

# The Amazing Adolescent Brain: What Every Educator, Youth Serving Professional, and Healthcare Provider Needs to Know

By Linda Burgess Chamberlain PhD, MPH



## The Amazing Brain

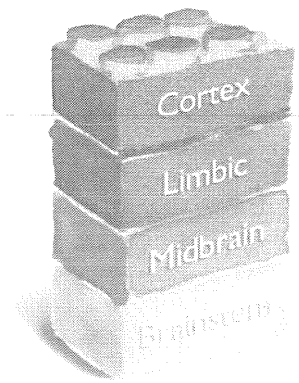
Some of the most exciting new discoveries in neuroscience focus on adolescent brain development. Researchers have learned that the adolescent brain is far from completed. Many of the most important finishing touches in brain development occur during the second decade of life.

Adolescence is a window of opportunity for developing a better, smarter, faster brain. It is the time when the brain becomes more efficient and develops more advanced skills. But it can also be a time of missed opportunities and vulnerabilities if a teen does not challenge her/his brain or exposes the brain to neurotoxins, such as alcohol, tobacco, and drugs. Similar to what happens in early childhood, adolescent brain development is a period of 'use it or lose it'. Brain connections that are stimulated and used repeatedly grow stronger while unused connections wither away. How teens spend their time – their activities and experiences – influences both the organization and also the capacity of the brain.

This article reviews some of the latest research and describes how educators, healthcare providers, and youth serving professionals can help teens engage in activities that will lead to healthy, strong, and well developed brains.

### I. Nature Saves the Best for Last.

The brain develops from the bottom up, like a stack of building blocks. The lower building blocks, the brainstem and the mid-brain, are the first areas of the brain to develop and connect. These areas are often referred to as the 'survival brain' because they control basic body functions, such as regulating blood pressure and body temperature. The upper building blocks, the limbic system and the cerebral cortex, are referred to as the 'intellectual' or thinking brain. The limbic system is the emotional core of the brain. The cortex forms an outer covering around the brain that accounts for 85 percent of the human brain mass. The cortex is where reason, logic, and rational thinking originate. Reading, writing, and arithmetic are cortical functions. During adolescence, the cortex goes through a major period of growth and change that helps adolescents transition into adulthood.



The portion of the cortex that is located right behind the forehead is called the prefrontal cortex. Often called the CEO of the brain, the prefrontal cortex is one of the last areas of the brain to mature. A mature prefrontal cortex is necessary for good judgment, controlling impulses, solving problems, setting goals, organizing and planning, and other skills that are essential to adults. Following a growth spurt that occurs around age 9 or 10, when the prefrontal cortex actually thickens, this area of the brain goes through a pruning process that

starts around age 11 and continues into early adulthood. New experiences will stimulate more brain connections and new neural pathways. Connections that are not used will be eliminated. The human brain also gets its final layer of insulation during adolescence. Myelin, a fatty substance, is deposited on critical brain connections. Myelination increases the speed with which electrical and chemical messages are transmitted throughout the brain. The prefrontal cortex is the last area of the brain to complete myelination.

Changes in the adolescent brain are not limited to the cortex. One of the other regions of the brain that is going through a metamorphosis during adolescence and that is particularly shaped by environment and experience is the cerebellum. The cerebellum not only coordinates certain types of movement but also acts as a support system for other cognitive functions, such as recognizing social cues. The cerebellum, which has more neurons than any other place in the brain and which continues to grow into the early twenties, appears to be the last area of the brain to mature.

As teens mature, their brains become faster, sharper, and more specialized. They begin to: develop advanced reasoning abilities; expand their capacity for abstract and critical thinking; understand 'how' and 'why' questions; analyze complex issues; and evaluate alternatives before making a decision. Although teens have an amazing capacity for learning and memorizing new information, they often experience difficulty with prefrontal cortex functions, such as prioritizing what is important and organizing tasks. Teens need guidance from adults as they develop these skills.

Teachers and healthcare providers can do a number of things to help teens while the prefrontal cortex is still developing:

- Give teens simple instructions, both verbally and in writing. Avoid asking a teen to multi-task. (For example, avoid: "Read two chapters; write a brief response; don't forget to study for your unit test; and have your parents sign the permission slip for the field trip.") Avoid giving complex directions. (For example, avoid: "Take the first prescription three times a day – two pills each time, on an empty stomach, and for 10 days. Then take the second prescription, right before bed, for 14 days.") Being asked to multi-task or to follow complex directions can overwhelm an adolescent whose brain is just learning how to sort and prioritize.
- Help teens create systems to manage their time, organize tasks, and identify priorities. Teachers can encourage teens to use calendars and planners to organize homework and testing schedules. Healthcare providers can give teens appointment cards and make phone calls or send text messages to remind teens of upcoming appointments.
- Provide many, varied opportunities for teens to get involved in new hobbies and to discover their own interests, passions, and talents. The teenage brain needs lots of stimulation. So, be sure that teens have access to a wide range of learning opportunities, both in and out of the classroom. Activities should include: music, drama, photography, and other arts; dance, games, physical education, and sports; and outdoor recreation as well as classroom education.
- Use active learning methods to encourage teens to develop their skills. For example, use interactive exercises, such as role-plays, values clarification exercises, and forced choice scenarios. These teach teens to make decisions, be assertive, negotiate, prioritize, and

set goals. Provide opportunities for hands-on experiences. Give teens concrete examples, since they are still developing their capacity for abstract thinking. Healthcare providers and educators can use visual aids, websites, computer-assisted tools, and clearly written materials to teach teens about health topics.

## **2. The Emotional Brain Is in Transition.**

Teens often use the word ‘drama’ to describe what their lives feel like. It is this drama that can make working with teens challenging. You can promote a more peaceful adolescence and communicate more effectively with your students and patients by understanding how the teen brain thinks. Teens process information differently than do adults. While adults usually rely on the frontal lobes, the center of reasoning and language, to respond to situations, adolescents rely more on the amygdala; it controls a wide range of emotions. This means that teens are more likely than adults to respond emotionally to a situation. Then, too, teens may not be able to find the words to express their feelings. It also means that teens are prone to react more quickly and without considering the consequences of their actions. As they move through adolescence, teens learn to read other people’s emotions, but they still frequently misinterpret how others feel. For example, they may confuse sadness or concern with anger. Due to all the changes in the brain, teens get slower, for a while, at being able to identify emotions – their own and other people’s.

The developing adolescent brain is very vulnerable to stress and, in emotionally charged situations, teens may overreact. They may push the boundaries and break the rules. They may cry or get angry without apparent reason. As the brain matures, teens will operate more and more from the cortex, where reasoning and judgment occur.

Teachers and healthcare providers can help support teens in the following ways:

- Help teens to understand and make sense of their shifting emotions and mood swings by educating them about the changes that are occurring in the brain. Provide opportunities for teens to share their feelings with you. Ask open-ended questions such as, “How did that make you feel?” Develop scenarios and use role-plays to help them practice dealing with potentially difficult situations.
- Clearly state rules and expectations for behavior, and involve teens in creating a system of both rewards and consequences. For example in the classroom, teachers should clearly communicate the consequences for unacceptable school performance, such as late homework, unexplained missed classes, or failing grades. Equally important, teachers should provide rewards and offer consistent praise for a job well done.
- Talk to teens about age-appropriate, healthy ways to deal with stress. A few of the many healthy ways to deal with stress include physical exercise, journaling, peer support groups, yoga, and meditation.

## **3. Male and Female Brains Are Not the Same.**

Gender and hormones influence how the human brain develops. Recognizing some of the differences between the male and female brain can help us to understand why teenage males

and females often have different learning styles and behavioral patterns. The cortex is composed of gray matter and white matter. Gray matter is densely packed with cell bodies. White matter consists of myelinated axons that form the connections between brain cells. The female brain has a higher proportion of gray matter while the male brain has a higher proportion of white matter. Having more gray matter may explain why young women are usually more efficient in processing information, often have stronger verbal skills, and usually excel at juggling several activities. Having more white matter appears to help the male brain transfer information throughout the brain. This can enhance young men's spatial skills, such as navigation and solving math problems. A person whose brain thinks spatially often needs more space when learning; so many males may spread out their work assignments while their female classmates may not.

There are several structures in the brain that grow differently in adolescent females and males. The hippocampus helps to transfer new information to long-term memory. The hippocampus is sensitive to the female hormone, estrogen, and grows faster and larger in young women. Scientists believe that a larger hippocampus may explain females' strong social skills. Females often excel at sizing up social situations, being emotionally supportive, and coordinating complex relationships. The amygdala and the hypothalamus are sensitive to male sex hormones and grow larger in young men. Both of these structures are involved in the body's response to fear and danger. Enjoying contact sports, having increased sexual desire, and being more assertive are behaviors that make sense with the male growth spurt in the amygdala and hypothalamus. A busier, bigger amygdala may also explain why boys and young men need to move around more while learning compared to girls and young women, who tend to have a longer attention span that allows them to sit still and focus on one subject for longer periods of time.

In addition to these physiological differences, male and female brains mature at a different pace. The female brain matures sooner than the male brain. Youth serving professionals should evaluate where each teen is, neuro-developmentally, as opposed to assessments based solely on chronological age or grade level.

The following strategies can enhance teachers' and youth serving professionals' work with adolescent males and females:

- Promote gender-specific enrichment activities, tailored to the individual teen's interests. Create opportunities for separate-sex education by creating all male and all female teams or work groups to take advantage of gender-based learning differences.
- Provide ample opportunities for females and males to engage in activities centered on relationships. For example, volunteer and community service activities can help foster communication and promote a sense of connectedness. Service learning is a major trend in schools where educational objectives are linked to community outreach. Service learning can provide youth with opportunities to develop leadership and skills in a wide range of settings.
- Recognize how gender may influence students' classroom needs. For example, males may need more tutoring in reading and writing; females may need tutoring in math.
- Be sure to promote physical activity among both males and females. Sports, exercise, and exploring the outdoors are just as important for healthy brain development as things that actively engage the mind, such as reading, math, and science.

#### 4. Teens Need More Sleep.

Fifty brain chemicals have been identified as having a role in making the brain feel drowsy. Many of these brain chemicals also have a role in building brain connections. Due to all of the changes occurring in the adolescent brain – including dramatic changes in the brain’s sleep systems – teens need substantially more sleep than do adults. Starting around puberty, melatonin, a hormone that helps to induce sleep, is released two hours later at night and stays in a teen’s brain later into the morning, as compared to the brain of a child. Consequently, teens do not feel tired until later at night and have a harder time waking up early. The deepest form of sleep, called slow wave sleep, will decrease by as much as 40 percent during adolescence. Due to the transition in slow wave sleep, some childhood sleep problems, such as sleep walking and wetting the bed, will resolve. However, adolescence is also the time when other sleep problems, such as narcolepsy and insomnia, may emerge.

Adequate sleep is essential to brain maturation. Teens function best with about 9 hours of sleep each night. In one study of high school students, the majority of teens were sleep deprived and 20 percent fell asleep in class (Carskadon, 2002). Sleep deprivation can compromise teens’ ability to concentrate. Sleep deprivation may cause some teens to present with symptoms similar to attention-deficit/hyperactivity disorder (ADHD); or it may exacerbate symptoms of ADHD. Adolescents who get less than six hours of sleep each night are more likely to report symptoms of depression than are teens who get more sleep. Research also showed that teens who are sleep deprived are less able to control their emotions and are more likely to become angry or aggressive.

The following strategies can be used by educators and healthcare providers to help teens maximize their potential and get the sleep they need:

- Discuss the value and benefits of getting adequate sleep with teens and their parents. Sleep contributes to a healthy brain, a stronger immune system, less stress, and better memory functioning.
- Teach interactive subjects that involve movement, such as physical education, art, dance, and band, during morning class periods to help awaken the adolescent brain and body.
- Conduct a sleep assessment for teens who are doing poorly in school, having behavioral difficulties, or experiencing depression or other mental health concerns. Ask these teens how many hours they are sleeping each night and what they do before bedtime to relax and unwind.
- Encourage teens to avoid stimulating activities close to bedtime. Activities to avoid include playing computer games, exercising, and drinking caffeinated beverages, including energy drinks, coffee, or sodas. Encourage teens to find ways to wind down before bed, such as reading or taking a hot shower.
- Encourage parents to let their teens sleep in on the weekends.

#### 5. Teens Like Living on the Edge and Other Excitement.

Whether it’s skydiving, speeding, or staying out late at night, adolescents’ attraction to risks is no coincidence. Puberty and changes in the adolescent brain motivate teens to seek both new

experiences and also excitement. Teens perceive risk differently than adults do, and they are more enticed by the challenge than by the reward or outcome. The 'good judgment' area of the brain that helps teens to control impulses is still growing and maturing. This means that teens may not anticipate the consequences of their actions. Teens are also much more likely to take risks in the presence of other teens.

Chemical changes occurring in the adolescent brain also contribute to risk-seeking behaviors. The levels of serotonin and dopamine fluctuate in the adolescent brain. Serotonin, a chemical messenger in the brain, has a calming effect that helps to control impulsive behavior. Dopamine is part of the brain's 'feel good circuitry' that gives a sense of well-being. Taking risks can elevate dopamine levels.

As a youth serving professional or healthcare provider, you can do a number of things to help teens make good decisions, take positive risks, and become more independent, even in the face of hormonal and chemical changes in the brain:

- Provide opportunities for novel, challenging experiences such as hiking, rock climbing, and other outdoor recreational activities.
- Encourage teens to stretch their boundaries and take healthy risks by engaging in positive activities in the community. Performing on stage, giving a media interview, making a presentation, volunteering after a natural disaster, or building a shed with power tools can feel like risky endeavors for teens. They are positive risks that also help teens strengthen and develop the prefrontal cortex and teach them to assess risks, consider consequences, and make tough decisions under pressure and in unfamiliar circumstances.
- Help teens to understand how the teen brain works and to identify the potential consequences of taking unhealthy risks, such as skipping school, driving recklessly, using drugs or alcohol, or fighting. Coach them on how to avoid these dangerous risks.
- Healthcare providers should ask teens directly about the following areas: sexual, physical, and/or emotional violence in their lives, including dating violence; the use of alcohol, tobacco, and other drugs, including prescriptions and anabolic steroids; unprotected sex; depression; and thoughts about suicide. Equally important, healthcare providers should praise teens for engaging in healthy, positive, and self-protecting behaviors, such as eating well, getting adequate sleep, participating in sports, etc. Finally, healthcare providers should encourage teens to take an active part in decisions that affect their health and healthcare.

## 6. Understand the Danger of Alcohol and Drugs.

Teens' tendency to seek risks and novel experiences also increases the likelihood that they may experiment with alcohol and drugs. Alcohol, drugs, and tobacco can cause damage to the adolescent brain. Most addictive substances, including alcohol, cocaine, heroin, amphetamines, and nicotine, increase the level of dopamine, a neurotransmitter, in the brain.

Neurotransmitters are chemical messengers that transmit important information between brain cells. Increased levels of dopamine in the reward centers of the brain cause a sense of well-being.

Approximately one-fourth of high school students are considered binge drinkers (defined as consuming five or more drinks in a row within a couple of hours). Research on the impact of alcohol on the adolescent brain has led to some startling discoveries:

1. Teens are more likely to blackout (be conscious but unable to remember) than to pass out. In blackout, teens may continue to drink, drive, use drugs, and/or engage in other risky behaviors, yet have no memory of what they did.
2. Compared to adults, teens are less likely to succumb to the sedative effects of alcohol. Impairment of their motor coordination is delayed. Consequently, adolescent drinkers are less sensitive than adults to these two key warning signs of inebriation.
3. The hippocampus, which has an important role in forming new memories, is smaller in adolescents who are heavy drinkers than in other teens. Young drinkers have more learning problems as well as long-term memory impairment when compared to teens who don't drink.
4. Drugs, such as ecstasy and meth, cause imbalance in brain chemicals and can lead to problems with impulse control and depression. The nicotine in tobacco also causes chemical imbalance and problems with connections in the brain.
5. Teens are more prone to addiction than are adults. The younger teens are when they start using an addictive substance, the more quickly they become addicted. Preventing or delaying a teen's exposure to addictive substances, such as tobacco, alcohol, and drugs, including prescription drugs, is a *win-win situation*. The teen's developing brain is less likely to be harmed and the teen is less likely to become addicted.

Teachers, healthcare providers, and youth serving professionals can help teens to avoid the harmful effects of addictive substances:

- Talk with teens about the vulnerability of the developing adolescent brain to neurotoxins (alcohol, tobacco and drugs). Teachers can add a unit to health or science classes. Healthcare providers can offer anticipatory guidance to teens and their parents.
- Be aware that teens who are experiencing trauma, such as living in a violent household or being in an abusive dating relationship, are more likely than other teens to look for ways to self-medicate. Health care providers should routinely screen for substance use and should be familiar with community substance abuse treatment services that also deal with trauma-related addiction.
- Support and advocate for evidence-based substance abuse prevention programs in schools. Go to registries such as the National Registry on Evidence-based Practices ([www.modelprograms.samhsa.gov](http://www.modelprograms.samhsa.gov)) to learn more about substance abuse prevention programs for youth. A number of cost-effective programs exist that can be integrated into health, physical education, and other classes and that have demonstrated significant reductions in the number of youth who start using substances early.

## 7. Help Teens Develop Healthy Relationships.

During the adolescent years, teens begin to develop closer relationships with peers and intimate partners. Some adults might prefer that teens wait until adulthood or marriage to become sexually active. Yet, the reality is that half of all teens have had sex by 17.5 years of age and most teens have had sexual intercourse and/or a romantic relationship by the age of 20. Both hormones and changes in the adolescent brain affect teens' sexual development, desires, and decisions.

Teachers and healthcare providers can use the following strategies to help teens develop healthy sexual relationships:

- Help teens, parents, and everyone working with youth to recognize that sexual development is a healthy, normal part of adolescence.
- Implement developmentally appropriate and age appropriate programs that help teens to make healthy decisions. Social emotional learning (SEL) curricula, integrated into classrooms across the country, have been shown to improve students' interpersonal skills, reduce problem behaviors, and improve academic performance.
- Implement evidence-based, effective family life education programs that teach young women and young men skills in negotiation, communication, and refusal and that emphasize joint responsibility and mutual consent.
- *Before* they become sexually active, teach teens about the importance of using birth control, including condoms. Make sure teens know where to go for confidential sexual health services.
- Healthcare providers know that confidentiality is extremely important to teens. To help protect teens' privacy, establish procedures to protect confidentiality in scheduling, billing, and follow-up care. The following steps can help to ensure confidentiality for teen clients:
  - Include a statement of confidentiality on advertising materials and on clinic forms.
  - Display a statement of confidentiality in a visible area of the waiting room.
  - Clearly and consistently explain to teens (and their parents) the extent and limitations of the confidentiality protection that adolescents will receive. Explain the meaning of informed consent.

## 8. Recognize the Impact of Violence in Teens' Lives.

Teens are exposed to violence in many different ways. While considerable attention has been focused on community and gang violence, a significant number of teens are exposed to domestic violence and/or are victims of abuse in their own home. An increasing number of today's teens have experienced bullying, cyber bullying (bullying via cell phones and the Internet), and aggressive behavior from their peers. The average American teen spends more

than 70 hours a week with some form of media (Internet, television, and video games, etc.), and a growing body of research indicates that high doses of media violence can compromise learning and increase aggressive behaviors.

An additional concern is that adolescence is the time when the hidden epidemic of dating abuse begins. Physical, sexual, and emotional abuse by a dating partner is exceedingly common, starts early, and affects both females and males. According to a national survey of high school students, nearly one in five female teens (17%) and nearly one in 10 male teens (9%) has experienced physical and/or sexual dating violence (Ackard *et al*, 2003). Equally disturbing is the fact that approximately one-half of the students who were experiencing dating abuse also reported that they were still in the relationship because they feared physical harm if they tried to get out of it. In a survey of male and female college students, more than one-third (35%) of students had experienced some more of relationship violence before coming to college and 1 in 4 (24.9%) reported experiencing relationship violence during college (Forke *et al*, 2008). Dating violence is a school and college health issue.

Teens need a predictable and stable environment at home, at school, and in their communities. Like younger children, they need to feel safe and nurtured. Teens growing up in fear and chaos tend to spend more time in the 'survival brain', trying to feel okay, rather than in activities that develop their pre-frontal cortex. They adapt to their environment, but at a high cost. For example, because these teens spend less time thinking from the cortex, they often have trouble paying attention, sitting still, and controlling emotions. In addition, violence in any teen's life has serious long-term health effects, including increased risk of involvement in teen pregnancy, risk of depression or suicidal thoughts, and risk for using tobacco, alcohol, and/or drugs.

Educators and healthcare providers can learn to identify the signs and symptoms of exposure to violence. They can intervene appropriately, and refer teens for treatment and care. Consider the following tips:

- Help teens understand that they have the right to say no and the right to be safe. Make sure they know where they can get help, if needed. Contact your local domestic violence program for posters, brochures, and information about dating violence and display these in your classroom or waiting room. Teachers should become familiar with dating violence prevention curricula that are tied into national academic standards and that can be integrated into existing classes.
- Recognize that some populations of adolescents, such as runaway and homeless youth, those in foster care or juvenile justice programs, and youth in substance abuse treatment programs, have higher rates of having suffered physical, sexual, and/or emotional abuse than their peers. Thus, they will need more intensive support.
- Promote stronger connections with healthy adults who are trained in adolescent development and enjoy being with teens.
- Teach media literacy in the classroom so you can educate students on how gender stereotyping and violence can influence their beliefs, desensitize them to violence, and lead to unrealistic expectations about lifestyles and relationships.
- Encourage parents to set limits on the time teens spent with electronic media. Encourage parents to be closer to their teens simply by spending more time together.

## Promote a Peaceful Adolescence.

Nature saves the best for last, as the brain goes through intensive changes during the second decade of life. The teen's brain is acquiring the 'hardware' it needs for functional adulthood. But, the adolescent brain is not there yet. Adolescents need healthy and caring adults in their lives to provide a supportive, enriched environment that optimizes this developmental window of opportunity. Teachers and healthcare providers can do a number of things to help promote a peaceful adolescence. First, we can anticipate some chaos and conflict, emotional peaks and valleys, risk-taking and rule-breaking as teens navigate the tremendous physical and neurodevelopmental changes that will bring them to adulthood. We can also take an active role in creating opportunities for teens to: practice making decisions; develop new skills; seek healthy adventures and take positive risks; spend quality time with adult mentors; and adopt healthy lifestyles that minimize stress and allow time for plenty of sleep. All of these strategies promote resilience in youth. In turn, the resilience reduces the likelihood of unhealthy risk behaviors and increases the potential of teens' brains.

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## Resources

**Why Do They Act That Way?** By David Walsh. Free Press, NY, NY. 2005.

**The Primal Teen: What the New Discoveries About the Teenage Brain Tell Us About Our Kids** by Barbara Strauch. Random House, NY, NY. 2003.

**Your Child's Growing Mind: Brain Development and Learning from Birth to Adolescence** by Jane M. Healy, PhD. Broadway Books, NY, NY. 2004.

## Websites

[www.nimh.nih.gov/Publicat/teenbrain.cfm](http://www.nimh.nih.gov/Publicat/teenbrain.cfm)

A brief overview of research into brain development during adolescence.

[www.duke.edu/~amwhite/Adolescence](http://www.duke.edu/~amwhite/Adolescence)

Explores recent scientific evidence that alcohol affects adolescents and adults differently.

[www.cdvp.org/teens/](http://www.cdvp.org/teens/)

A teen relationship website talks about respect and abuse in relationships, provides links, and a chat room for teens.

[www.burstingthebubble.com](http://www.burstingthebubble.com)

An informational website for children exposed to IPV

[www.ThatsNotCool.com](http://www.ThatsNotCool.com)

Multi-media campaign to educate teens about dating violence that includes an interactive website web ads, posters, radio and television public service announcements

[www.loveisrespect.org](http://www.loveisrespect.org)

National Teen Dating Abuse Helpline – 1-866-331-9474

loveisrespect.org provides resources for teens, parents, friends and family, Peer Advocates, government officials, law enforcement officials and the general public. All communication is confidential and anonymous.

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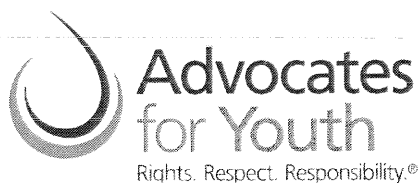
Dr. Chamberlain is a National Advisor to the Institute for Safe Families (ISF) in Philadelphia. ISF, Multiplying Connections of the Health Federation of Philadelphia, and Advocates for Youth are collaborating with Dr. Chamberlain to produce materials for parents and providers on the Amazing Brain.



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