



MY TEEN BRAIN

Ten things you need to know about the teenage brain

Dr. John Coleman

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He is the author of many books, including *“The nature of adolescence: 4th Edition”* (Routledge, 2011) and *“Why won’t my teenager talk to me?”* (Routledge, 2014).

He has served as a Policy Advisor in the Department of Health, and is currently Chair of the Association for Young People’s Health (AYPH). He is also a Trustee of Family Lives.

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CONTENTS

SECTION 1	Introduction: The brain undergoes major change during the teenage years	4
SECTION 2	The main changes that take place in the teenage brain	5
SECTION 3	Two areas of the brain are most affected	6
SECTION 4	A time of significant change in the hormone balance	7
SECTION 5	The hormone melatonin affects teenage sleep patterns	8
SECTION 6	New skills are developing all the time	9
SECTION 7	There may be links between risk-taking and brain development	10
SECTION 8	The social brain	11
SECTION 9	Brain development can contribute to increased vulnerability	12
SECTION 10	Adults can contribute to healthy brain development	13
	Resources	14



SECTION 1: Introduction

The brain undergoes major change during the teenage years

Until recently it was assumed that there was little further development in the brain after the end of childhood. However we now know that the brain continues to change and develop all through adolescence. In fact, there is more change in the brain during adolescence than at any other time in human development apart from the first three years of life.

This means that the teenage years are a critical period. What happens during this period has major implications for later development. Of course the brain does not develop in isolation. The brain and the environment interact, each influencing the other.

In this short introduction I will be describing the changes that occur in the teenage brain. I will show how these changes affect behaviour. Finally I will outline how adults can use this knowledge to encourage healthy brain development. The more adults understand what happens to the brain at this time, the more we can help teenagers manage this period of transition.

SECTION 2:

Here are some of the main changes that occur in the teenage brain

I should start by saying that the brain is immensely complex. The human brain is the most complex thing in nature. There are in the region of 100 billion nerve cells in the brain.

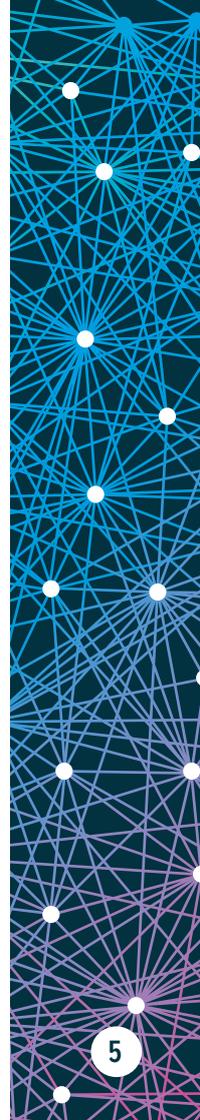
During the teenage years the brain undergoes substantial change. There is growth and maturation in most areas of the brain. This is something we have learnt as a result of the technology of scanning.

The maturation of the brain allows for new learning and the development of new intellectual skills. In addition the bridge between the two halves of the brain strengthens, allowing for greater connectivity, and enabling the brain to use its capacity better.

The material that encases the nerve fibres – called myelin – is also strengthened, so that impulses can travel faster and more effectively around the brain.

A further change that occurs in late childhood is a significant increase in the amount of grey matter. This is the area of the brain where most of the nerve cells are to be found. The grey matter is then gradually reorganised and re-arranged during the teenage years.

The networks of cells that are useful are reinforced, and the networks that are of little use are allowed to die away. This process is known as pruning. The phrase “use it or lose it” is one that readers may have heard of. It means that connections between cells that are valuable should be developed and rehearsed.





SECTION 3:

Two main areas of the brain – those to do with emotion and thinking – are most affected

Two of the most important areas of the brain are the pre-frontal cortex and the amygdala. Both these areas undergo very significant change at this time. The pre-frontal cortex is the area most associated with thinking, planning and problem-solving. The amygdala is the area associated with emotion, sensation and arousal. There are also areas in the brain associated with pleasure seeking, and these are more active during the teenage years.

These centres in the brain undergo significant alteration during these years. The brain is maturing, but this does not happen overnight. It takes a long time for all parts of the brain to function well together.

In some young people the amygdala may develop at a faster rate than the prefrontal cortex, and this is sometimes considered to be an explanation for risky behaviour. There may be times when some teenagers simply do not think ahead and do not take into account the consequences of their actions. In these

circumstances the parts of the brain associated with pleasure and rewards can, for a time, prove to be more powerful than the areas linked to thinking and reasoning.

A third area of the brain which is important to mention is the hippocampus, the site in the brain most associated with memory. The hippocampus is the centre that processes and encodes memory traces, and is also associated with the retrieval of memories. It is especially active in adolescence, and plays an important role in learning.

SECTION 4:

The teenage years are a time of significant change in the balance of hormones in the body

It has always been known that teenagers are affected by their hormones. This upset in the hormone balance is often seen as an explanation for moody or irritable behaviour. What is new in our knowledge is that the balance of hormones affects brain development. The alterations and fluctuations of hormones act on various parts of the brain that have already been mentioned, such as the amygdala and the prefrontal cortex.

High levels of sex hormones, such as testosterone and progesterone, have an impact not only on the development of the sex organs, but they also lead to changes in behaviour. Surges of these hormones may encourage teenagers to seek out emotionally charged experiences, or to look for novelty and excitement.

It is worth noting that levels of hormones such as cortisol and serotonin fluctuate considerably during this period. The release of cortisol is linked to experiences of

anxiety, whilst serotonin helps moderate anxiety. If these hormones are in flux it will be apparent that emotions may be difficult to manage.

Lastly it is important to mention dopamine. This is a hormone which is released when we get pleasure or enjoyment from an activity. The brain is particularly sensitive to dopamine during the teenage years, and some risky or thrill-seeking behaviours can be explained by increased dopamine activity at this time.

SECTION 5:

The hormone melatonin affects teenage sleep patterns

One other hormone plays a big part in teenage development. This is melatonin, the hormone which is released at night to tell us it is time to go to sleep. In the last few years we have learnt that melatonin is released later among adolescents than in other age groups. This means that many teenagers become sleepy later than their parents.

This has big implications. Sleep is important for teenagers. If they have to get up early for school, they may be missing some hours of much needed sleep. Research tells us that sleep deficit (less than seven hours a night) can influence both learning and behaviour.

In recent years there have been attempts to address this problem. One suggestion is to provide guidance about how to develop good sleep routines, so that the melatonin effect can be overcome.

Here are some ideas about developing good sleep routines for teenagers:

- Turn off all digital devices at least half an hour before bedtime;
- Turn lights down, put on soothing music;
- Have a hot drink of some sort (without caffeine);
- Most important of all, develop a routine. Adults can help with this. Routines make all the difference.

Recent research has shown that there is another reason why sleep is especially important for teenagers. Sleep is a time of memory consolidation. The hours of sleep allow the brain a period when the learning that has taken place during the day can be rehearsed and embedded in long term memory.

SECTION 6:

New skills are developing all the time

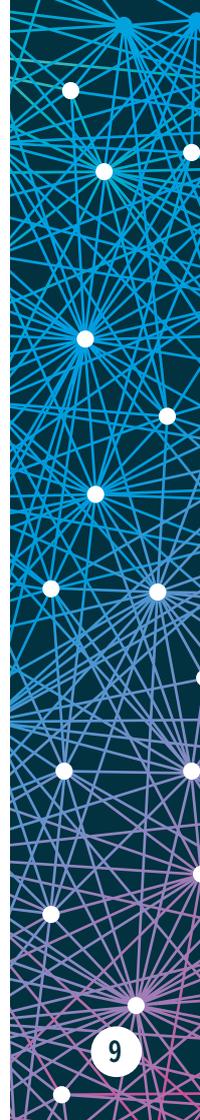
It is essential to keep in mind that the teenage years are a time of large gains in intellectual skills. The regions and networks in the brain that are to do with memory, language and learning are altering to allow new thinking and greater cognitive capacity.

As far as new thinking is concerned, as young people move through Key Stages 3 and 4 they begin to be able to think at an abstract level, and to pursue scientific reasoning.

Memory capacity also increases. Although this is not routinely tested in school, research shows that there is a marked change with age. As young people mature, their memory capacity expands, and there is a development of their ability to remember more facts for a longer time.

Language is another area which shows marked change at this time. Vocabulary increases, as does the ability to communicate more effectively.

Adults sometimes find this hard to comprehend, since many teenagers come across as either tongue-tied or unwilling to talk to adults. Nonetheless communication skills do develop during these years as areas of the brain related to language go through a process of development. This is clearly in evidence when young people are observed in communication with friends.



SECTION 7:

There are links between risk-taking and brain development

One of the most common ideas about teenagers is that they are risk-takers. As was suggested in Sections 3 and 4, it may be that the area of the brain to do with thinking and planning matures more slowly than the area to do with sensation and arousal.

If this is the case, behaviour may be more under the control of the parts of the brain to do with short-term rewards rather than with the areas related to problem-solving and thinking about consequences.

However it should be noted that there are different views about this. Some commentators argue that it is not “defects” in the brain that lead teenagers to do risky things. Rather it is lack of experience, combined with the desire to explore the world and look for novelty and new experiences, that are the real factors to be taken into account.

Another possible explanation has to do with the pleasure centres in the brain, and the role of the hormone dopamine. Research shows that the centres associated

with pleasure are more active during adolescence. In addition heightened levels of dopamine, and the effect of this on the pleasure centres, may have the effect of leading some teenagers to seek thrills and pleasure, without having taken into account what may happen as a result of these activities.

Finally it is important to keep in mind that the environment plays a part too. What is happening in the brain interacts with the experiences of the young person, as well as the influences of key people.

Adverse childhood experiences may increase the likelihood of risk-taking because of the impact of these experiences on brain development. The behaviour of important adults and of the peer group can also influence the degree of risk-taking on the part of the young person.

SECTION 8:

One aspect of development has to do with the social brain

The term “social brain” refers to the regions that have to do with understanding other people. On the one hand the development of the social brain brings with it new skills. On the other hand there are also some short-lived deficits that make it hard for the teenager to see the wider picture.

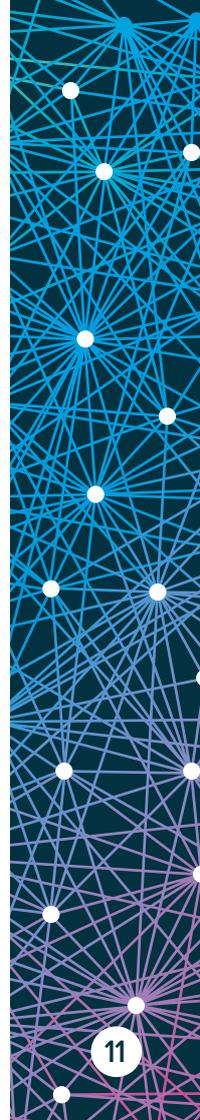
Looking first at the new skills, these have to do with understanding the thoughts or intentions of others. Skills include being able to take the perspective of another person, understanding the mental states of others, recognising emotions and making assessments of people. All these are essential as the teenager becomes more involved with the peer group.

Strangely, however, just as these new skills are developing, the young person also becomes more self-conscious and self-centred. This is sometimes described as a “pre-occupation with the self”. Developments in the social brain allow the young person to think about how he or she appears to others. This new capacity, combined

with concerns about the changing body, are the factors that underlie a period of “adolescent egocentrism”.

This is also the time when young people are unusually influenced by the peer group. Studies show that increased sensitivity to what others are thinking, and awareness of the reactions of friends plays a part in influencing behaviour. Centres in the brain that take account of the reactions of others are particularly active at this time.

We should not be surprised that all this appears contradictory. Major structural change is happening in the brain, and this cannot happen overnight. It takes time for all areas of the brain to function effectively together. There will be occasions when self-consciousness will be developing alongside the growth of new skills.



SECTION 9:

Brain development can contribute to increased vulnerability

There are many ways in which teenagers show their vulnerability. This may be through moods and emotions, through behaviour, poor health, or troubled relationships. The brain plays some part in all this, but it is only one part. Childhood experiences and the circumstances around the young person will play their part too.

As far as the development of the brain is concerned, there are many ways in which this can contribute to increased vulnerability. As has been mentioned on the previous page, major structural change is happening, and this will not always proceed smoothly.

It is inevitable that such a degree of change brings with it a period when things are a little off-centre. It is completely understandable that things will take some time to settle down following such a period of alteration and reorganisation.

The hormone balance will have an influence as well. Hormones play a critical role in either helping or hindering the flow of messages around the brain. When hormones are out of balance this can make it difficult to

concentrate in class, or to manage relationships in a sensible manner.

A good example is the role of the hippocampus, already mentioned in Section 3. This centre plays a very important role in memory and learning, but is also significantly affected by stress hormones. Higher levels of cortisol, for example, will have an impact on the way the hippocampus functions, interfering with the learning process.

As far as the influence of the environment is concerned, adverse childhood experiences such as trauma and abuse will inevitably have an influence on brain development. However we still know relatively little about how these contribute to vulnerability in adolescence.

Positive experiences during the teenage years may do something to mitigate the negative effects of adverse events. It is here that adults can play such a crucial role. Stability and ongoing support during these years will have a clear benefit for brain development in adolescence.

SECTION 10:

Adults can encourage healthy brain development

Throughout this booklet there has been an emphasis on the fact that the environment around the teenager makes a difference. Here are four things that adults can do which will have a positive impact on brain development.

Understanding

If adults can make allowances for the fact that teenagers are experiencing a major upheaval and readjustment of their brains, this will make relationships easier and contribute to well-being.

Hormone balance

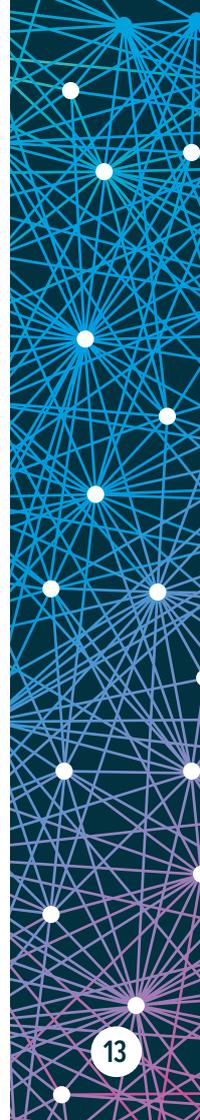
A good balance of hormones is essential if the brain is to manage the process of pruning unwanted connections, whilst developing and cementing useful neural pathways. If the young person experiences too much anxiety or stress the hormone balance will hinder this fundamental process. There is no way to avoid some degree of anxiety and stress, but adults can do all they can to keep this to a reasonable level. In addition they can help young people learn to manage these difficult emotions.

The amygdala and the prefrontal cortex.

The more adults can do to encourage the development of the prefrontal cortex, the better for emotion regulation. The more enriching the environment, and the wider range of activities the young person is engaged in, the more opportunities there will be for the prefrontal cortex to mature faster.

Good routines

For teenagers routines make a difference. Where sleep is concerned, the melatonin effect can be overcome, but only with good sleep routines. This is hard to manage on your own, so adult help can make a significant difference.





Resources: Further reading

The brain: the story of you

David Eagleman

Canongate. 2015.

This is a general book about the brain by an expert communicator. A good read, with lots of interesting examples to help the reader understand this topic.

The teenage brain: a neuroscientist's survival guide to raising adolescents and young adults

Frances Jensen

Harper Books. 2015.

The title tells it all. The author is a parent and a doctor, and she gives a refreshing insight into her experiences bringing up two boys. Strongly recommended.

Blame my brain: the amazing teenage brain revealed

Nicola Morgan

Walker Books. 2013.

This is the only book so far for teenagers themselves. It has proved very popular, both with young people and adults. Easy to read, with quizzes and exercises for the reader to complete.

Why we sleep: the new science of sleep and dreaming

Matthew Walker

Penguin Books. 2017.

A best-selling book by one of the world's experts. Reporting up to date research on this fascinating topic, it will help the reader understand why sleep is so important for teenagers.

Resources: Useful websites

Professor Sarah Jayne Blakemore's TED talk is entitled: "*The mysterious workings of the adolescent brain*"

It can be found at www.TED.com

The Wellcome Trust has an extensive research programme on the teenage brain. It is entitled: "*The neuroscience and education programme*"

It can be found at www.wellcome.ac.uk

The Hertfordshire programme entitled *My Teen Brain* can be found at:

www.hertsdirect.org/myteenbrain

The Mentor-Adepis organisation is based in the UK and has useful briefing papers on the teenage brain. These can be found at:

<http://mentor-adepis.org/brain-under-construction>



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From child to adult,
the adolescent period
represents one of the
greatest psychological
transitions we experience.

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