

Teenage brains

Several discoveries from the latest findings of cognitive neuroscience have important implications for those who work with young people, said Howard Sercombe at the recent CCYP conferences

Brains are fascinating, but difficult to study because they are complex in structure and function. Until recently, most of the information we had was from brains that weren't working: our knowledge about brain *structure* came from dissecting the brains of dead people, and our knowledge of brain *function* came from studying people who had injury or damage to particular parts of the brain. But over the last decade, that has changed. A new generation of technologies (especially Magnetic Resonance Imaging (MRI)) is able to present computer-generated images of brain structure in exquisite detail (Figure 1), and also enables us to study brain function: to see areas of the brain that are working at any moment *while people are awake and thinking*. This means, also, that we can see the areas of the brain that are engaged when people are asked to perform different cognitive tasks or respond to different stimuli. We can also see differences in both structure and function between different populations: men and women, older people and younger people. There has been a whole new wave of research into the 'teen brain', and, as a result, a further wave of popular writing about it.

There are a number of discoveries from these new developments in cognitive neuroscience that have important implications for people who work with young people. There are also, unfortunately, ways in which the research, or interpretations of it, do nothing more than embellish old prejudices against young people – another round of the 'noisy, crazy, dirty, lazy loafers' chorus¹, and we need to be cautious and ready to defend children and young people from the sometimes repressive consequences of this.

Experience creates brain structure

The first, and arguably most important, of these findings is that experiences create physical structures in the brain. Falling in love, falling off your bicycle, falling asleep all leave fragments of connection in your brain. Every experience of every second of every day causes the brain to try to physically incorporate it by making connections between neurons, trying to wire the experience into the brain's circuitry. As a result, the physical structure of different people's brains is different – or similar – depending on their experience. London taxi drivers' brains are different from other people's² (no surprises there, perhaps). You can see

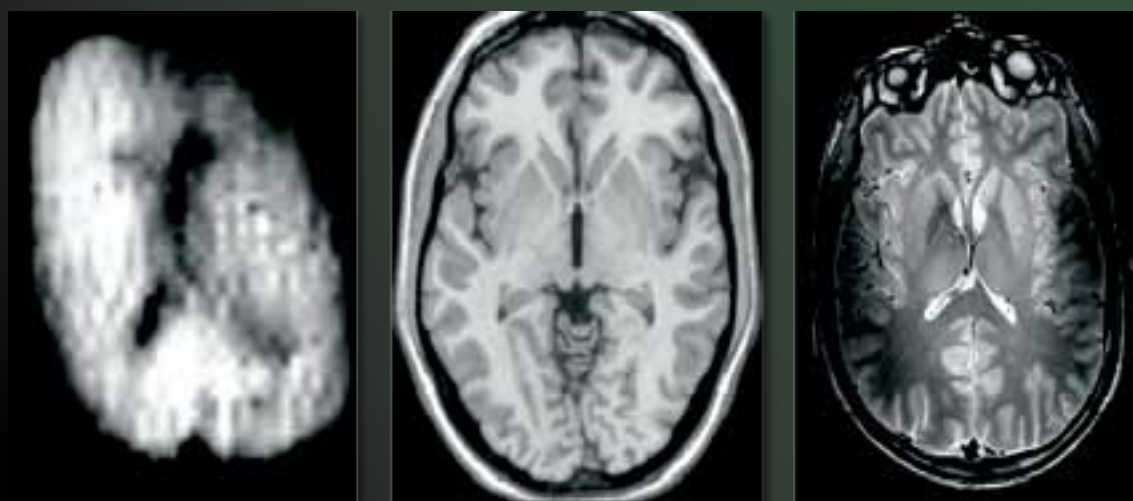


Figure 1. Improvement of MR images of brain structure in the last 30 years

From left to right: An image of a dead brain obtained on a 0.1 T scanner in Nottingham in 1978 (courtesy of Prof. Peter Morris, Sir Peter Mansfield MR Centre); an average of 27 images obtained by scanning the same individual repeatedly on a 1.5T scanner in 1995 (courtesy of Prof. Alan Evans, Montreal Neurological Institute); and an image acquired on a 7.0 T scanner in Nottingham in 2005.

that someone is a musician in their MRI scan^{3,4}. In one famous experiment, college students were taught to juggle. After a period of time, you could see the part of their brains that had developed. When they stopped, it shrank again⁵.

The way that the brain works in incorporating experiences like this will be shaped by prior experience, your genetic makeup, and your own agency and decision-making. But what it means is that our brains are not a product of nature *or* nurture, but always, constantly, nature *and* nurture, in a perpetual dance, in which neither genetics nor environment nor individual agency can ever be independent of each other. The nature *versus* nurture argument is obsolete⁶. Nature and nurture are on the same team.

Making the brain more efficient (but less flexible?)

We have discovered some important things about brain development in the teenage years. It used to be thought that there was no significant difference between the brains of teenagers and those of older adults. The new brain science has shown that this is not so^{7,8,9}.

The brain is composed of different kinds of tissue. Among these, **grey matter** is responsible for information processing functions. **White matter** is a fatty substance called *myelin* that provides insulation for the brain's circuitry, massively increasing the speed and efficiency of message transmission. There is a significant increase in the ratio of white matter to grey matter through the teenage years^{10,11}. It therefore appears that the organism is selecting various circuits in the brain for the myelin treatment: presumably because they are used a lot, have proved to be efficient, or are important for survival. This begins with the deep structures of the brain that are more fundamental for survival, including the circuits for social relationship, and moves forward to embrace the parts of the brain that are associated with conscious thinking and reasoning¹.

A useful analogy is that of roads. Where I grew up, in the Western Australian goldfields, there were roads everywhere: little dirt roads running to diggings or shacks or forgotten places that didn't exist any more; graded roads to sheep stations or

water tanks or places people still lived in; gravel roads between small towns; and bitumen roads between bigger towns or places of wealth and importance. Back at the turn of last century, in the gold rushes, if you wanted to go somewhere, you pointed your vehicle or cart or wheelbarrow in the direction you thought you wanted to go, and off you went. Others might follow your track, and as they did, a road formed (like in the Dire Straits song *Telegraph Road*). Or they might go another way that they thought was quicker or easier, and make another road. Over time, if the road was used a lot, the council might grade it and lay gravel, and eventually bitumen. Once the bitumen was down, everyone went along the bitumen, and the little dirt roads got overgrown. They rarely completely disappeared because it was so dry, but going along them was hard work and they mostly ended nowhere. Myelin is the bitumen of the brain.

Childhood is a process of creating little dirt roads all over the place, learning so fast, learning or inventing a hundred ways to do things, and learning a hundred things to do every day. Children's grey matter is just blossoming. In adults, it is much harder to see all these little dirt roads. Instead, there is a network of bitumen highways: serious, efficient, fast. All the roads that don't go anywhere, or aren't the fastest or safest ways to get there, have been left to grow over.

At the level of practice, our work is often about helping young people find other ways to do things. They may have myelinised a circuit in a context where their life was full of threat and violence, and where there were few real options. Now, later, they are in a place where the hyper-alertness and instant defensive reactions appropriate to that kind of life are no longer necessary – and, indeed, threaten their survival in the present. Change can often be the struggle to find the way onto a little, overgrown dirt track that will enable the person to deal with situations in a way that is happier and more successful. It isn't easy: the bitumen is always easier to find and quicker and smoother to travel down. But in time, with practice and hard work, the dirt becomes a graded road, the graded road becomes gravel, the gravel becomes bitumen, and the old bitumen road becomes broken up and potholed.

In counselling situations, helping young people connect with the relationships or experiences in their past that worked and nourished them can help them find a different way of being in the present. So asking questions such as 'So who liked you as you were growing up? What teachers respected you? What was that like?' or 'When have you been at your best with this stuff? When has it worked? What was going on for you then?' or 'How would you like to be? What are you like when you are at your best?' can help young people



find the beginning of the little dirt track and move off the bitumen.

I have used this approach a lot in working with young people, especially young men, around a range of issues, including violence and drug use. The mechanics of how the brain works often make real sense to them, helping them understand why they react the way they do, and empowering them to take charge of the way they want their brain to work.

Risk

One of the key areas of inquiry has been to do with how this development affects young people's risk-taking behaviour. The appetite that some young people have for taking risks has been of concern to researchers for some time, with a range of assessments and explanations. Generally, the feeling is that young people take more risks, on average, than others (for an alternative view, see Males¹²). There are sociological explanations for this, in terms of inexperience or the fact that they have less to lose, and more chances to recover, if things don't work out. But there may also be things going on in brain development.

According to neuroscientists, a major part of the brain's work involves inhibiting impulses and reactions: it is not so much that our actions are determined by 'free will' as 'free won't'¹³. Steinberg notes that in the early teenage years there is an increase in reward receptors in the brain that release feel-good chemicals in response to particular experiences. At the same time, areas of the brain associated with inhibiting impulses (such as the prefrontal cortex) are still developing connective efficiency. He suggests that this combination produces a developmental deficit in risk management in teenagers, which seems to be exaggerated in the presence of peers. So, the argument goes, young people are biologically more prone to irresponsibility, risk taking, hedonism, drug use, driving cars fast, and a range of other potentially dangerous behaviours, especially when they are with their mates¹⁴.

This is possible. But there are a number of reasons to be cautious. First, as was discussed above, structure does not unilaterally determine function. It may be the other way round: that taking risks is precisely the experience that develops the prefrontal cortex. To use our earlier analogy, were the roads sealed because they were used a lot, or were they used a lot because they were sealed? By preventing young people taking risks, we may be consigning them to a conservative and fear-driven adulthood that does not know how to assess and manage risks healthily.

For 150 years, youth workers have used the confrontation with risk (through outdoor and wilderness experiences, sport, public speaking,

theatre etc) to help young people 'grow up'. We find that when young people face risks, and face them down, they change. They are afterwards more 'mature', more balanced, more effective agents, more thoughtful. A very real hazard at the moment is that the elimination of risk, or access only to trivial, virtual or ineffectual risk creates an endless adolescence and an ineffectual adulthood. We need young people to take more risks than they are doing at the moment, not fewer. What risks they take, and how the downside is managed, is, of course, another question.

Public health officials have sometimes argued, on the basis of brain science, that we need a range of policies, from restrictions on driving to access to alcohol, which would be protective of young people while their brains are connecting up. However, secondary risks arising from excluding young people from risky social practices are often unrecognised and under-evaluated. Reducing young people's access to driving licences in particular has massive implications, not only for their personal mobility, but for their employability, income, access to education and many other social resources and opportunities. In societies without good public transport, being without a car is both an indicator and producer of poverty – itself *the* risk factor for people of all ages. Considering there is some biological predisposition for young people driving hazardously, *many* young drivers are very cautious indeed, *most* young people drive safely almost all of the time, and a *few* are sometimes crazy. To exclude all young people from access to personal motorised transport on the basis of a predisposition rarely realised is, I think, a deep injustice.

Increasing the drinking age exposes many more young people to intervention by police and the criminalisation of quite normal social behaviour, as well as making illegal drugs more accessible, comparatively speaking. It also excludes them from any entertainment venues where alcohol is sold, driving them to construct their own homemade sensation-seeking opportunities. These policies are hazardous to young people, and expose them to risks arguably in excess of any reduction achieved through the restriction.

We need especially to be careful of exclusion as a means for dealing with what appears to be delayed or yet-to-develop competence. The law itself is one of the forces that shapes this: if experience shapes the brain, legal exclusion from experience also shapes the brain. We could simply be creating vicious circles, where our exclusion of young people *because they are not ready* prevents them from developing readiness.

And – this is difficult to say – in the process of living and taking risks, some young people are injured, sometimes with permanent consequences, and some die. There is a deep discomfort about



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even talking about the acceptable risk of a young person dying (though note that it doesn't stop us in wartime). But the risk to wellbeing of there not being enough real, life-threatening risk in a young person's life needs to be balanced against the risk itself. Eliminating risk is risky. I have three sons myself, now in their twenties, and cannot contemplate the scenario in which any of them were killed. But I also do not want them to live in a world where it would not be possible for them to lose control under the influence of drugs (which is not to say I approve) or ride motorcycles or fall crazily in love with the wrong girl.

Conclusions

These developments in cognitive neuroscience represent an exciting new front in our understanding of young people. This article has only canvassed a few of the more major findings, and research is proceeding apace all over the world.

At the same time, this work is new. The work on brain structure is gaining a solid footing, but the study of brain function is inherently trickier. The technology is expensive, research cohorts are often small, and studies are confined (obviously) to the laboratory and to simulations of what happens in the real world. For example, testing a teenager's reaction to an image of an angry face requires that we know that the person in the photo is actually angry, that the researcher has selected a photo with enough objective (and unambiguous) indicators of anger (and is such objectivity possible?), and that the teenager in the scanner is going to react to a photo the same way they would react to a real instance of an angry person. There are a lot of interpretive steps in this chain, a lot of places for the ideology or bias of the researcher to be introduced. The material needs to be interpreted cautiously, and it isn't always. Interpretations happen within existing frameworks of understanding about young people, and these often exaggerate the pathology of young people and underestimate their competence.

So we need to be cautious. But the increased understanding that is flowing from this work is potentially significant for us as practitioners, and, particularly where it is supported by other work in psychology, sociology and other disciplines, has the potential to enrich our practice and add depth to its rationale. ■

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development of our ideas about young people and the representation of youth in the media. He is currently working with colleagues from neurophysiology and developmental psychology on the implications of the new brain architecture research on our understanding of young people.

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