Adolescent Brain Development: Understanding the Impact of Technology Use

A Literature Review

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Abstract

The adolescent brain undergoes major developments that affect teenagers’ self-identity, decision-making, emotions, and sociomoral judgment. Recent brain research shows the underlying neural mechanisms and connections of the adolescent brain providing a foundation for understanding adolescent behavior. Teens are increasing their use of technology and making decisions that affect their overall well-being. Teenagers who share inappropriate, private, or harmful information online risk facing consequences from schools and the law. Many teenagers do not know about the long-term consequences of inappropriate technology use and the impact on reputation that is so critical to adolescents. Technology and social media use are essential to teenagers and provide significance to their personal and social lives more than any other generation. Equipping teenagers with the knowledge base of how their brains work during times of stress, decision-making, and under peer influence helps to increase their overall well-being and academic success. Wellness education in schools provides a holistic preventive framework that benefits students, teachers, and families. These types of programs include student learning on brain signals, emotion identification and management, mental health, and identifying appropriate resources. Teenagers who have knowledge of how their brain connects to their thoughts, feelings, and actions will ultimately have better mental health and overall academic success.
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Adolescent Brain Development: Understanding the Impact of Technology Use

**Adolescent Brain Development**

Adolescents undergo dramatic changes in identity, self-consciousness, cognitive flexibility, and decision-making as they transition from childhood to adulthood. Over the past ten years, research has significantly increased in the areas of neural development during puberty and adolescence. Before this surge in empirical research, very little was known about brain development after childhood (Blakemore & Choudhury, 2006). Early studies show that the structure of the prefrontal cortex (PFC) significantly changes in adolescence. These changes include the development of gray matter volume following an inverted U-shaped trajectory, which peaks in early adolescence, and slowly declines into early adulthood (Blakemore & Robbins, 2012). The inverted U-shaped trajectory is associated with cognitive and emotional function. The second major change that occurs in the PFC during puberty is a rapid increase of synapses in the subgranular layers. After puberty, these synapses undergo an elimination and reorganization, or pruning process (Blakemore & Choudhury, 2006). These major changes factor in to adolescent decision-making, reward processing, executive function, and emotions.

The hormonal events of puberty trigger a period of structural reorganization and plasticity in the brain (Blakemore, Burnett, & Dahl, 2010). Research done by Giedd et al. found that the volume of grey matter in the frontal lobe increased during pre-adolescence with a peak at 12 years old for males and 11 years old for females. Then, there was a decline during post-adolescence. There was a similar pattern in the parietal-lobe grey matter (as cited by Blakemore & Choudhury, 2006). The parietal-lobe processes sensory information related to taste, temperature, and touch (Cortex and Lobes of the Brain, n.d.). In the temporal lobe, which is responsible for processing auditory information from the ears, Giedd et al. found that grey matter
peaked at 17 years old (as cited by Blakemore & Choudhury, 2006). Gogtay et al. found that sensory and motor brain regions matured first, followed by the remainder of the cortex. This maturing process starts in the back of the brain and moves forward, ending in the superior temporal cortex (as cited by Blakemore & Choudhury, 2006). Research done by Solwell et al. found that the loss of grey matter in the frontal cortex sped up during adulthood between the early 20’s up to the age of 30 (as cited by Blakemore & Choudhury, 2006). In other words, the PFC continues to mature until approximately 30 years of age.

To summarize, the adolescent brain undergoes a structural reorganization and plasticity in the brain during puberty. The maturing process in the brain starts in the back of the brain and moves forward, ending in the prefrontal cortex (Blakemore & Choudhury, 2006). At puberty, grey matter is found in several regions of the brain, including the PFC. This means that complex functions such as cognitive flexibility, working memory, social cognition, and sociomoral judgment slowly mature during adolescence (Barrasso-Catanzaro & Eslinger, 2016). White matter on the brain shows sophisticated transmission of neuronal signals that ultimately means better and clearer decision-making. Environmental and social experiences in a teen’s life shape the white matter connections formed during the pruning process in adolescence (Mills, Lalonde, Clasen, Giedd, & Blakemore, 2014). Having a base understanding of adolescent brain development is important in understanding teen decision making, sociomoral judgment, peer relationships and influence, and maturing executive function skills. Additionally, this emerging research is important when considering social and emotional education for teens. Mills et al. (2014) provide an underlying neural mechanism explanation for behaviors common in adolescence. It is also an important factor to consider when examining the impact of technology on the adolescent brain.
Prefrontal Cortex

The PFC is the biggest lobe of the human brain, and contains the most complex types of synaptic patterns that interconnect neurons (Barraso-Catanzaro & Eslinger, 2016). This is one of the most critical areas of the brain used in decision-making. It has a particular impact on adolescents, especially as the use of technology and social media has skyrocketed for this age group. The PFC receives communication from all of the senses and other cortical related areas. The development of the PFC matures slowly, at least into the late 20’s (Barraso-Catanzaro & Eslinger, 2016). Since this region of the brain is changing, the cognitive abilities that rely on the PFC change too. Executive function skills are the cognitive abilities found in the PFC. These skills include selective attention, decision-making, voluntary response inhibition, and working memory. (Blakemore & Choudhury, 2006) Different parts of executive function have different developmental trajectories. This is because development relates to the pruning and myelination process happening in adolescence in the frontal cortex (Blakemore & Choudhury, 2006).

Executive Function

Executive function includes three dimensions: representational knowledge, operational processes, and self-regulation. Representational knowledge includes the acquired knowledge regarding actions, rules, conventions, and cultural norms carried out in daily life within the family and community (Barraso-Catanzaro & Eslinger, 2016). Additionally, it includes abstraction and theory of mind. Operational processes include planning, organization, attention control, working memory, and sequencing that connect intentions to goals and actions over time and space (Barraso-Catanzaro & Eslinger, 2016). Several behavioral studies, as outlined by Blakemore and Choudhury (2006), found that inhibitory control, processing speed, working memory, and decision-making continues to develop over adolescence. Luna et al. showed that
performance on an oculomotor task makes a large improvement from childhood to adolescence, followed by a plateau between adolescence and adulthood (as cited by Blakemore & Choudhury, 2006). Self-regulation functions include self-awareness, initiation, sustained action, inhibitory control, shifting thought, and actions/set shifting (Barrasso-Catanzaro & Eslinger, 2016).

Executive function approaches multiple courses of information processing and experiences, and may interact with all available mental resources during decision-making and goal attainment.

Given the development of executive function, there is an impact on the developmental psychosocial process that is critical to maturation. These developmental psychosocial processes include empathy, identity formation, moral maturity, and vocational maturity. Developing empathy requires cognitive flexibility and perspective-taking ability (Barrasso-Catanzaro & Eslinger, 2016). Identity formation requires impulse control, integration of feedback over time, synthesis of multiple pieces of information, and self-monitoring. Moral maturity requires the executive function skills of symbolic thinking, consideration of different possibilities, anticipating consequences among alternatives, and weighing various costs-benefits of decisions. Vocational maturity requires planfulness, time perspectives, decision-making, and goal orientation. The development of these capabilities depends on the anatomic and physiological integrity of specific brain regions and their connections, which is often called the “social brain” or “mentalizing network” (Barrasso-Catanzaro & Eslinger, 2016, p.109).

**Mentalizing**

“Mentalizing is the ability to infer the intentions, beliefs and desires of others to predict their behavior, and is fundamental to human development” (Mills, Lalonde, Clasen, Giedd, and Blakemore, 2014, p. 2). The network of brain regions that is known to be connected to social cognition is the medial prefrontal cortex (mPFC), temporoparietal junction (TPJ), posterior
superior temporal sulcus (pSTS), and anterior temporal cortex (ATC) (Mills et al., 2014). The role of the mPFC is to learn associations between context, locations, events, and corresponding adaptive responses, specifically emotional responses. It mediates decision-making and it is involved in the retrieval of remote long-term memory (Euston, Gruber, & McNaughton, 2012). It is active when inferring the mental states of others, reflecting on knowledge of another’s traits, and reflecting on one’s own traits (Mills et al., 2014). The TPJ is involved with theory-of-mind, or taking another person’s mental perspective. The TPJ activates when thinking of strategies of other players in a game (Fehr, 2009). The pSTS is one of the core structures for theory of mind and is essential for speech processing and processing of faces (Hein & Knight, 2008). The pSTS is involved in decoding complex social gestures conveyed through eye gaze and body movement (Mills et al. 2014). Finally, the ATC is critical for semantic memory, which includes knowledge of objects, people, words, and facts (Bonner & Price, 2013). The ATC is involved in interpreting social narratives and processing social scripts (Mills et al., 2014). Social narratives are visually represented stories that describe social situations and socially appropriate response or behaviors. A social script is a series of behaviors, actions, and consequences expected in a specific situation or environment. People learn from experiences and use these expectations to build scripts to make things easier cognitively (Social Script, n.d.). Technology use, specifically social media use, shape teenagers’ experiences and social scripts. This is important information to consider as adolescents mature and make decisions with technology.

Mills et al. (2014) showed that mPFC, TPJ, and pSTS reach a peak in grey matter volume during childhood, followed by a decrease in adolescence, and leveling off in early adulthood. The ATC increased in grey matter volume until adolescence before gradually decreasing and leveling off in the mid-twenties. Given this difference, Mills et al. (2014) concluded that the late
myelination of ATC projections allowed for a longer window for learning social scripts. Social scripts and narratives influence adolescents’ moral judgments and reasoning. Research conducted by Barrasso-Catanzaro and Eslinger (2016) with adolescents age 9-17, attempted to show the relationship between PFC and sociomoral tasks. Barrasso-Catanzaro and Eslinger (2016) concluded that during moral ambiguous situations, there was robust activity in the PFC. However, in situations where subjects were morally certain; there was an increase in activity in the superior temporal lobe, which links well-learned conceptual and rule-based knowledge. Adolescents rely on an immature PFC and limited life experiences to guide them in uncertain situations. Additionally, different parts of the brain that are associated with emotions come into play during ambiguous situations causing teens to act differently from what they may know is right and wrong (Barrasso-Catanzaro & Eslinger, 2016).

Why are there discrepancies between a teen’s tested knowledge of moral right and wrong and actions that are contrary? Barasso-Catanzaro and Eslinger (2016) pointed to the emergence of executive function skills that provide the necessary skills to direct a teen’s actions in the face of ambiguous situations. Older adolescents manage simple sociomoral judgments with less emotion and spread of activity, likely due to their experiences (Barrasso-Catanzaro & Eslinger, 2016). Thomas et al. (2001) conducted research with adults and young adolescents by studying amygdala activation to fearful facial expressions. The amygdala is associated with emotion processing. The adults showed greater amygdala activation to fearful facial expressions. Young adolescents showed greater amygdala activation in neutral faces. Thomas, Drevets, Whalen, Eccard, Dahl, Ryan, and Casey (2001) think this is because of the ambiguous nature of the neutral facial expressions. Again, this shows the heightened emotional response to ambiguous situations in adolescents, due in part to their lack of experiences and developing brains.
The PFC is a critical part of the brain that is necessary in decision-making. It is particularly impactful for adolescents as this part of the brain slowly matures until approximately 30 years of age. Executive function skills are cognitive abilities that rely on the PFC and they develop and refine as the brain matures. Many important skills such as working memory, inhibitory control, self-awareness abilities, planning, organization, and attention control are part of executive function skills. (Thomas et al., 2001) Another critical piece of development throughout adolescence is the maturity of the mentalizing network. The mentalizing network is formed by connections between the PFC and other areas of the brain that assist in decision-making, reflecting on others and one’s self, processing and decoding social gestures, and interpreting social narratives and scripts. The main objective of a mentalizing network is to understand and predict the beliefs and desires of other people and relate that information to one’s self (Thomas et al., 2001). The mentalizing network helps people make moral judgments and decisions. Given this information about the developing adolescent brain, teens make decisions with an immature mentalizing network and limited experiences. Additionally, studies have shown that in morally uncertain situations, younger teens rely on heightened emotions to make decisions (Thomas et al., 2001). This information provides an underlying neural explanation for teenage behaviors. This information is a critical component of social emotional education for teenagers especially as they make decisions regarding technology and social media that can have lasting impacts.

The PFC & Reward Processing

Adolescence is a time of social identity formation as teenagers learn to integrate the perspectives of others with their own (Welborn et al., 2016). Teenagers’ peers, parents, and guardians influence their emerging sense of self. A unique feature of adolescence is a sharp
increase of concern over social evaluations from childhood, daily self-consciousness, and adolescents interpret themselves as being the target of social evaluations (Somerville et al., 2013). Dynamic features of brain development in adolescence relate to the unique aspects of behavior that emerge during this period, and throughout a lifetime.

Unique interactions between the PFC and striatum form a means by which social-evaluation contexts influence adolescent behavior (Somerville et al., 2013). The striatum is necessary for voluntary motor control. It has been shown to play a part in cognition and reward processes because of its role in movement planning and execution. It is important to understand the properties of the striatum while it engages in social behavior. The striatum contains neurons that signal the social action that will result in own reward. Social rewards and learning in a social context have a controlling influence on the striatum (Baez-Mendoza & Schultz, 2013).

**Social Influence**

Social influence relates to reward processing, more specifically, the need to belong and fit in during adolescence (Blakemore & Mills, 2014). Blakemore and Mills (2014) found that aligning one’s attitudes with his or her peers is rewarding, and is associated with reward regions in the brain. The striatum is composed of three nuclei: caudate, putamen, and ventral striatum. The ventral striatum contains the nucleus accumbens (Baez-Mendoza & Schultz, 2013). Reward learning may have a substantial impact on social influence processes through activity in the PFC and nucleus accumbens (Welborn et al., 2016).

Research conducted by Welborn et al. (2016) aimed to determine the neural mechanisms of social influence of peers and parents. The results showed a diverse set of brain regions implicated in mentalizing, self-control, and reward. During the study, participants received information regarding their own peers’ and parents’ attitudes towards an artwork stimulus. Then,
the participants gave their own feedback regarding the artwork. Welborn et al. (2016) analyzed the interplay between self-control, theory of mind/mentalizing, and reward processing. Welborn et al. (2016) concluded there was activity among the different parts of the brain included in the above analysis of interplay. Social influence in adolescence is a complex process that involves mentalizing, inhibition of one’s own prior attitudes, and the change in attitude that elicits a reward response via the striatum when thinking of peers and parental input (Welborn et al., 2016). Mentalizing is essential for adolescents to process the consequences of their attitudes in an evolving social realm. Self-control skills help adolescents hold back their original thoughts and change them to agree with those of others. Additionally, reward processing may reflect the essential value adolescents place with conforming to their peers, which ultimately enhances the desire to keep conforming through reinforcement learning (Welborn et al., 2016).

Research conducted by Somerville et al. (2013) analyzed the response properties and connectivity of the medial prefrontal cortex (mPFC) during instances of experimentally induced social evaluation in participants ranging in age from 8 to 22.9 years old. Participants believed that there was a small, one way video camera embedded in the head coil of the fMRI scanner. The camera would cycle through settings of ‘off’, ‘warming up’, and ‘on’. During the “on” setting, participants learned that a same sex peer of similar age viewed their images. After the task, participants were asked to rate the extent to which they experienced various emotions including happiness, excitement, nervousness, worry, fear, and embarrassment (Somerville et al., 2013)

The social evaluation task showed an increased rating of self-conscious emotion, or embarrassment, and physiological arousal in adolescents. The peak embarrassment rating was at 17.2 years old (Somerville et al., 2013). Additionally, the mPFC showed elevated responses in
adolescence to the anticipation of the camera turning on and during the “on” stage. Somerville et al. (2013) found nonlinear changes from childhood to young adulthood in self-conscious emotion and emotional arousal during peer evaluation. The non-linear pattern of embarrassment showed that small social-evaluative situations, or the anticipation of them, lead to heightened self-conscious emotion and arousal during adolescence. Another observation found during the study was the sharp rise from late childhood into adolescence of certain mPFC and striatal connectivity. This connection shows the increasing response to peer influence (Somerville et al., 2013). In other words, adolescents may act before they think while being evaluated by peers. An additional outcome of the study was that physiological patterns of embarrassment do not manifest until later in adolescence, because of the emergent perspective taking skills that improve throughout adolescence (Somerville et al., 2013).

Risk Taking

During puberty, hormones change the structure of the reward-related brain (Blakemore, Burnett, & Dahl, 2010). Connections between the nucleus accumbens and dopaminergic pathways to the PFC change at this time. At a primal level, these changes take place to develop a strong motivation to seek out reproductive opportunities (Blakemore, Burnett, & Dahl, 2010). In addition to seeking out these opportunities, adolescents’ inclination for risk-taking and reward-seeking behaviors increase, as well as structural changes in reward circuitry in the brain (Ernst et al., 2005). These structural changes are important to understand adolescents’ decision-making, reduced harm avoidance, and vulnerability for addiction.

A study conducted by Ernst et al. (2005) aimed to show the differences in adult and adolescent brains during reward receipt and reward omission. Participants in the study engaged in a series of gambling activities that included win vs. win games, and win vs. non-win games.
Researchers concluded that adults and adolescents showed similar activation in the amygdala and nucleus accumbens during reward receipt. During omission of rewards, adults showed reductions in activity in the amygdala and nucleus accumbens, with a larger reduction in the amygdala. This shows that not receiving a reward, or receiving a reward smaller than expected, drops dopaminergic activity. Since activation in the amygdala increased more than the nucleus accumbens, adults’ brains warn them to avoid or move away from negative situations (Ernst et al., 2005).

Adolescents showed stronger activity in the nucleus accumbens than the amygdala during reward omissions in the study (Ernst et al., 2005). This shows that there is a greater response to negative feedback in adolescents. The role of the nucleus accumbens is to permit or motivate humans to choose the most opportune choice. Adolescents are more likely to approach a situation and use less of the amygdala to warn them when to move away from negative situations. This study helped show the maturation process the brain takes in adolescence concerning decision-making (Ernst et al., 2005).

Emerging Research

Zhang, Japee, Safiullah, Mlynaryk, and Ungerleider (2016) used functional Magnetic Resonance Imaging (fMRI) to measure brain activity with a group of adults while viewing emotionally loaded stimuli. The fMRI measured the size of the attention field of the person based on viewing positive or negative images. When a subject observed a smiling face, their attention field broadened. Oppositely, when a subject viewed a frowning face, the attention field narrowed. The effects of emotional valence on the size of the attention fields relate to the prefrontal cortex, which contributes to working memory, cognitive flexibility, planning, and abstract reasoning. The interaction between emotions and attention shape adults’ life experiences.
Further research is necessary on the PFC and attention while viewing emotionally loaded stimuli with adolescents, given their executive function and empathy development. Additionally, brain research on the PFC and attention while viewing positive and negative images may provide further insight into the neural mechanisms that occur while teenagers view photos on social media sites and how it influences their self-identity.

Adolescent Brain Summary

Adolescence is a transformative time as the brain undergoes major changes as it matures. This maturing process starts in the back of the brain and moves forward, ending in the superior temporal cortex (Blakemore & Choudhury, 2006). During the maturing process, a major pruning process occurs in several areas of the brain. The pruning process relates to the types of experiences a person has. This information is important, as it shows the long-lasting effects of experiences during adolescence and the imprint they leave on the brain (Blakemore & Choudhury, 2006). The PFC is the slowest part of the brain to develop, which explains the slow development of many executive function skills in adolescence (Barrasso-Catanzaro & Eslinger, 2016). Compared to adults, adolescents use less of their PFC and more of their amygdala when facing ambiguous situations (Thomas et al., 2001). Additionally, adolescents use their reward-center brain more than adults do during risk-taking activities, particularly when peers were involved (Somerville et al., 2013). With all of this emerging research, it is critical to connect adolescent brain development with the most recent and largest change in society, the increased use of technology.
Adolescent Brain Development and Technology

According to research done by Pew Research Center, 56% of teens, ages 13-17 years old go online several times a day (Lenhart, 2015). According to the study, 71% of teens use more than one social network site and African-American and Hispanic teens report using the internet more frequently than White teens. Roughly, 90% of teens have access to smartphones and 33% of teens have smartphones with social media apps such as Facebook, Instagram, SnapChat, and Kik accessible on them (Lenhart, 2015). With this explosion of technology and the emerging research on adolescent brain development, what drives teens to use social media and how do they make decisions about what they are posting? Are they really becoming addicted? Additionally, what types of education help teens stay safe? These are important questions to consider since teens spend so many hours on technology during a time of major brain development.

Decision-Making

Teens rely on emotion rather than sociomoral judgment in ambiguous situations (Barrasso-Catanzaro & Eslinger, 2016). Additionally, teens are more sensitive to the reward center of the brain and are more apt to take risks, especially when they know peers are involved (Weigard, Chein, Albert, Smith, & Steinberg, 2014). Social media sites provide ambiguous situations for teens all while knowing their peers will be watching and potentially commenting or “liking” their input. Weigard et al. (2014) showed that adolescent risk-taking increased in the face of anonymous peers from afar. The participants knew very little about the peer who would be observing them from afar, and it still had an effect on their willingness to share information. Weigard et al. (2014) concluded the increase in reward sensitivity caused by the presence of peers was not due to the consideration of the friends’ values and attitudes. The reward center of the brain is so sensitive during adolescence; it is one of the main drivers of decision-making.
Sherman, Payton, Hernandez, Greenfield, and Dapretto (2016) analyzed brain activity with fMRI while teenage participants viewed their own photos with a certain amount of “likes”. Thirty-two teenagers, 13-18 years old, participated in a social networking site, comparable to Instagram. They viewed 148 photos on a computer screen, including 40 photos each teenager had submitted. Each photo included the number of likes it had received from other anonymous teenagers when, in reality, the researchers assigned the likes. When teenagers viewed their own photo with a large amount of likes, the nucleus accumbens was very active as seen in the fMRI. When given the chance to “like” photos, teenagers were more apt to “like” a photo if the photo had many likes rather than a few. Additionally, when viewing risky photos compared with neutral photos, the brain showed less activation in the anterior cingulate cortex, bilateral prefrontal cortices, and lateral parietal cortices (Sherman, Payton, Hernandez, Greenfield, & Dapretto, 2016). The anterior cingulate cortex has a role in rational cognitive functions such as reward anticipation, decision-making, empathy, and emotion (Anterior Cingulate Cortex, n.d.). The lateral parietal cortex is involved with self-processing and the PFC is involved with several executive functions. Sherman et al. (2016) showed the sensitivity of reward processing during decision-making and the importance of peer conformity and acceptance during adolescence. Sherman et al. (2016) also showed the importance and addicting nature of receiving “likes” on social media sites, even if a teenager does not know the person “liking” the photo.

**Sharing Information**

Understanding the underlying neural mechanisms of sharing self-related information online and the maturing adolescent brain provides insight into why teenagers may share private or inappropriate information. Meshi et al. (2016) conducted research with young adults to examine the intrinsic functional connectivity of certain brain regions when sharing self-related
information. The prefrontal cortex (PFC), central precuneus (CP), and anterior cingulate cortex (ACC) interconnect when sharing self-related information. The CP is associated with many resting state functions and the recall of autobiographical memories. Tamir and Mitchell conducted research to determine connectivity while sharing self-related information and that study examined the PFC and nucleus accumbens (as cited by Meshi et al., 2016). Tamir and Mitchell found activation and connectivity between these two areas, which is important as it shows the rewarding nature of posting information online (as cited by Meshi et al., 2016). Meshi et al. (2016) found connectivity in the PFC and CP, but not in the ACC. Meshi et al. (2016) conclude that many executive function skills contribute to deciding whether to share personal information on social media, including working memory. Essentially, Meshi et al. (2016) showed that adults need to think about others and how they may react, also known as mentalizing, when sharing self-related information. Mentalizing is an important part of self-disclosure and helps people process the consequences of attitudes in an evolving social realm (Welborn et al., 2016).

Meshi et al. (2016) included only adult participants in their study. The adults relied on a developed PFC and CP, a mature mentalizing system, and years of experiences to help them decide to share self-related information on social media. Since adolescent brains are maturing, and the PFC takes the slowest to mature, adolescents rely on an immature mentalizing system, limited experiences, and a reward focused brain when processing sharing self-related information on social media. (Meshi et al., 2016) This could provide an underlying neural explanation as to why teenagers inappropriately share private information, cyberbully, sext or send nude photographs, and engage in other online risky behaviors when compared to adults.
Is it Addiction?

Since the reward center of the brain is so sensitive during adolescence, many people have concluded, or have self-identified as addicted to social media (Turel, He, Xue, Xiao, & Bechara, 2014). Turel, He, Xue, Xiao, and Bechara (2014) conducted research to determine how technology-related addictions compare to substance and gambling addictions. Their study focused on participants with a perceived Facebook addiction as indicated by certain symptoms such as dependence on Facebook, tolerance, withdrawal, and loss of control to the point that the behavior caused a significant impairment to the individual (Turel et al., 2014). Turel et al. (2014) aimed to find the underlying neural systems affected by different addictions. Two parts of the brain were analyzed, the impulsive, amygdala-striatal system and the reflective-inhibitory prefrontal brain system. Turel et al. (2014) found the impulsive brain system was positively associated with a person’s Facebook addiction score. However, there was no association between this score and activation of the prefrontal cortex brain system. Therefore, individuals with low to medium Facebook addiction have addiction-like symptoms because of a hyperactive amygdala-striatal system, but they do not have a hypoactive prefrontal lobe inhibition system that occurs in substance and gambling addictions (Turel et al., 2014). This research is important in understanding the neural basis and addictive symptoms adolescents face when over-using technology. Additionally, Turel et al. (2014) concluded that those with Facebook addiction might respond well to cognitive behavioral therapy to break their bad habits. Additionally, this information is important when distinguishing technology-related addictions from substance and gambling addictions and the implications of both.
Consequences and Education

Teenagers’ use of technology and social media is ever evolving, and lawmakers, parents, and schools seem to be playing catch up to the changing times. Knowing the underlying neural mechanisms of the adolescent brain is important when adults are establishing laws, rules, guidelines, and educational plans regarding technology and social media. Additionally, adolescents should be educated on the potential consequences of violating certain rules, laws, and guidelines. Educating adolescents on the neural mechanisms of their brains in a developmentally appropriate way will help normalize their feelings (Centre for Studies on Human Stress, 2012). Identifying connections between the brain and emotions will also help adolescents understand their decision-making as it relates to technology use, social media, and decision-making. Finally, encouraging teenagers to set limits on technology, recognize symptoms of social media “addiction”, as well as finding belonging in real world places other than virtual realms is an important piece of social media education. England is progressing quickly in this area. In 2018, England will mandate all schools including public, academies, independent schools, and religious-free schools to provide sex education, which will include cyber-bullying, sexting, online safety, and internet porn (Turner, 2017). England sees the necessity of educating students on these issues.

The Law

Social media education for teens should include information on certain laws that could affect them. Of particular importance are laws surrounding sexting, sending nude photographs, and inappropriate communication on social media. Rice et al. found that 15% of 1,839 youth ages 14-17 years old had engaged in sexting (as cited in Lorang, McNiel, & Binder, 2016). A study conducted by Strassberg et al. found nearly 20% of 606 high school student participants
had sent sexually explicit images of themselves. Additionally, 38% of these students had received a sexually explicit image, and 24% of them had forwarded images to others (as cited in Lorang, McNiel, & Binder, 2016).

Each state has its own laws regarding sexting and the transmission of sexually explicit images by minors. For instance, in Pennsylvania, it is illegal for a minor, anyone between the ages of 12-18, to send an electronic message with a nude picture of himself/herself to anyone else between the ages of 12-18 (Kulick, 2014). Most states omit adolescents from the same laws enacted to protect them from adult perpetrators who engage in child pornography (Lorang, McNiel, & Binder, 2016). Teenagers who use cell phones to take, send, or keep a sexually explicit photo of themselves, or a friend, break the law per Federal Child Pornography Laws (The United States Department of Justice, 2015). Additionally, the adult who owns the cell phone or cell phone plan the teenager uses can be charged under the child pornography laws and have to register as a sex offender (Theodore, 2011). A few states have enacted laws that consider a minor’s age and context of the situation. Additionally, most cases that go to court regarding sexting or sharing nude photographs between minors get dismissed (Lorang, McNiel, & Binder, 2016). This is because child pornography laws were created to handle cases of adults exploiting children and adolescents rather than to handle sexting cases between adolescents.

Under Minnesota Statutes Use of Minors in Sexual Performance Prohibited and Possession of Pornographic Work Involving Minors (2016), the sending and receiving of nude and suggestive photos of teenagers are included in child pornography laws. It is a crime to possess or distribute sexually explicit or nude and suggestive photos or videos of any child under 18 years of age. For example, if someone takes a topless photo of a friend under 18 years old, he or she may receive charges of making child pornography. If that person sends the photo to three
classmates, each classmate may receive charges of possession of child pornography. Even if a minor agrees to take a picture and send it to a friend, but the friend does not request it, he or she may receive charges of child pornography. Again, most of these cases drop because the laws are not appropriate for these types of situations. Child pornography laws do not have specific language pertaining to adolescents who send nude photographs between each other. Child pornography laws typically involve adults who victimize children and adolescents. However, adolescents involved with sending nude photos may receive harassment charges if the distribution of the photo was malicious (Lorang, McNiel, & Binder, 2016). It is important that adolescents are aware of the severe consequences of sexting. Additionally, it is critical for lawmakers to create appropriate laws and consequences for adolescents who engage in inappropriate and malicious sexting activities. It is also another reason for schools to handle sexting situations within the school, and only use law enforcement for extreme cases.

In other areas of the law, adolescent brain development is a consideration when developing laws and punishments, and sexting/child pornography should follow suit (Lorang, McNiel, & Binder, 2016). Adolescents have an immature mentalizing system, and rely on a sensitive reward-processing center when making decisions, instead of making sound sociomoral judgments in highly charged situations (Barrasso-Catanzaro & Eslinger, 2016). Additionally, further research into effective forms of education for minors about sexting may help decrease the number of minors involved in legal problems (Lorang, McNiel, & Binder, 2016).

The Power of What is Written

In ambiguous situations, adolescents rely on emotions, peer evaluation, and potential reward incentives to make decisions (Somerville et al., 2013). Social media sites provide an ambiguous platform with constant peer attention and immediate reward processing. It is no
wonder teenagers post private, inappropriate, and harmful information on social media sites. However, these postings can have lasting consequences. In 2014, a Minnesota high school senior responded to a question on the Rogers Confessions website that landed him in a lot of trouble. The question asked, “Did he ever make out” with a 28-year old teacher at the school. His answer was, “Actually, yeah” (Kulick, 2014). The student’s post was a joke, and he did not mean for anyone to believe it. His consequence included a ten-day suspension for threatening, intimidating or assault of a teacher. His parents are upset because the actions taken by the high school forever tarnished his online reputation by linking him to a felony charge (Kulick, 2014).

To help combat long-term consequences of inappropriate posts, the state of California enacted an “eraser button” law (Costello, McNiel, & Binder, 2016). Effective January 1, 2015, California law, entitled “Privacy Rights for California Minors in the Digital World” requires websites to allow minors to remove their own postings from the website (as cited by Costello, McNiel, & Binder, 2016). The statute requires the websites to provide clear instructions on how to delete the postings (Costello, McNiel, & Binder, 2016). Other popular sites, such as Twitter and Facebook, allow users to delete postings (Costello, McNiel, & Binder, 2016) In addition to these reactive solutions, parents can provide guidance and education to their children as they have the ultimate right and responsibility of raising their children. The job of the schools is to educate children. To help combat and proactively prevent sexting, social media downfalls and technology safety, schools can enable and encourage responsible online behavior (Costello, McNiel, & Binder, 2016).

**Education**

Currently, there are limited social media educational programs. One reason for this is that sexting and social media etiquette are relatively new phenomenon. Secondly, many schools
believe it is the role of parents and guardians to provide guidance and education on social media (Harris, Davidson, Letourneau, Paternite, & Tusinski-Miofsky, 2013). Lastly, some schools intertwine cyber-bullying into school-wide anti-bullying programs. Cyber-bullying is prevalent, and can go hand-in-hand with sexting and internet porn, but most programs do not include these topics. Common Sense Media provides educational resources for parents, students, and educators (Common Sense Media, n.d.). They provide a Digital Citizenship Curriculum that provides educational classroom lessons for grades K-12. Many of the topics surround internet safety, privacy, digital footprint, oversharing, copyrights, cyber-bullying, digital drama, building online relationships, and a lesson on sexting for grades 9-12 (Common Sense Media, n.d.). Howard Gardner at Harvard Graduate School of Education created the GoodPlay Project curriculum in 2009 (as cited by Common Sense Media, n.d.). The curriculum resources were developed and supported by many foundations which enables Common Sense Media to offer the curriculum to educators for free (Common Sense Media, n.d.).

Harris, Davidson, Letourneau, Paternite, and Tusinski-Miofsky (2013) received a grant from the Office of Juvenile Justice and Delinquency Prevention, Office of Justice Programs, U.S. Department of Justice to address teen sexting behaviors and building a prevention framework. Harris et al. (2013) interviewed adolescents, parents, school professionals, law enforcement, and community mental health providers to gain their perspective on sexting, education, and prevention. Harris et al. (2013) asked participants to define sexting and many people were unsure of how to define it specifically. Many participants knew it had something to do with inappropriate pictures, but some wondered if inappropriate sexual language was sexting. One parent wondered who makes the decision whether a picture is suggestive enough to be qualified as sexting. When Harris et al. (2013) asked about consequences and laws surrounding sexting,
many adolescents were unaware of the severe consequences of the law under child pornography laws. Some parents had heard of news stories and understood the nature of the laws. School personnel indicated they were aware of some laws and school policies (Harris et al., 2013).

Harris et al. (2013) asked participants whom they would seek guidance from regarding sexting, many adolescents said they would not seek out an adult unless something was out of control. One student indicated they would not tell their school counselor as the counselor would have to tell parents and this would create an uncomfortable situation for the student. One counselor indicated that adolescents seek him or her out to talk openly about sexting. Many teens talked about the embarrassment and loss of respect if peers or adults were to find out. Parents expressed their hopes that their children would come to them with questions and concerns. Law enforcement officials responded that adolescents who have a trusted adult to speak with are less likely to get in to legal trouble (Harris et al., 2013). Finally, when participants responded to questions about education regarding sexting, many adolescents indicated they would prefer to hear real-world experiences from students their own age. Parents indicated parental responsibility in addition to education in the schools. School personnel referenced cyber-bullying efforts, but they also indicated that adding on another educational prevention program would be very difficult to implement given the plethora of other expectations and responsibilities in their workload (Harris et al., 2013).

Given all of the information collected from research, interviews, review of policies, laws, adolescent development, and trends in technology use, Harris et al. (2013) addressed several factors to build a prevention framework for sexting behaviors. Harris et al. (2013) referenced adolescent brain development and the increased risk-taking behaviors in combination with the developing prefrontal cortex that are common to adolescents while trying to make sociomoral
judgments. Harris et al. (2013) acknowledged the need for laws to change surrounding teen sexting, and used adolescent brain development as the basis. Other ambiguous areas that Harris et al. (2013) found included defining sexting, situational context, interpersonal and psychological dynamics, mutual interest, indirect participants, developmental context, and environmental context.

The environmental context includes the various spheres of influence that may affect teen decision-making about sexting and related behaviors (Harris et al., 2013). The three broad domains are interpersonal (family, peers, and community), extrinsic (media, popular culture, and communication technology), and institutional (schools, legal institutions, and community institutions). Harris et al. (2013) indicated the institutional domain served as the catalyst for defining and implementing public policies and practices related to teen sexting and associated issues. Harris et al. (2013) found that schools emphasized the amount of time spent reacting and responding to sexting incidents, rather than focusing on prevention initiatives. Harris et al. (2013) acknowledge and see the overwhelming amount of responsibilities that schools take on. Harris et al. (2013) recommended and promoted the importance of embracing a holistic view grounded in promoting healthy youth development. Instead of burdening schools with another prevention program, Harris et al. (2013) suggested schools adapt a schoolwide healthy youth development programs. Many of the underlying factors that drive teens to sext are the same reasons they engage in other unhealthy behaviors that are common in adolescence (Harris et al., 2013). Some of these underlying factors include a lack of belonging, untreated mental illness, and peer pressure. For example, teenagers who try drugs do it because they want to fit in. Additionally, teens use drugs to help them feel better as they are depressed or anxious (National Institute on Drug Abuse, 2014). Similarly, teens reported they sext or engage in risky online
behavior because of peer motivation. Another motivating factor is the immediate gratification and attention teens receive from inappropriate postings and messages (Harris et al., 2013). Although this attention may be positive at first, it quickly becomes negative, similar to the downward spiral of drug abuse.

Goals of programs, such as Social Emotional Learning (SEL), that promote healthy youth development include healthy sexual relationships and modes of self-expression, encouraging tolerance, and respect for others, fostering emotional resilience, and improving teens’ capacity to navigate difficult social terrain and situations (Harris et al., 2013). The Collaborative for Academic, Social, and Emotional Learning provides SEL-based interventions that include classroom-based curriculum, school-based student supports, and partnerships with families and youth-serving agencies in the community (as cited by Harris et al., 2013). Durlak, Weissberg, Dymnicki, Taylor, and Schellinger found that students who participated in SEL interventions had fewer behavioral issues, lower levels of emotional distress, and increased academic success (as cited by Harris et al., 2013). Students learn self-awareness, self-management, social awareness, relationship skills, and responsible decision-making. Ultimately, this preventative education lowers the risk of unhealthy behaviors and greater school success (Harris et al., 2013).

Adlerian Consideration

Many Adlerian principles such as belonging, contribution, encouragement, and community feeling, complement the idea of promoting a holistic, healthy youth developmental education as a means to deter adolescents from engaging in risky behaviors, such as sexting (Griffith & Powers, 2007). Emerging brain research shows the remarkable maturation process the brain undergoes during adolescence. Even though this research was not available to Adler
during his time, Adler still saw the uniqueness of this time in a person’s life. Adler indicated that a “great portion of responsibility for the success or failure of young people in their socio-sexual adaptations resides in the encouragement (or lack of it) they receive from parents and other teachers” (as cited in Griffith & Powers, 2007, p. 2). The power of encouragement during adolescence is a positive tool to use to promote healthy development. Blakemore and Mills (2014) have shown the neural mechanisms that underlie the importance of peer acceptance and conformity during adolescence. Issues surrounding social media and sexting can exacerbate an already vulnerable adolescent’s self-esteem (Banyai et al., 2017). Banyai et al. (2017) conducted a study connecting the amount of time spent on Facebook and overall well-being. Banyai et al. (2017) found that adolescents who used Facebook the most showed the lowest self-esteem and the highest level of depressive symptoms. Adlerian theory indicates that a healthy self-esteem relates to a satisfactory self-concept. Positive self-esteem is a result from activity on the useful side of life. Ultimately, activities that allow for belonging and contributing to the greater good of the community foster a healthy self-esteem (Griffith & Powers, 2007). Behavior that is on the useful side of life means a person is acting in a cooperative way towards the common good. People who have useless behavior promotes himself or herself, often times by criticizing others and degrading themselves. An adolescent who has behavior on the useful side finds acceptance through belonging and contribution in the community, family, and school (Dreikurs, Grunwald, & Pepper, 1998).

Adolescents act on the useful or useless side of life every day, including how they use technology. Teenagers use technology in a useful way by strengthening social connections with friends and family. Additionally, teens can use social media to promote positive community and
school events. Oppositely, teenagers use social media in a useless way by degrading others, or by engaging in risky behaviors, such as sharing nude pictures (Banyai et al., 2017).

Adolescents’ brains are sensitive to rewards and the feedback received in social situations (Somerville et al., 2013). As part of a healthy youth development, teens should be encouraged by parents, educators, and peers to make healthy sexual relationship decisions and modes of expression (Harris et al., 2013). Ultimately, teenagers’ brains receive reward feedback for positive decision-making while making choices on the useful side of life (Somerville et al., 2013).

School counselors can provide open environments for students to discuss issues surrounding development, such as sexting. Promoting community feeling in the school and larger community for students to belong and contribute will help them develop courage and resiliency (Dreikurs, Grunwald, & Pepper, 1998). For example, adolescents who have special jobs in the school or belong to special interest groups within the school or community feel that they are valued. If the adolescent feels valued, he or she is less likely to get discouraged and lose his or her sense of belonging when mistakes happen (Dreikurs, Grunwald, & Pepper, 1998). Schools can create environments that bring students together to solve problems and build community. Such environments allow students to make mistakes, and not suffer consequences that are long lasting. Adler, and those that have followed his work such as Rudolf Dreikurs and Jane Nelsen, emphasized the need for the courage to be imperfect (Dreikurs, Grunwald, Pepper, 1998; Nelsen, Lott, & Glenn, 2000). Having the courage to be imperfect is realizing that someone is good enough as he/she is (Griffith & Powers, 2007). During adolescence, teenagers’ brains are developing necessary social skills such as empathy, self-control, social awareness, and working memory (Barrasso-Catanzaro & Eslinger, 2016). At this critical time in brain development,
Nelsen, Lott, and Glenn (2000) indicates the importance of children and adolescents learning strong interpersonal, intrapersonal, systemic, and judgment skills. These skills promote self-control, self-discipline, sharing, empathizing, adaptability, flexibility, and applying wisdom to evaluate situations (Nelsen, Lott, & Glenn, 2000). Fostering these social skills is critical to healthy brain development and ultimately a healthy self-esteem.

During adolescence, teens are constantly comparing and judging themselves and others. Social media exasperates these feelings and many teens find themselves making decisions in the useless side of life. Banyai et al. (2017) found that high amounts of Facebook use is connected to low self-esteem and increased depressive symptoms in adolescents. When teenagers have low self-esteem and are discouraged, they make choices that are unhealthy and do not promote the greater good of the community (Dreikurs, Grunwald, & Pepper, 1998). When mistakes happen, educators can help teenagers see their mistake as separate from their self-worth. If an adolescent refuses to do homework or take a test, a teacher or school counselor can sit down with the student to understand the issue and navigate the outcomes of the behavior. If the student finds a place to belong, such as a special interest club, then he or she will feel belonging at the school and will lead to more effort in the classroom (Dreikurs, Grunwald, & Pepper, 1998). With encouragement resiliency grows, which is necessary for a healthy life. Encouragement helps an adolescent find inner-strength and the courage to handle the difficulties in life (Dreikurs, Grunwald, & Pepper, 1998).

**Interventions**

Finding an appropriate research-based curriculum to educate adolescents on their brain development as it relates to decision-making, emotions, and wellness is critical to healthy adolescent development. Curriculum must be developmentally appropriate and fit into core
learning in the classroom. Project School Wellness is a wellness education curriculum that focuses on strengthening students’ social well-being, which ultimately increases their academic success. (Kay, 2016). Project School Wellness provides a school-wide program of wellness that reaches every student. The curriculum offers school-wide curriculum, small group activities, and one-to-one teacher or counselor and student activities and ideas (Kay, 2016). Project School Wellness aligns with the American School Counselor Association (ASCA) framework to provide counseling services to each student (ASCA, 2012).

Project School Wellness provides curriculum for teachers that align with their core learning and reinforces a common wellness language (Kay, 2016). There are ideas to help school counselors expand their wellness education as part of their comprehensive school counseling program. Some of these ideas include advisory activities, emotional health, and school wellness lesson plans. Finally, there is information for administrators about community and school relationships, school-wide initiatives, parent-teacher connection, and student-teacher connection (Kay, 2016).

Project School Wellness has a mental and emotional health curriculum for middle school students (Kay, 2016). The curriculum uses parts of the movie Inside Out to help explain the complexities of emotions and how they relate to the brain. The curriculum focuses on explaining how core memories shape personality, understanding how and why personalities evolve and change with age, and building empathy for others. This provides a way to explore brain development as it relates to adolescents’ behavior and emotions. Students learn how to identify emotions based on body language, action, and words (Kay, 2016). One activity has students identify the emotion by writing the purpose of the emotion. Then students write what the emotion sounds like. Finally, students write what the emotion looks like. Since each person is
unique, answers are reflective of each student and how he or she experiences emotions. Students are learning about the signals that their brains are sending them by reflecting, writing, and sharing how their bodies are responding to emotions (Kay, 2016).

Students learn how to express emotions in a healthy and productive way (Kay, 2016). Students write in a booklet about how they express themselves. The booklet offers a place to write down what they are learning and why they are learning it. One journal entry prompts students to write about a time when they expressed themselves in a positive way. There are pre and post worksheet that measure the outcome of student learning and allows schools to collect data on their interventions. Finally, students learn about the connection between mental and emotional well-being and total well-being (Kay, 2016). When adolescents have the underlying neural explanation for their thoughts, emotions, and actions they can problem-solve appropriately and seek help, when needed (Welborn et al., 2016).

Another research-based program that addresses brain development and wellness is Destress for Success (Centre for Studies on Human Stress, 2012). The Centre for Studies on Human Stress created a program for adolescents that shows teenagers the major impact stress can have on their lives, mental health, and cognitive and emotional processing (Centre for Studies on Human Stress, 2012). The program aims to be fun and interactive while de-emphasizing the negative view of stress. Students engage in fun activities such as games, journaling, and experimenting with various destressing techniques. Teenagers learn to identify and listen to signals from the brain that the body sends to prevent and manage stress (Centre for Studies on Human Stress 2012).

Destress for Success is a five-week program that is taught by a trained educator (Centre for Studies on Human Stress, 2012). During the program, students learn the NUTS model
Novelty, Unpredictability, Threat to the self and low Sense of control) which outlines the four universal elements of stress (Centre for Studies on Human Stress, 2012). Additionally, students learn that not every person will perceive every situation in the same way. To help normalize and identify stressful feelings, students learn about different parts of the brain and how they relate to stress. Additionally, students learn coping strategies and the importance of turning to the right people in times of need (Trepanier, 2009). Some of the coping strategies included breathing techniques, physical activity, and identifying areas in life that can be controlled versus areas that cannot be controlled (Centre for Studies on Human Stress, 2012). Identifying appropriate people such as school counselors, teachers, or parents are critical for adolescents to know in times of uncertainty. This is particularly important as teenagers encounter stressful experiences while using technology and social media (Centre for Studies on Human Stress, 2012).

A study conducted by Lupien et al. (2013) measured the impact Destress for Success had on adolescents. The participants of the study were adolescents who were transitioning to high school. This is a particularly stressful time in a teenager’s life, as shown by high levels of cortisol (Lupien et al., 2013). Lupien et al. (2013) concluded that teenagers with high levels of anger responded significantly to the Destress for Success program. Adolescents who participated in the study showed decreased cortisol levels following the completion of the program. Adolescents who did not participate in the program showed increasing levels of cortisol as the transition to high school approached. Overall, this study shows the effectiveness of the program, particularly with students who are lacking in emotional management tools. Students who lacked in tools gained knowledge on stress and reported decreased levels of stress, depression, and improved recognition of joy and increased self-esteem (Lupien et al., 2013). Destress for Success is a short-term intervention that requires a trained teacher to implement. Destress for Success
provides training for teachers who want to implement the program in their classrooms (Centre for Studies on Human Stress, 2012). Destress for Success incorporates adolescent brain development and how it relates to stress and decision-making. Destress for Success educates students about stress and mental health in hopes that they will seek out appropriate help when needed (Centre for Studies on Human Stress, 2012).

**Implementation**

Finding ways to incorporate adolescent brain development curriculum as it relates to decision-making, emotions, and wellness is a challenging task that schools face. Per the American School Counselor Association (ASCA) National Model, school counselors deliver core curriculum via instruction and group activities. Core curriculum includes developmental guidance lessons delivered in the classroom that reaches each student. Classroom lessons focus on social emotional learning as well as addressing specific needs of the school such as alcohol/drug offenses, social media issues, and mental health needs (ASCA, 2012). These direct student services reach every student in the school (ASCA, 2012).

School counselors collaborate with teachers to team teach the school counseling core curriculum (ASCA, 2012). For example, if a school counselor is teaching lessons on mental health, he or she may collaborate with the health teacher to deliver the lesson during health class. Project School Wellness advises teachers to deliver wellness curriculum during health class (Kay, 2016). Wellness curriculum includes learning about mental health, identifying emotions, peer relationship issues, and overall preventative care. Additionally, Project School Wellness provides activities and lessons for school counselors to deliver during an advisory period. These activities include journaling, reflecting, and practicing destressing techniques (Kay, 2016). Advisory period is another time for a school counselor to be in the classroom to deliver lessons.
Finding the right partner in the school to collaborate with to deliver and implement the curriculum is the key to success. Finding a teacher in the school to help deliver wellness curriculum ensures that school counselors have a time and place to reach each student (ASCA, 2012).

**Conclusion**

Adolescents undergo dramatic changes in identity, self-consciousness, cognitive flexibility, and decision-making as they transition from childhood to adulthood (Blakemore & Choudhury, 2006). Brain maturation starts in the back of the brain and moves forward, ending in the superior temporal cortex until approximately 30 years of age (Blakemore & Choudhury, 2006). Environmental and social experiences in a teen’s life shape the white matter connections formed during the pruning process in adolescence (Mills et al., 2014). Having a base understanding of adolescent brain development is important in understanding teen decision making, sociomoral judgment, peer relationships and influence, and maturing executive function skills (Barrasso-Catanzaro & Eslinger, 2016). Additionally, this emerging research is important when considering social and emotional education for teens as it provides an underlying neural mechanism explanation for behaviors common in adolescence. It is also an important factor to consider when examining the impact of technology on the adolescent brain.

Executive function skills are the cognitive abilities found in the PFC (Barrasso-Catanzaro & Eslinger, 2016). These skills include selective attention, decision-making, voluntary response inhibition, and working memory. The development of these capabilities depends on the anatomic and physiological integrity of specific brain regions and their connections, which is often called the “social brain” or “mentalizing network” (Barrasso-Catanzaro & Eslinger, 2016). The main objective of a mentalizing network is to understand and predict the beliefs and desires of other
people and relate that information to oneself (Barrasso-Catanaro & Eslinger, 2016). The mentalizing network helps people make moral judgments and decisions. Given this information about the developing adolescent brain, teens make decisions with an immature mentalizing network and limited experiences. Adolescents rely on an immature PFC and limited life experiences to guide them in uncertain situations, specifically situations surrounding social media and technology use. Older adolescents manage simple sociomoral judgments and uncertain situations with less emotion and spread of activity, likely due to their expanded experiences (Barrasso-Catanaro & Eslinger, 2016). Again, this shows the heightened emotional response to ambiguous situations in adolescence, due in part to their lack of experiences and developing brains.

A unique feature of adolescence is a sharp increase of concern over social evaluations from childhood, daily self-consciousness, and adolescents interpret themselves as being the target of social evaluations (Blakemore & Mills, 2014). Social influence relates to reward processing, more specifically, the need to belong and fit in during adolescence (Blakemore & Mills, 2014). Reward processing reflects the essential value adolescents place with conforming to their peers, which ultimately enhances the desire to keep conforming through reinforcement learning (Welborn et al., 2016). Adolescents may act before they think while being evaluated by peers because of the power of the reward center of the brain (Sherman et al., 2016). Brain research shows this through brain activity while receiving “likes” on social media sites, even if a teenager does not know the person “liking” the photo (Sherman et al., 2016). Teenagers may inappropriately share private information, cyberbully, sext or send nude photographs, and engage in other online risky behaviors as a result of their unique brain development (Harris et al., 2013).
Educating adolescents on the neural mechanisms of their brains in a developmentally appropriate way will help provide an understanding of their feelings (Centre for Studies on Human Stress, 2012). It will also help them understand their decision-making as it relates to technology use, social media, and decision-making. Encouraging teenagers to set limits on technology, recognize symptoms of social media “addiction”, as well as finding belonging in real world places other than virtual realms is an important piece of social media education. In uncertain situations, adolescents rely on emotions, peer evaluation, and potential reward incentives to make decisions (Weigard et al., 2014). Social media sites provide an uncertain platform with constant peer attention and immediate reward processing. It is no wonder teenagers post private, inappropriate, and harmful information on social media sites. However, these postings can have lasting consequences. Common Sense Media provides educational resources for parents, students, and educators. They developed a Digital Citizenship Curriculum that provides educational classroom lessons for grades K-12 (Common Sense Media, n.d.). Finding an appropriate research-based curriculum to educate adolescents on their brain development as it relates to decision-making, emotions, and wellness is critical. Curriculum must be developmentally appropriate and fit in to core learning in the classroom. Project School Wellness is a wellness education curriculum that focuses on strengthening students’ social well-being, which ultimately increases their academic success (Kay, 2016). Finding the right partner to collaborate with to deliver and implement the curriculum is the key to success (ASCA, 2012). Teenagers that have knowledge of how their brain connects to their thoughts, feelings, and actions will ultimately have better mental health and overall academic success (Kay, 2016).
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