. Expertise in counseling coupled with knowing specific developmental characteristics are required to provide effective interventions with middle and high school students.

**Individual counseling.** Individual counseling must be brief and focused in school settings, but must be part of the overall program. The creation of an empathetic relationship with adolescent clients is the first step and creates a climate for change (Badenoch, 2008). As Martin (2003) aptly states, “All of the brilliantly understood knowledge in the world will not make a clinician effective with adolescent clients unless he or she is able to form good relationships with those clients” (p. 2). Martin (2003) suggests that personal warmth, empathy, and acceptance are at the core of personal

bonds needed to provide effective counseling for adolescents. Cognitive abilities and affect are constantly changing in teens; this results in the need for control and freedom. Counselors who work as partners instead of authorities with secondary students will meet teens' need for control and freedom, enhancing the possibility of positive outcomes.

Traditional talk therapy may not work; the use of brain-friendly strategies for building therapeutic relationships may be needed. These include use of expressive therapies such as sand tray and art. Martin focuses on expressive approaches, "Because of the brain's limitations, counselors must incorporate multisensory learning to incite areas of the developing brain that are prepared to aid in healing" (2003, p. 57).

Due to the complex and complicated cognitive, affective, and behavioral nature of adolescents, an integrative approach may be the most effective (Whitmarsh & Mullette, 2009). The authors have developed a unique integrated strengths-based approach aptly named the SEARCH Model. The model incorporates Lazarus's technical eclecticism and multimodal therapy, the more contemporary solution-focused model, and positive psychology (with a focus on identification of developmental external and internal assets (Whitmarsh & Mullette, 2009, p. 146). Whitmarsh and Mullette suggest that such a model allows teens to gain insight into risky behaviors, increase their awareness of assets and personal resiliency skills, and build additional coping skills that enhance their degree o control over future development (2009, p. 146). The SEARCH Model is a good fit regarding adolescent brain development. Other theoretical approaches identified to work with adolescents in schools and "brain appropriate" include Adlerian approaches, reality therapy, cognitive-behavioral approaches, solution-

focused , multimodal techniques, and family counseling approaches (Erford, 2011; Brown & Trusty, 2005).

**Group counseling.** Group counseling, another mode of direct service delivery in a comprehensive, developmental counseling program, is a modality well-suited for secondary students. Groups allow the school counselor to be more efficient by multiplying the number of students seen at one time. Since adolescents are social beings, they usually enjoy interacting with other teens. The group dynamic itself can be therapeutic; teens learn they are not unique in their thoughts and feelings. Adolescents often learn best from each other when in small groups (Goodnough & Lee, 2004). Small counseling groups offer teens a safe environment to develop insights about themselves and others, give and receive feedback from peers, and learn and practice new behaviors. Groups are places where teens may find support for the first time in a school setting. In group settings, cognitive and affective domains of the adolescent brain are addressed; through experiential interaction with others, teens develop the ability to help themselves and others.

## Consultation

School counselors are ideal consultants in schools due to their education and training (Campbell & Dahir, 1997; Studer, 2005). Consultation is important in school counseling as evidenced by discussion in the literature for years (Wrenn, 1962; Dinkmeyer & Caldwell, 1970; Gysbers & Henderson, 2000). ASCA describes the school counselor role including the use of “consultation with parents, teachers, and other educators” in providing services to meet students’ immediate and future needs (ASCA, 2009). ASCA considers consultation a critical component in implementing an effective

comprehensive developmental guidance and counseling program. Consultation is a process of assisting teachers, administrators, and parents better understand or work with children and adolescents. Schmidt (2010) identifies consulting as a process by which the school counselor "…collaborates with other school and community professionals to design strategies that enhance student development" (p. 86). Through effective use of consultation, school counselors can impact a large numbers of kids; getting information out to school personnel on adolescent brain development can impact the entire student population.

Helping administrators and teachers understand the need to create safe school climates is imperative. This may be done through numerous counselor-prepared or commercially prepared programs and delivered through in-service activities. School counselors can really impact school climate through their guidance curriculum, but, all school staff, parents, and community members must be involved if systemic change can truly take place.

School counselors can also educate and train teachers in relationship-building behaviors. Teens have many unmet social and emotional needs. As stated earlier, emotionally stressful environments are counterproductive and may be harmful; students will have diminished learning abilities. Teachers are on the frontline with adolescents and teaching them to communicate with teens in brain-friendly ways and build healthy relationships may decrease acting out behaviors. School counselors can train teachers in active listening skills, empathetic statements, and assist teachers in more effective communication skills in dealing with student conflicts.

Involving teachers in guidance curriculum through the various content areas is another way to involve teachers. School counselors collaborating with science and health teachers can provide information to students about their brains. Teachers in all subjects can provide valuable career development content in their curriculum; through effective consultation, school counselors can provide teachers with numerous career resources.

Taking this one step further, all teachers can employ the use of inquiry and higher order thinking skills. Shifting from lecturer to the role of "facilitator, coach, and guide" will allow teachers to use methods that stimulate higher levels of thinking (Jones, 1999.) As cited earlier, this is a critical period of "use it or lose it," and adolescent brains are being hard-wired. Teachers can offer students the opportunity in the classroom to use skills such as planning, problem-solving, making and carrying out plans, etc. to assist their brains in building effective circuitry and maturation. School counselors may help teachers understand how important stimulation, experience, and opportunity are for teen brains in "hard-wiring" for success.

## Implications for Future Research

Neuroscience and study of the developing human brain is a new frontier in modern science. There are still many outstanding questions according to Blakemore (2008). Triggers for the synaptic reorganization that takes place during adolescence are still unknown. Environmental influences on brain development are yet another empirical question, thus the age old question of "Is it nature or nurture….or both?" The study of neural development during adolescence will likely have important implications for society in general, and school counselors more specifically. As technology continues to

better equip scientists to study not just the structure, but also the function of the brain, more will be known about how best to provide essential counseling services to this population. It is imperative for PSCs to stay up with research as it becomes available. School counselors, through their comprehensive programs and making this knowledge available to teachers, administrators, parents, and students will undoubtedly improve the quality of counseling, educational services, and parenting.

## Conclusion

Neuroscience confirms that adolescent brains are still under construction. No longer can school counselors, teachers, administrators, or parents blame hormones for what is typically considered the normal adolescent angst. Adolescence is an evolution, and current research suggests that brain growth and change is a major factor in a teen's development (Spinks, 2000). School personnel working with adolescents must be aware of current research to be effective. As Gorman (2006, p. 34) states, "You can't change what's physically happening within a teen's brain, but you can use this information to change how you react and respond by developing a method for working with teens that'll help them rather than send them racing out the door." The profound neurological and biological changes taking place in their brains makes adolescents more understandable and logical. Their unpredictable behavior is really very normal.

School counselors must know and understand recent research on adolescent brain development and provide a comprehensive developmental secondary school counseling program that is "brain appropriate."

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