TIRF

Young and New Driver RESOURCE CENTRE

Brain Development

What Is...

How does the brain develop?

A child's brain begins to develop in the womb and does not stop until the mid 20s. There are different stages of development that must occur before the brain is considered to be fully developed, or to have reached adult status.

By age six the brain is 95% of its adult size, but the 'grey matter' or the thinking part of the brain, continues to thicken until about age eleven for girls or twelve for boys. This grey matter is the area responsible for functions such as organization and strategizing. After age twelve the 'pruning stage' begins during which unused parts of the brain die off. This time period of 'pruning' is an important process that determines the permanent shape of the brain.[1] It is at this point that the adolescent brain is very flexible and will be influenced by the outside environment to form the life path of the individual.[2] The last part of the brain to develop is the frontal lobe, which is characterized as the 'CEO' of the brain because it is in charge of executive functions such as, planning, impulse control, reasoning and integration of information. [3]

Behaviour

How does brain development affect adolescent behaviour?

Because the frontal lobe is the last part of the brain to develop, adolescents will have more difficulty with mental tasks that involve thinking clearly, decision-making and impulse control. The impulsive part of the brain, on the other hand, is almost fully developed at adolescence. This leads to the impulsive, reckless behaviours that are common among adolescents, such as thrill seeking, irrational decisions and dangerous behaviours (which will be explained further in coming sections).

Although the adolescent brain has the ability to make rational decisions, teens are more likely to act impulsively with gut instinct when they are put in stressful or emotional situations (peer pressure being a good example of this).[4] The peak of puberty brings a desire for thrills, risks and stimulation.[5] The combination of irrational decision-making and thrill-seeking can result in adolescents who can be aggressive, emotionally volatile and more likely to focus on and overestimate short term pay offs, as well as underestimate long term consequences.[6] These tendencies may influence adolescents to participate in risky behaviours such as drinking and driving or experimenting with drugs.

How does brain development affect adolescent driving?

The frontal lobe is also responsible for initiating attention and stopping attention.[7] Planning, reasoning, integration of information and impulse control,[8] all skills that are needed to become a safe driver, are underdeveloped until a person reaches an age of mid-20s. This means that once adolescents get behind the wheel, they have difficulty keeping their attention on the task of driving, understanding all the stimuli in their surroundings and making quick decisions about how to react to hazardous environmental changes. They may also have a desire to speed, drive aggressively (run red lights, cut other drivers off) or to get behind the wheel when they are intoxicated. This also puts them at higher risk of distraction (by passengers, road signs, cell phones), increases their crash risk if there is an unexpected change in the driving environment, and encourages them to drive drunk or high.

What limitations do young drivers have that older drivers do not?

The limitations associated with young drivers can be understood as a result of hazard perception studies. Adolescents do not have much difficulty acquiring basic car handling skills when learning to drive (such as steering, braking) but the higher order tasks of driving which involve mental and perceptual skills are much harder to come by due to the underdeveloped frontal lobe. Thus, adolescents' abilities to perceive hazards, visually search the road, and pay close attention to the entire environment are less developed than older drivers. Studies comparing hazard detection and hazard response of young drivers with experienced drivers show that adolescents detect fewer hazards than more experienced drivers and react more slowly to these hazards.

1 Giedd 2012
2 Dahl and Spear 2004
3 ECMT 2006
4 Winters 2008
5 Dahl and Spear 2004
6 Winters 2008
7 Giedd 2004
8 ECMT 2006

There is also evidence suggesting that the brain functions that control voluntary eye movement are not fully developed in adolescents, which means young drivers cannot move their eyes as fast or as frequently as older drivers, making their road scanning abilities weaker.[9] Novice drivers have difficulty forming a holistic understanding of their current driving situation and use the same scanning patterns for all road types. Experienced drivers, on the other hand, change their scanning patterns based on changing circumstances. This means that young drivers only understand hazards in a single dimension and are less able to identify potential hazards. In other words, they are only able to recognize a hazard once it has presented itself as such.[10] For instance, a study examining the ability of young drivers to detect potential hazards asked participants to drive a route where children were present (the route went through housing districts with primary and secondary schools). Young drivers were less likely to detect children than the older drivers – young drivers detected the presence of children in only 51% of the cases while older drivers did so in 63% of cases.[11]

How do the limitations of young drivers affect their involvement in crashes?

Major sources of death and disability of adolescents are related to difficulties in the control of behaviour and emotion. The top three causes of death for adolescents are accidents (mostly road crashes), suicide and homicide.[12] The increased likelihood to drive recklessly, whether speeding, being distracted, or impaired, and limitations such as inability to perceive hazards, contribute to adolescents having a disproportionate crash rate among all licensed drivers. In other words, young drivers are more likely to be involved in crashes than older drivers.

Motor vehicle collisions are the leading cause of death among those aged 15-24, and collisions account for one-third of all deaths for this age group. Collisions also account for one-third of all traumatic injuries of this age group. The motor vehicle death rate among young people is double those of other age groups. One-quarter of road deaths in 2008 involved drivers aged 15-24, although this age group only accounted for 13% of the licensed driving population.[13] This is illustrative of the magnitude of road deaths among youth, which can be explained by their different stages of brain development and impulsive behaviour.

What are common types of crashes among young drivers?

A study conducted in Florida investigated the contributing factors associated with young at-fault drivers in fatal traffic crashes. The most common road crashes involving young drivers were single vehicle, run off the road crashes. They were also overrepresented in at-fault forward impacts with control loss, meaning they were disproportionately involved in crashes in which a head on collision with an oncoming vehicle occurred due to the young driver losing control of the vehicle. This generally involved speeding or reported inattention, inability to use sound judgment and difficulty making quick decisions.[14] All of these characteristics are representative of the nature of the adolescent brain. Speeding is due to the risk-seeking desire and the underdeveloped frontal lobe contributes to the lack of attention or improper decisions that result in a crash.

The main factors contributing to young driver crashes where the driver was at fault include alcohol, inattention and speed. Secondary causes include steering input, decision errors, inexperience and disregarding traffic signals and stop signs. All these behaviours reflect the weaknesses of the developing adolescent brain.[15]

How does alcohol affect the brain development of teens?

Because the adolescent years (ages 11 to 24) are crucial for the last phase of brain development, certain behaviours could have damaging effects. Drinking alcohol is quite dangerous for teens in two ways. First, adolescent brains are resistant to the effects of alcohol. This is due to the underdeveloped brain receptors that are responsible for recognizing and preventing excessive alcohol intake. In other words, the part of the brain that signals to adults that there is more alcohol in their body than their body can handle, does not give this signal to adolescents. Thus, youth are much more likely to drink too much and have no desire to stop, making them more likely to get behind a wheel when their judgment is impaired both by alcohol and underdevelopment in the brain. Second, the more a youth drinks the greater their tolerance to alcohol, which leads to a greater risk of alcohol abuse in the future.[16]

Youth that begin drinking at a young age (eleven or twelve) can exhibit brain deficiencies in later years. For instance, youth that begin drinking alcohol before age 14 have a 41% chance of developing alcohol dependence compared to those who wait to begin drinking until age 21 who will only have a 10% chance of developing dependence.[17] Early alcohol use also leads to elevated risk of mental health and social problems, such as depression, personality disorder and drug abuse.[18] This is exhibited by females convicted of driving while impaired (DWI); these offenders often report substance abuse that began at a young age, which led to alcoholism later in life, and the resulting DWI charge. Also, it is important to note that mental health problems are more prevalent among the drunk driving population than the general population.[19]

How do drugs affect the brain development of teens?

Similar issues arise when adolescents begin taking drugs at a young age. Cannabis (weed, marijuana) use is associated with psychopathology. This means cannabis has been known

9 Isler et al. 2009
10 Borowsky et al. 2010
11 Oude Egberink et al. 1986
12 Dahl and Spear 2004
13 Emery et al. 2008
14 Alam and Spainhour 2009
15 Alam and Spainhour 2009
16 Spear 2004
17 Grant and Dawson 1997
18 Brown and Tapert 2004
19 Robertson et al. 2011

to aggravate existing mental illness or act as a catalyst to mental illness. The earlier the use of cannabis, the greater the implications: teens aged 12 to 17 who smoke marijuana weekly are three times more likely to have thoughts of suicide than non-users.[20] Girls aged 14 and 15 who use cannabis daily are five times more likely to experience depression by age 21.[21] Heavy cannabis users by age 18 are six times more likely to be diagnosed with schizophrenia later in life than non-users.[22]

Getting high impairs judgment which leads to risky behaviours. Judgment skills in adolescents are already weak, meaning cannabis leads to an even greater decrease in the ability of teens to rationalize and make good decisions. In other words, teens who get high are more likely to behave dangerously (such as getting in a car with an impaired driver).[23] Cannabis also decreases concentration and the ability to retain information.[24] This is problematic because adolescence is a time where the brain absorbs important information (lessons at school, learning how to drive) that is needed for the healthy shaping of the brain. If this is compromised, adolescents are likely to face difficulties in their future.

ATTITUDES, CONCERNS AND PERCEPTIONS

What are common misconceptions about brain development?

Until recently (the past decade), it was generally believed the brain was finished developing by age five. Parents were told to focus on stimulating their child in the first three years of their life in order to facilitate productive brain development. After this, it was believed the brain was 'set' and could no longer change or develop. Thus, parents no longer sustained efforts to stimulate the brain as they had in the earlier years. Now it is known that a child's brain needs stimulation to promote development from age three to 16 and that adolescence is a crucial time to shape the mental path of a child.

Recent discoveries have taught scientists, researchers and parents that it is not fair to expect youth to think and act like adults. Characteristically the ages 13-18 are seen as years during which youth become independent and start developing their own lives without the help of adults. Although this is still true, and fostering independence is important at this stage, parents still need to take an active role in guiding and influencing the decisions of the impulsive adolescent.[25] It is important that adults acknowledge that, although adolescents can rationalize almost as well as adults in calm situations, it is stress that impairs the decision-making skills of teens in more emotionally charged situations,[26] creating the need for parents to step in with their perspectives when possible.

20 Greenblatt 1998
21 Patton 2004
22 Andreasson 1987
23 DHHS 2002
24 Shinar 2006
25 Giedd 2012

SOLUTIONS

What can be done to help adolescents maximize brain development?

Several steps can be taken to ensure adolescents maximize brain development such as:

- **Prevent drug and alcohol use from starting at a young age.** This can help ensure the brain does not suffer any permanent damage from harmful substances. Drug use should be avoided at all costs and alcohol use should be delayed until it is legal for the adolescent to drink;
- **Incorporate educational tools into school curricula to teach youth about the importance of brain development in a constructive manner.** By understanding the risks for potential brain damage, youth are more likely to refrain from these behaviours;
- **Encourage youth to take 'thinking' breaks when faced with an emotional or difficult decision can help prevent impulsive behaviour.** This could be as simple as instructing youth to take a few breaths and really think about the consequences involved with the decision at hand or to walk away when feeling overwhelmed by a decision, instead of reacting without thinking; and,
- **Support adolescent brain development by becoming aware of the unique needs of a young mind.** Instead of scolding youth when they do something erratic or impulsive, parents should act preventatively; develop an open and honest relationship with youth which encourages youth to communicate and to seek parental guidance before decisions are made.[27]

How can parents foster open communication with their young driver?

Fostering an open and supportive relationship with a new young driver can encourage young drivers to talk to parents or adults before making decisions or after a bad decision has been made. For instance, adolescents may drive to a party with no intention of drinking, but end up drinking alcohol. They may judge the negative consequences of driving themselves home as much less 'scary' than the consequences of calling their parents and admitting they have been drinking. Parents, on the other hand, would much rather receive a phone call in the middle of the night from their teen asking for a ride than a knock at the door from a police officer coming from a fatal collision. It is important that parents communicate these facts and let teens know during these times that they made the right choice to call.

Gary Direnfeld, a social worker who specializes in family issues, developed the 'I Promise Program – Teen Safe Driving Initiative' to help develop teen-parent communication. The

26 Dahl 2004
27 Winters 2008

program is intended to initiate discussion between parents/adults and their teenagers about road safety issues that may otherwise be missed or overlooked, compared to discussing the matters on their own. The initiative is based on *The Parent Youth Safe Driving Contract* which is a nine-page document developed with input from police, driving instructors, insurance executives, stakeholders in traffic safety, parents, and youths. The contract covers risk issues, expectations and responsibilities for the safe use of the vehicle being driven, and instructions on what to do in case of collision as recommended by police and driving instructors. The contract can be used as a starting off point for parent/teen discussion which can then lead to a supportive honest relationship.

For more information about the program or to get a copy of the Driving Contract please visit: http://www.ipromiseprogram.com/

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