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Opening extract from

Blame My Brain: The Amazing Teenage Brain Revealed

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CHAPTER ONE

Powerful Emotions

"I hate you – oh, and by the way, can I have some money?"

Meet Matt. And his mum. There is an emotional war going on. And neither of them knows why.

Matt's parents are worried about him. He used to be a model pupil but recently his grades have slipped. He is moody, spends a lot of time in his room, and listens to dreadful music with lyrics which are negative, depressed and frankly weird. He has posters of Kurt Cobain around his room and when his mum asked politely why he liked Kurt Cobain his answer was: "Because, like, he killed himself and that is just SO neat."

"Unlike your room," she joked, trying not to react.

"God, Mum, you're always going *on*. Just leave me alone!" he shouted, giving her an odd manic glare. Was he on drugs? she wondered.

Anyway, yes, so they are worried about him. They only want him to be happy. And safe. And nice to them. And successful. And an A-grade student. And get a brilliant job. And score more goals than anyone else in the inter-schools football tournament when everyone

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is watching. Yes, they are worried about Matt. But it's only because they *care*. It's a tough world out there and how will he get on if he shouts at his parents? Will he shout at his employers too? Will he be a complete failure? It's enough to drive a mother to breaking point herself.

So, this evening, Matt's mum has decided to have a little chat. Just a relaxing chat about nothing in particular. A chance to do some mother-son bonding. She's going to go into his room and ask how his day was. No pressure.

She knocks on the door. No reply. Again, louder. No reply. So she turns the handle, at the same time calling his name. The room is quite dark. There's a smell of incense. But she will ignore that. It's quite a nice smell, actually. Soothing. Though no amount of dry-cleaning will ever get it out of the curtains. And she made those curtains herself, sewed till her fingers bled, to make the house look beautiful, and what does Matt care? She pushes aside the shiver of teeth-grinding irritation.

"Matt," she calls. He is lying on his bed, eyes closed, headphones wrapped around his head, drumming the beat on his mattress. His homework is lying open on the desk. Peering through the gloom, she reads the title: "To what extent was Macbeth's downfall within his control?" He has written two lines so far: "In the

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play *Macbeth* by William Shakespeare, Macbeth has a very tragic downfall. It was entirely the witches' fault because they shouldn't of ever said what they said." Crammed into the margin are detailed doodles and when she looks closely she sees they are dozens of hangman's nooses all entwined together.

She moves the burning incense to a safer place and accidentally kicks over a can of Coke on the floor. Matt opens his eyes.

"Mum! What the hell are you doing? This is my room! Get out! OK?"

"Yes, sorry, Matt. I did knock."

"Yeah, well, knock louder next time."

"I just thought I'd come and ask how your day was. Can I get you anything? I could bring you some tea or something. It's quite a good idea to drink tea while you're doing your homework. Relaxing and stimulating at the same time."

"Yeah, well, I'm not doing homework, am I?"

"Don't you think you should finish this essay?" she says, pointing at the almost empty page.

Matt rips his headphones off and with exaggerated effort hauls himself to his feet. He is six inches taller than his mum and looking down on her is a great feeling. "Look, butt out, Mum. It doesn't need to be done for ages."

"When?"

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"Like, days. I don't know, Friday or something."

"Don't you even know?"

"Yes, it's written down. It's under control. I'm not stupid, you know."

"Well, OK, but how about doing some other homework then? There must be something that needs to be done for tomorrow. It's a good idea to try to be ahead of things, Matt. Don't you get weekly French tests? I could test you or something. It's so much easier to learn when someone tests you." She picks up a book from a pile on the floor.

You can almost see the electricity fizzing through Matt's body. You can see the anger in his clenched muscles and his thunderous face.

"Put it down, Mum. Leave me alone! I'll do it by myself. You don't know any French anyway."

"Well, if you *will* do it on your own, fine, Matt. But will you? That's what I want to know!"

"Oh, right, so you don't trust me now?"

"Well, I want to trust you. But how can I trust you after last week, when I found that message in your notebook from Mrs Legless saying you hadn't done your homework?"

"That was just once!"

"And the week before? Mr Golightly?"

"That was because you made me do the ****** housework!"

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"No, Matt. You have your chores to do at the weekend and you know the deal is that if you don't do them then, you have to do them during the week."

"It's unfair. No one else has to do chores. Why does the house have to be so bloody tidy anyway? What are you? A cleaning obsessive? Even my friends think this house is weird cos it's so clean. There's medical treatment for people like you – I was reading about it the other day. There's even a name for it. It's a mental disorder. You should see a doctor."

"That's enough, Matt!" shouts his mother. "Don't speak to me like that!"

A voice shouts irritably from downstairs. Matt's dad. "What's going on, you two? Keep the noise down, for goodness' sake! I can't hear myself think."

Matt looks at his mum triumphantly. She fumes, betrayed, furious. And it had all started with her offering to help.

She picks up some dirty socks and leaves the room. Matt slams the door.

"Don't slam the door!" she shouts.

"Get out of my life!" he yells back.

Five minutes later he comes downstairs.

"There's a party at someone's house on Saturday. Not sure where. I need new jeans. Can I have some money?"

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What's going on in Matt's brain?

Why does a previously sensible, happy boy, who was ticking along quite nicely, working reasonably hard, being reasonably nice to his parents, suddenly turn into someone whose anger erupts like a volcano at the slightest hint of intrusion? Why the arguments that blow up out of nothing? And why does Matt feel lousy inside with that eternal cry of "It's not fair!"?

Experts used to say, "It's just **hormones**", or "It's just a natural desire to break free from parents and move towards independence." Both those things are partly true. But new research shows something very special going on in the teenage brain.[5] Something which makes it work in a different way – something which even makes it look different inside from either a child's brain or an adult brain.

Before you read on, remember two things: first, not all teenagers go through this difficult emotional phase. Second, teenagers are not the only people who can be irrational and emotional, volatile, argumentative and snappy. Ever look at the adults around you? What's their excuse for rattiness and foul temper? They would probably say that YOU are their excuse. Hmm.

Previously we thought that teenage humans were the only ones to go through adolescence, but when scientists looked at other mammals, like rats and monkeys, they

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found similar changes in the brain and similar changes in behaviour. Maybe rats feel ratty too.

What about Matt and his arguments? What's this got to do with our new knowledge about teenage brain changes?

Scientists are careful about drawing conclusions. They say: "We see these changes in the brain and we see these changes in behaviour: they *might* be linked but we can't be sure exactly how." They're right to be cautious – scientists are supposed to be cautious – but let's look at what we see, because it is fascinating. And all the scientists agree on THAT.

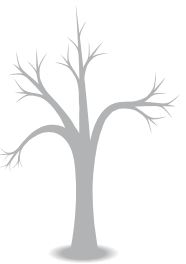
First, we see a major increase of grey matter in the prefrontal cortex – the part of the brain that has most to do with thinking, reasoning, logic, decision-making. It is like a tree suddenly growing and branching out in the spring. This increase mainly happens just before **puberty**, usually between the ages of 10 and 12. The peak of grey matter growth is at around 11 years for girls and 12 for boys. In fact, far too many connections or synapses grow at this stage (which is also what happens in a young baby's brain). They will need to be cut back, or pruned, which is what happens next.

After the huge growth which happens just before and at the start of puberty, you have a period during adolescence where the branches are cut back or pruned. It's as though the cells the brain doesn't need just fall away. Scientists think that this pruning is more important than

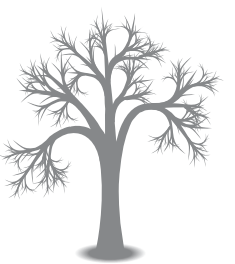
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the growth, like pruning a tree to make its branches fewer but thicker and stronger. By the age of 16 or 17 you have adult levels of synapses – but when you were 1 or 2 you had twice as many.

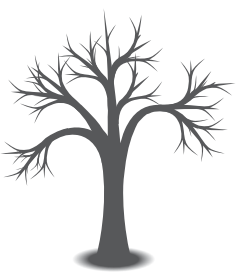
During normal adolescence you lose around 15% of grey matter from your cortex. Then, in late adolescence and into early adulthood, the brain spends time building up and thickening the branches that are left, coating the axons to make them strong. This strengthening stage is called myelination. There is more about it in Chapter Six.



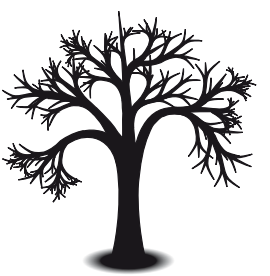
child



early puberty



middle of puberty



end of puberty

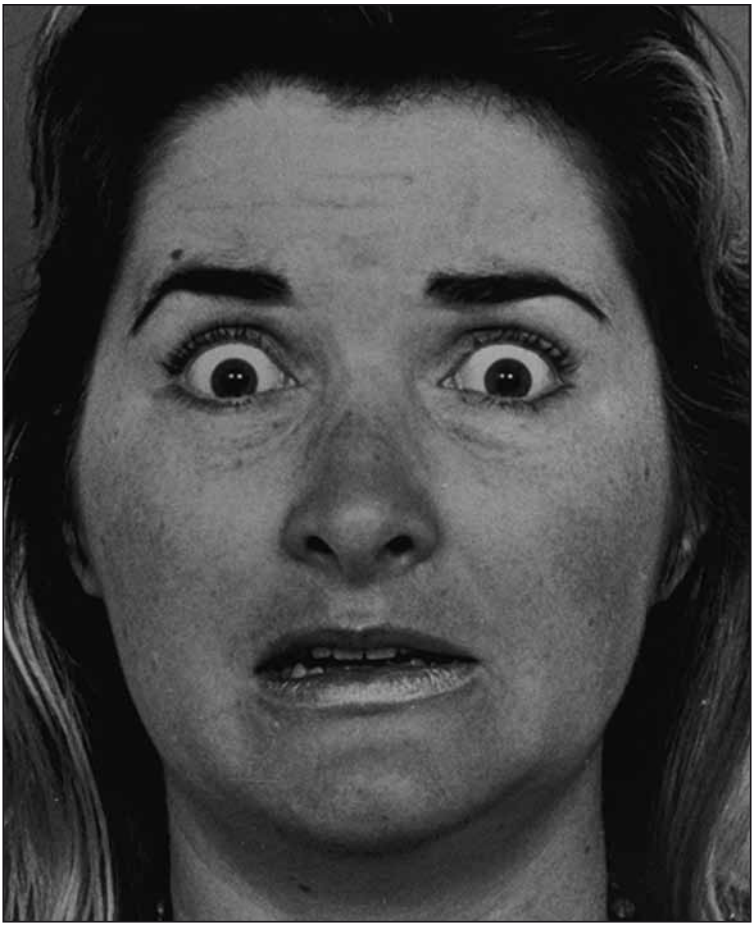
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Adolescence is a period of huge and surprising physical change in the brain. It is as though many different parts are being remodelled to work in the more complex ways necessary in adult life. And during this upheaval and change, maybe the pathways for sensible behaviour are just not working well.

In support of this theory, researchers have found something else very interesting about Matt's brain. It's time you took the teenager test.

Look at the picture opposite.

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Photos of Facial Affect © 1976 Ekman and Friesen

What emotion do you think this person is showing? What is she feeling? Think about it for a few seconds.

Now turn the page.

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WHAT DID YOU SAY?

Did you say any of these:

Anger? Shock? Disgust? Pain?

If you said any or all of these, you are just like many teenagers, but you are also *completely* wrong.

The person in the picture is showing one emotion, and one only. And that is *fear*. Or you could call it terror. But it is *not* anger, or shock, or disgust.

In an experiment researchers asked a group of adults and adolescents the same question.[6] Quite simply, *all* the adults got it right and a large number of the adolescents got it wrong.

Amazingly, when the researchers scanned the brains of the participants, they discovered that most of the teenagers were using different parts of their brain when they looked at the picture.

When adults looked at the picture, the part of the brain which showed activity was mainly in the prefrontal cortex – that sensible bit which tells you not to order your mother to get out of your life if you want her to give you some money.

When adolescents like Matt looked at the picture, the part of the brain which seemed to be working overtime was the **amygdala**. This is a tiny part linked to gut reaction, raw emotion. The amygdala is one area of the brain which is almost fully developed in a baby – it works through instinct, not logic. It is not a thinking part at all.

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Dr Deborah Yurgelun-Todd, the researcher who discovered this interesting behaviour, suggests that this *may* mean that teenagers have difficulty reading the faces of the adults around them – they may think an adult is showing anger when it is worry and concern, or disgust when it is simply surprise. She found that boys are also slightly worse than girls at this, and seemed to be using their emotional amygdala more strongly. The research is still going on, and even more interesting things may yet be discovered. Some research suggests that 11-12 year olds are 15% slower than younger children at matching the emotion on a face to the emotion word, and that this ability doesn't recover fully until about the age of 16. (This result hasn't been repeated, so it may turn out to be different when more research is done, but it does seem that many young adolescents have particular problems with this task.)

Now, we can't say, "We see this in the brain, *therefore* teenagers are reacting emotionally instead of logically." Brains are not that easy to understand. What we can say is, "The teenagers get it wrong and seem to be using a different part of the brain *while* they are getting it wrong."

It makes you think, though. Is the way Matt's brain is currently wired up affecting the way he interprets his mother's face and voice? Is he misreading her signals? Is he unable to work out that, actually, she does want the best for him, *is* concerned about him, does want to help

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him? Yes, she's nagging horribly, but does his teenage brain make it impossible to understand and to do what he knows he should: which is to do his homework before the deadline? Is this why he can't see beyond his gut reaction of fury, a feeling of invasion, a need to shout "Get out of my life"?

Psychologists say that there are 412 separate emotions which humans can feel, each of which we express on our faces. If you want to see how good you are at telling what someone is feeling, try the test at the end of this chapter.

Mind you, let's remember that parents can also be emotional, furious, illogical, irritating, irrational, uncontrolled, plain stupid. And regret it afterwards if they've got any sort of decency. Wouldn't it be interesting to see an fMRI scan of what's going on in a parent's brain during arguments with teenage offspring?

A possible theory about what is going on in Matt's brain is this: the early teenage brain is changing its structure. First it increases in density and number of connections, far more than it needs, especially in the prefrontal cortex. Then it does massive pruning, losing connections in some areas and restructuring itself in ways we do not yet understand. And Matt hasn't reached the final stage

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of strengthening myelination yet.

Matt's behaviour could be affected by all this change, and this is perhaps partly why he behaves like the "typical teenager". Personally, I can't see how he could *avoid* being affected. After all, it's our brains that make us feel the way we do.

Apart from anything else, Matt is probably under stress from many things going on in his life – friendships, pressure at school, exams, fears for the future – and stress does make us more ratty, more snappy. Add that to what's going on in his brain, and you have a recipe for volatility.

Other emotional brain differences

Recent studies have shown other differences between teenage and adult brains when they think about emotional situations. For example, research[7] shows teenagers and adults using different parts of the brain when thinking of socially embarrassing situations. Interestingly, some studies[8] show areas of the prefrontal cortex working *harder* in teenagers than in adults for some activities. So, it's not at all the case that your prefrontal cortex is sleepy: just that it works differently and may produce different results.

Hormones

What about hormones? Hormones are the chemicals which adults for generations have blamed for all teenage

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mood swings. Well, hormones are certainly still guilty. We know very well that they affect mood and therefore behaviour very directly, and we know very well that hormones are racing madly around the bodies of teenagers, turning them from children to adults within a few years. Scientists now also believe that hormones can change the physical structure of your brain too.

But what controls the hormones? The brain. We are not sure what triggers puberty, but it is certainly something in the brain that tells those hormones to start racing. Hormones and changes within the brain are linked in complicated ways, but what *is* certain is that both are particularly important during adolescence.

There's more about the effects of hormones in Chapter Four.

Why do we have adolescence? And why is it so much longer in humans than in other animals?

We now know that some other mammals have a period of adolescence, too, including monkeys, rats and mice. New research in the US on macaque monkeys[9] has shown more clearly than before that neurons and synapses are pruned away during adolescence, as they are in humans. Those mammals that have a period of adolescence get through it much more quickly than humans. The female rhesus monkey goes from puberty to adulthood between the ages of around 18 and 48 months – and displays many

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equivalent characteristics, including teenage sleeping patterns, risk-taking and spending huge amounts of time hanging out with other adolescent monkeys.[10] Maybe they even do the monkey equivalent of swearing at their parents.

Here are some ideas about why humans need a relatively long adolescence and why it's the emotional ride that it is. They are not separate possibilities but are closely linked together. For example, evolution is responsible for our biological make-up, and our biology in turn leads to the way we behave as a society. So don't look at them as separate theories, but just as different ways to focus your thoughts.



THEORY 1 – IT'S EVOLUTION

An evolutionary biologist always looks at questions like this by saying: "This must have given some advantage to early humans. What could it have been?" In the case of adolescence, it could be because early human society was much more complex than other animal societies, so we needed more time to learn the skills required.

THEORY 2 – IT'S CULTURAL

There are adults who say, "Huh, it was different in my day. In my day we weren't *allowed* to feel like that. We just did what we were told. This modern teenage behaviour is all

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because there are not enough rules any more. If adults got tough and teenagers never watched television, there'd be no teenage behaviour to talk about." I would say these people are in denial. "Get real," I'd say. The Greek genius Aristotle talked about the strange behaviour of teenagers. And that was almost 2,500 years ago.

THEORY 3 – IT'S THE NEED FOR INDEPENDENCE

All mammals need to leave their parents and set up on their own at some point. But human adults generally provide a comfortable existence – food arrives on the table in quantities, money is dished out at regular intervals and can be pleaded for more or less successfully, the bills get paid and the electricity for the TV doesn't usually run out. If teenagers didn't build up a fairly major disrespect for and irritation with their parents or carers, they'd never want to leave. In fact, falling out of love with the adults who look after you is probably a necessary part of growing up. Later, when you've gone, you can start to love them again because you won't need to be fighting to get away from them. And you can come back sometimes for a home-cooked meal and even bring your dirty washing with you if you play your cards right.

The need for separation could also explain why teenagers are far more concerned about what their friends think than what their parents think. Recent and

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ongoing research shows that teenagers even use different parts of the brain and sometimes make different decisions depending on whether their friends are with them. Friends are everything – because friends are what we need when we leave home. Humans rely on sociability. It makes sense to cultivate friends. In fact, this drive towards independence is possibly the most important thing about adolescence. It is, if you think about it, pretty much the whole point. And it's what your parents and all the adults who care about you want for you in the end. What they may not realise is that if you're going to be independent at 22 you may need to start rattling the bars of the cage at 14.

THEORY 4 – IT'S JUST THE WAY THE BRAIN IS

We could simply say that it's not surprising the brain has this confusion and can't work entirely effectively, because there is so much change happening. Adolescence is an unfortunate side effect of all that change, and that's all there is to it.

Which theory do you find most interesting? Evolution? Culture? The struggle towards independence? Or just coincidence?

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