Your Brain on Hormones during Puberty

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Abstract

Humans go through a stage known as adolescence as they grow from children to adults. Adolescence is a period in a person's life when they experience significant social, environmental, and biological change. The onset of puberty, which usually occurs around the adolescent years, is a critical period in human physical and emotional development. In addition to the more visible bodily changes that occur during this time, an adolescent's brain undergoes changes that are not always visible. Hormones are chemicals that control these changes. Hormones assist our bodies in growing taller, changing shape, and even growing hair. Although hormones affect different parts of the body (such as bones, muscles, or skin), several important hormones for puberty are produced in the brain. Scientists are learning more about how hormones influence how the brain grows and changes, and how this affects how you act and feel.

Introduction

Wherever you are from, whether you are a boy or a girl, your body begins to change the moment you are born and continues to do so as you grow older. This is referred to as human development. Human development can be thought of as a series of important stages in life, such as infancy (ages 0 to 2), childhood (ages 3 to 11), adolescence (ages 12 to18), and young adulthood (ages 18 to 24). As you can imagine and perhaps have already experienced a lot changes between infancy and young adulthood. Understanding these changes and how they occur can help us better understand ourselves and others as we grow older.

The body and hormones

How does the body know when it is time to grow? What happens inside that causes us to change on the outside? When it comes to complex processes, an organized system is usually required to manage all of the moving parts. To produce the beautiful music we hear when we listen to a symphony, many different instruments must play the right notes at the right times. A conductor tells each instrument what, when, and how to play in order for all of these separate elements to work together. Our genes are like musical notes in the body, strung together to form each body's own unique song. When the time comes, special chemicals called hormones act as conductors, telling other parts of the body what to do. The body's many organ systems are then like instruments that carry out the conductor's commands and bring the entire process to life. Hormones act as messengers throughout the body, giving orders to grow (or stop growing), change shape and size, or make more (or less) of something the body requires.

What occurs during puberty?

Puberty is the term we use to describe a series of hormone-driven changes that occur in our bodies just before and during adolescence, the period when we transition from children to adults. Our bodies' shape, size, and composition change as we approach sexual maturity, which is the ability of an organism to reproduce. Puberty also causes changes in our moods and behaviors. Hormones that affect our bodies also influence the structure and organization of our brains. Our brains strengthen and fine-tune the connections that allow for mature ways of thinking, feeling, and behaving during puberty. During this stage, you may notice the first signs of puberty, such as pubic hair, body odor, oily skin, and acne. The hypothalamus and pituitary gland, two small brain regions, then send messages to the reproductive organs, instructing them to produce sex steroids such as testosterone, oestrogen, and progesterone. These hormones have the ability to shape the structure and function of the brain throughout development. Androgens are a class of hormones that are commonly associated with male characteristics, but they are also necessary for female development. While males experience a significant increase in the androgen testosterone during puberty, females experience a smaller increase. As a result, brain circuits are organized differently in men and women, resulting in slightly different brains. This includes differences in cell growth, survival, and type in various brain regions. These subtle variations, known as sexual dimorphisms, prepare our brains for the distinct biological demands of both sexes. Sex steroids are hormones produced by the ovaries in females and the testis in males that stimulate the development of secondary sex characteristics. This includes wider hips, larger breasts, and the onset of menstruation in girls. For boys, this entails increased muscle mass, a deeper voice, and the development of facial hair. In both boys and girls, puberty is accompanied by a rapid increase in height known as a growth spurt. Steroid hormones also activate brain circuits involved in sexual behaviors, which explains why adolescents have a stronger desire for sex.

Pubertal hormones change the structure and function of the brain

Puberty is a dynamic period of transition that prepares us for adulthood. Even as adults, life is constantly changing, and our brains require ways to adapt to these constant changes. The same hormones that help shape the brain and body during puberty are also present throughout life. Even before birth, testosterone and oestrogen are involved in early brain development, assisting in the formation of new neurons and guiding them as they form the structure of the brain. These hormones then act to permanently change the organization and structure of the brain into its mature form during puberty. Brain structure can be altered in a variety of ways. The first is neuron growth or death, which alters the overall size of brain regions. Pubertal hormones are required for the proper development of brain structures such as the hypothalamus, pituitary gland, and amygdala in both animals and healthy humans. Because the hypothalamus and pituitary gland are essential for long-term hormone regulation, improper growth of these brain regions during puberty can result in long-term health consequences such as sleep or metabolism disorders. In adolescence, Klinefelter syndrome, a genetic disorder caused by an extra X chromosome, causes a lack of testosterone and a significantly reduced amygdala volume. These hormonal and brain structure changes may contribute to these people's social and emotional problems, such as social anxiety and difficulty expressing feelings. Another method for changing brain structure is to change the number of connections that each neuron has with other neurons, which changes the overall complexity of brain circuits. For example, the hippocampus contains a high number of oestrogen receptors, and oestrogen has been shown to increase the number of connections between neurons in rats. An increase in the number of neuronal connections in the hippocampus could explain why adolescent learning and memory improve. Sex steroids play an important role in myelination, a process that insulates the brain's neurons to make electrical signals more efficient in both animals and humans.

Puberty is a fun challenge

Finally, what we currently know about the effects of pubertal hormones on the brain is just the tip of the iceberg. It's a little like trying to understand how a symphony is performed without being able to see the orchestra. We hear the music, which means we see children grow through puberty and become adults, but we don't fully comprehend all of the details. We know there are notes (our genes), a conductor (our hormones), and many different

instruments (our organ systems), but we don't know who the musicians are, where they are sitting, or what instruments they are playing or when they are playing them. We don't know who the composers are because we still don't know how DNA encodes the genetic instructions for puberty. And, as with any piece of music, there are subtle variations in rhythm and tempo with each performance.

All of these complexities make going to the symphony exciting, and they also make puberty a fascinating topic for scientists to investigate. Scientists can learn to interpret the body's cues and crack the code of complex biological mechanisms in the same way that experienced concertgoers can learn to identify the instruments being played. We hope that young scientists like you will join us in this endeavour.

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