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Present day adolescents: why they are, the way they are

Abstract

Adolescence, a period that begins with the onset of puberty and ends with successful independence from the parent, is best described as a period full of stress and strife. Apart from the strain placed by the society, it is a biological developmental phase characterised by rapid physical growth, sexual maturation, secondary sexual characteristics, emotional changes, cognitive development, maturation of judgement, and self-regulation skills. Empiric evidence proves that there are greater risks of mood volatility, increased conflicts with parents, increased risk taking behaviour, recklessness, and sensation seeking in adolescence. This article reviews the neurobiological basis of such behaviour in the context of modern society.

Keywords: Puberty. Brain. Adolescent Behaviour. Neurobiology.

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From dirty rooms to shocking fashion, from excessive sleeping to concerns about drug abuse, modern day parents can enumerate even longer lists of qualities they would wish they could change/control in their adolescents. But paradoxically, these were also the things their parents had wanted to change about them when they were adolescents and same holds true for their parents as well. Generations had proclaimed that adolescents are not like adults in desperation and now science is telling us that it is true and that there is a biological explanation to these differences.

The assumption for many years has been that the volume of grey matter was highest in very early childhood and gradually falls as child grows. More recently, science has revealed that the highest part of the volume of grey matter occurs during early adolescence.[1] In frontal cortex, the grey matter volume peaks at approximately 11 years in girls and 12 years in boys, reflecting the dendritic overproduction.[2] The brain develops from bottom up, like stack of building blocks.[3] Brainstem and midbrain are the first areas of the brain to develop and connect, followed by the limbic system. Then, the growth of the cortex follows, which accounts for 85% of the brain mass. The process of myelination is also completed during adolescence.[4]

A mature prefrontral cortex is necessary for good judgement, controlling impulses, solving problems, setting goals, organising and planning, and other skills that are essential to adult, and the striatum is related to detecting reward cues in the environment. The prefrontal cortex is the last region to mature.[5] Thus, we see that teens have an amazing capacity for learning and memorising new information; but, they experience difficulty with prefrontal cortex, such as prioritising what is important and organising tasks. Adolescents' heightened response in the striatal regions may be one factor in contributing to reward biased decision making and risk taking behaviour.[5] Galvan *et al.*[6] have also demonstrated that there is a positive correlation between accumbens activity and likelihood of engaging in risky behaviour across development.

The cerebellum also continues growing in the early twenties; cerebellum not only coordinates certain types of movement, but also acts as support system for other cognitive functions, such as recognised social clues.[7] Social brain refers to the network of brain regions that are involved in understanding others, in particular, the medial frontal cortex and the superior temporal sulcus. Research indicates that these parts of the social brain undergo structural development, including synaptic reorganisation during adolescence.[8]

Differences in the sexes owing to differential development of their brains also becomes evident in the adolescence. Besides, male and female brains have been known to mature at different pace, with the female brain developing faster. Functional imaging studies have shown different patterns of activation without difference in performance, suggesting that male and female brains may use slightly different strategies for similar cognitive abilities.[2] Adolescence may be a sensitive period for steroid dependent brain organisation, and the variation in the timing of interaction between hormones of puberty and adolescent brain may lead to individual differences in adult behaviour and risk of sex biased psychopathology.[9] Hippocampus is sensitive to

female hormone oestrogen,[10] and grows faster and larger in young females, which explains female's social skills and the ability to understand social situations or handle complex relationships. Amygdala and hypothalamus are sensitive to male sex hormones and grow larger in young men.[11] Hence, men are seen to be enjoying contact sports, having increased sexual desire, and being more assertive.

Oxytocin, the bonding hormone, increases sensitivity to effects of the limbic system and is linked to feelings of increased self-consciousness.[8] This may be the reason why adolescents are often considered self-absorbed. But, this does not mean that the adolescence is always a turbulent phase or that the adolescents cannot make good judgements and that they should not be held responsible for their actions. According to Casey and Caudle,[12] adolescents may even have better impulse control than adults but in emotional contexts, adolescents' impulse control is severely taxed compared to children or adults. Although adolescent behaviour may lead to danger, they confer an evolutionary advantage by encouraging separation from the comfort and safety of the natal family which decreases the chances of inbreeding. The behaviour changes also foster the development and acquisition of independent survival skills.[13]

It is a period of opportunity and should be utilised. Adolescent brain development is said to be a period of "use it or lose it" and this has similarity to that of early childhood. Pruning occurs immediately before birth and during transition to childhood as well as from adolescence to adulthood. This process results in different sensitive periods of brain development.[14] It can also be a period of missed opportunities and vulnerabilities if the adolescents do not challenge their brains; moreover, the vulnerability increases by exposure to neurotoxins, such as alcohol, tobacco, and other psychoactive substances.[15]

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