The Adolescent Brain – Wired for Taking Risks

This briefing paper is **part of a series** produced by Mentor-ADEPIS to support the delivery of effective alcohol and drug education and prevention in schools and other settings.

About Mentor

Mentor promotes best practice around building young people's resilience to prevent alcohol and drug misuse.

About ADEPIS

The Alcohol and Drug Education and Prevention Information Service (ADEPIS) is a platform for sharing information and resources aimed at schools and other professionals working in drug and alcohol prevention. In 2017, ADEPIS was recognised by UNESCO, UNODC and WHO as a 'prime example' of best practice in alcohol and drug education.

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This briefing paper forms part of a mini-series on the 'Brain under Construction.' and should be read alongside the 'Window on the Developing Brain' publication (available on the Mentor website).

Adolescence is a time of increased risk-taking; this paper looks at the role the brain plays in risk-taking, including adolescent substance use. It also considers some possible ways the harm of risk-taking in young people can be mitigated and notes that many adolescent risk behaviours put others in danger, making the prevention of risky behaviours among adolescents an essential public health issue (IOM & NRC, 2011). During adolescence, a key goal for those working in prevention is to reduce the harms of risk-taking, so some implications for prevention programmes will be outlined.

This briefing paper is intended for:

- Teachers
- Practitioners
- Those who wish to understand the developing brain

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Adolescence is the time of transition from childhood dependence to adult independence and, during this tumultuous transformation, it is evident how much the adolescent brain is a genuine instrument of learning. Advances in neurological research and technology can now show how behavioural and emotional changes occurring during this stage of life happen in the brain, driven by genes and hormones and continuously modified by experience, allowing us to navigate life on earth.

Storm and Stress

"If life were a white-water rafting trip, adolescence would be the rapids" – AM White

Many scholars and non-scholars alike accept some degree of GS Hall's 1904 theory that adolescence is a time of heightened 'storm and stress.' Hall used the term because he viewed adolescence as a period of inevitable turmoil. He used the word 'storm' to describe a decreased level of self-control, and 'stress' to describe an increased level of sensitivity. Hall stated that, aside from greater vulnerability to peer pressure, the adolescent period of 'storm' and 'stress' can be grouped into three categories:

- *Conflict with parents:* Adolescents tend to rebel against authority figures as they seek more independence and autonomy.

- *Mood disruption:* Hormonal changes and the psychological stress of adolescence can cause uncontrollable shifts in emotion.

- *Risky behaviour*: The combination of a neurological need for stimulation and neurological and emotional immaturity lead to increased risk-taking behaviour

Threat and Opportunity

Dahl (2009) notes that measures of most abilities during adolescence indicate it to be the healthiest and most resilient period of life. During adolescence, there are improvements in strength, speed, reaction time, mental reasoning abilities, immune function and increased resistance to cold, heat, hunger, dehydration, and most types of injury. However, Smith (2013) highlights that, although the neurological changes that take place during the adolescent years provide incredible opportunities for personal growth and development, they also bring about enhanced vulnerabilities to consequences. Brown et al. (2008) report adolescence as a time when there are increasing rates of accidents, suicide, murder, depression, drinking and substance use, violence, reckless behaviour, eating disorders and health problems related to risky sexual behaviours.

Emotional and Behavioural Self-Regulation

Resisting impulses to engage in activities leading to poor outcomes can be difficult for adolescents and can only be achieved through 'self-regulation, ' i.e., the ability to control and to plan behaviour (Brown et al., 2008). The inability or unwillingness to inhibit emotion-fuelled behavioural impulses has long-term consequences and so the ability to regulate them is critical for an adolescent to efficiently deal with their inevitable increased exposure to risk (Brown et al., 2008).

Heightened Risk

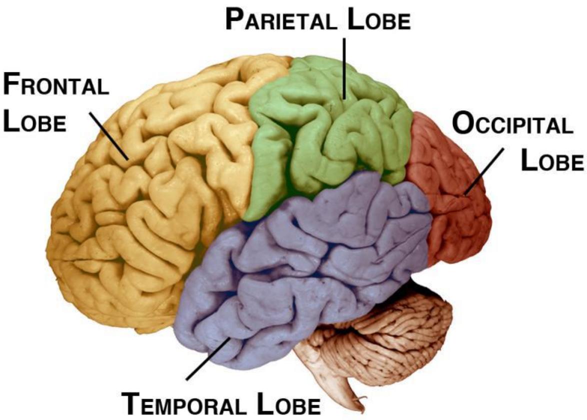
Research shows that teenagers tend to engage in risky behaviour much more often than adults (Reyna & Farley, 2006). Although most risk behaviours first become apparent between the ages of 10 and 12, when neuroendocrine changes are happening, adolescents take more frequent and higher risks than before puberty or as an adult (Ge et al., 2006),

Johnson (2009) suggests that teenagers are easily bored and so crave new experiences and stimuli, requiring higher doses of risk to obtain the same amount of 'rush' as an adult would. This increased stimulation can consequently strengthen the brain's neural pathways and alter its risk-taking circuitry during a time when the brain is more 'plastic' than it will ever be again, capable of remarkable adaptability.

Brain Networks

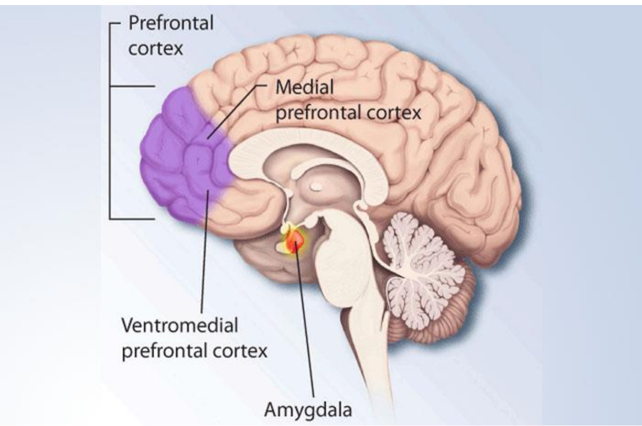
It is suggested that the extent to which an adolescent takes risks is dependent on two separate brain networks (Brown et al., 2008):

1. The cognitive network, responsible for planning and self-regulation and localised in the pre-frontal and parietal areas of the brain.



a) Pre-frontal Cortex

This region of the brain relates to meta-cognition, i.e., our unique skill of being aware of our ability to think. The pre-frontal cortex is understood to be responsible for such things as controlling planning, working memory, organisation, and mood control. It is also the area of the brain responsible for reasoning and decision-making and which stops us taking risks and acting on impulse.



An evolutionary explanation suggested for why the pre-frontal cortex becomes less active during adolescence is attributed to the need for offspring to leave their nests and take risks to survive independently. As the pre-frontal cortex develops and matures, teenagers can reason better, develop impulse control and make better judgments.

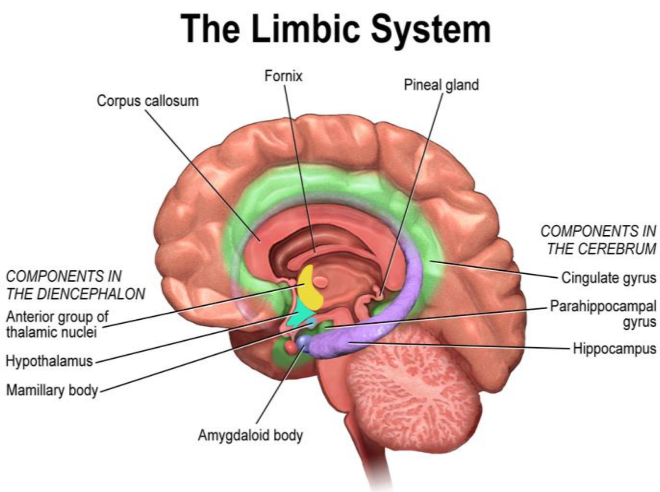
b) Parietal Cortical Region

This region plays a vital role in coordinating movement, spatial reasoning and attention, particularly attention driven by new stimuli.

2. The socio-emotional network, which is involved in the processing of social and emotional stimuli that are localised primarily to the limbic system.

a) The Limbic System

The limbic system comprises a complex set of structures including the hypothalamus, the hippocampus, the amygdala and the nucleus accumbens. Imaging has shown that it is primarily responsible for the emotional elements in our lives, and is related to memory formation.



The limbic system develops at a steeper gradient than the prefrontal cortex, making adolescence the time when these two regions are least similar. The result of this imbalance could explain why adolescents favour behaviours driven by emotion and response to incentives over rational decision making, something which contributes to the prevalence of risk-taking in adolescents.

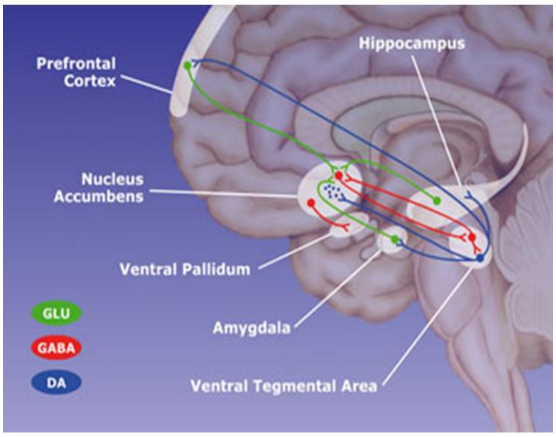
b) Amygdala

The amygdala is an almond-shaped mass of cells (neurons) and is often referred to as the emotional centre of the brain, playing a leading role in the learning of emotions and, based on our previous emotional experiences, determines our response to danger, helping us make ‘fight or flight’ decisions.

Evidence shows that the limbic system is associated with reward and is particularly sensitive to a rewarding feeling during adolescence (Blakemore & Choudhury, 2006).

The primary purpose of the reward system is to reinforce behaviours that the brain assumes are useful for survival. Practices that lead to the activation of the reward centre are enhanced and are more likely to occur again in the future. Findings show that the intensive learning-related changes that occur in the brain during adolescence combined with high motivation to activate the reward system during this time can quickly lead to the development of bad habits that can become stubbornly embedded in brain circuitry (White, 2013).

The Reward Circuit



c) Nucleus Accumbens

The nucleus accumbens is at the centre of the reward system. It receives signals in the form of the neurotransmitter, dopamine, from another deep-seated structure called the ventral tegmental area and is fervently activated in anticipation of reward and on the delivery of reward. Activation of this circuitry leads to pleasure, and pleasure increases the probability that the rewarded behaviour will be repeated (White, 2009).

Substance Use Risk-Taking

Substance use risk-taking is more likely to begin during adolescence than at any other time in life (Johnston, 2008). Like other risks already identified, Johnston notes that “risky drinking, including early and frequent drinking and drunkenness, is associated with adverse psychological, social and physical health consequences, including academic failure, violence, accidents, injury, use of other substances and unprotected sex” (Johnston, 2008). Research illustrates that alcohol and substance use activates the reward centre of the brain and essentially tricks the brain into thinking that a fundamental positive change has happened; therefore, every time the reward system is activated, the chances that the individual will repeat the behaviour in the future are increased.

Each time the urge to repeat the rewarded behaviour is expressed without being prevented by the frontal lobes, the probability decreases that the young person will be able to gather the amount of strength required from the frontal lobe to stop the behaviour the next time the impulse presents itself. The strong emotional impulses that lead to reinforced behaviour, combined with a developing and fragile cognitive control centre, make it easier for adolescents to move towards substance abuse and other risky activities – and to keep returning for more. During adolescence the brain learns very quickly; because of this, if substance use is initiated and repeated during this period of development, the probability of it becoming a permanent problem, increases. Like other learned behaviours, once the enhanced time of plasticity ends and the neural pathways become more fixed it becomes more difficult to change (White, 2009).

Teenage Stress

Adolescents exhibit an exaggerated stress response which seems to contribute to the difficulties that they have regulating their emotional reactions. In response to stressful situations, the body releases a steroid hormone called cortisol which helps the body prepare itself to deal with stressors and form memories of stressful events. Along with other physical problems, too much cortisol correlates with the onset of depression and the death of brain cells in the hippocampus, the area of the brain responsible for memory.

Research shows that adolescents experiencing stress engage in risk-taking behaviour more often and are more inclined to search for the mood-enhancing potential of substance use (Chassin, 2008).

During adolescence, there is an exaggerated response to stress and greater activity becomes evident in the reward centre which, combined with the still-developing circuitry in the frontal lobe area of the brain, could explain the strong emotional impulses and reactions adolescents have and the difficulty they find in regulating them (White, 2009).

Researchers have found that highly disruptive children or children with conduct disorders have reduced heart rates and other stress responses in stressful situations (Pine, 2008; Susman et al. 2010). Consequently, researchers suggest that these individuals do not experience appropriate arousal or reactivity and therefore engage in risky behaviour to increase their responsiveness or sense of pleasure (IOM & NRC, 2011).

There is a consensus that the changes in the structure and functioning of the brain during adolescence explain a great deal of an adolescent's behaviour, including the challenges they face when trying to regulate their impulses. Casey et al. (2008), however, argue that it cannot explain all of it – particularly risk-taking. The research team points out that younger children also have immature frontal lobes but do not display the same degree of risk-taking. However, they go on to explain that adolescents are driven more by stronger emotions and do not have the cognitive control to block out inappropriate thoughts and behaviour, or refrain from acting on impulse.

The fact that the immature frontal lobes are unable to operate at their full potential makes it easier for these deep emotions to influence moment-to-moment changes in behaviour (White, 2009). In support of this, neuroimaging studies have suggested that, when making risky decisions and processing emotional information, adolescents display increased activity in the limbic system, particularly in the amygdala and nucleus accumbens (Ernst & Mueller, 2008).

Programme Implications

As adults, it is our responsibility to look for ways to provide support to young people to will help them navigate the challenges they face during this time of fast-paced brain development and behavioural and emotional transformation.

Some researchers have highlighted some of the primary implications of the neuro-biological approach to risk-taking, and in 2009 Hawkins and Monahan suggest (in White, 2013), possible standards for intervention and prevention programmes:

a) Interventions should begin early – at the developmental point by which risk factors have been found to predict subsequent problem behaviours.

b) Interventions should focus on risk and protective factors that have been shown to influence problem behaviours. **

c) Interventions should focus on risk reduction and improved protection of those exposed to most significant cumulative risk.

The uniqueness of the causes for many risk behaviours, and the fact that only a proportion of adolescents exposed to elevated levels of risk face severe problems, makes it difficult to devise a generic prevention and intervention programme. If an intervention only addresses one set of influences (for example, environmental influences) but doesn't consider other factors such as brain function or psychosocial processes, the programme may be unsuccessful or have surprising unintended consequences (IOM & NRC, 2011).

Despite these challenges, risk-taking can be a positive experience if it can happen in the right environment (Casey & Jones, 2010). Steinberg (2008) suggests that rather than trying to eliminate adolescent risk-taking behaviour, which has been shown to be unsuccessful, a more constructive strategy might be to provide access to activities that pose positive risks under controlled settings (for example, programmes with an indoor climbing wall) and limit harmful risk-taking opportunities. The adolescent brain reflects experiences; with these safer risk-taking opportunities, young people would then be able to shape their long-term behaviour positively by fine-tuning their neural circuitry (Casey & Jones, 2010).

Tripodi et al. (2010) report that cognitive behavioural therapies focusing on refusal skills (cognitive control) to reduce risky behaviours have also proved to be successful interventions and note how individual and developmental differences may help to explain the vulnerability of some individuals when it comes to risk-taking behaviour. Spear (2013) suggests that because of this uniqueness, approaches to managing and preventing risky behaviours may require tailoring depending on age. For example, helping young people find safer ways to explore risks may work well with younger adolescents, while older young people may benefit more from a programme which will strengthen their emerging capacity for cognitive control. Some researchers have also noted the importance of considering individual interactions between environmental and genetic factors that could potentially contribute to risk-taking behaviour and resilience.

Summary

The physical and biochemical developments taking place during adolescence are complex. There is substantial evidence for how brain activity and development impact the adolescent's social and emotional behaviour and it is apparent how the brain helps to ensure that adolescence is a successful stage of development for the young person and that they have a positive transition from childhood to adulthood. Brain development, particularly the maturity of the pre-frontal cortex, is essential. According to Dr. Zsuzsanna Jakab, WHO European regional director, "health behaviours and social habits and attitudes acquired in the critical second decade of a young person's life can carry on into adulthood and affect the entire life-course" (WHO Report, 2017).

If we are to thoroughly understand youth development and risk-taking behaviour, it is essential to consider the inter-related cognitive, biological, social, and practical changes that occur during adolescence. It is necessary to take a multi-disciplinary approach and consider all dimensions of functioning because these areas not only influence each other but also influence the individual's danger of taking risks with unfortunate consequences. As Brown et al. (2008) state, "research which considers a range of integrated areas, such as these, will help to develop our understanding of the processes that underlie adolescent changes, including the emergence of alcohol use and abuse."

In conclusion it is essential to remember that, while risk-taking behaviour is a real challenge, "risks must be taken because the greatest hazard in life is to risk nothing. People who risk nothing, do nothing, have nothing, and <u>are</u> nothing. They may avoid suffering and sorrow, but they cannot learn, feel, change, grow, love and live." – WA Ward

** Smith (2013) suggests that examples of such interventions include: Communities That Care, early childhood education, the Good Behaviour Game, Guiding Good Choices, Incredible Years, life skills training, Nurse-Family Partnerships, and the Seattle Social Development Project

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