Introduction

Risk is a common topic in discussions about teenagers. Why do they behave in the way they do? In previous chapters, I have already mentioned the idea of teenagers as risk-takers. There has been evidence from brain research that has provided corroboration of this notion due to the way the brain develops during these years. In this chapter, I will explore the science behind these notions. I will also outline recent thinking to do with the special place that rewards play for this age group and indicate why I believe this evidence has particular relevance for teachers.

Risk

Larry Steinberg outlines a theory of adolescent risk-taking in his book *The age of opportunity* (Mariner Books, 2015). The argument is that the brain’s limbic system, which includes the amygdala, matures earlier than the prefrontal cortex. Thus, the part of the brain that seeks the positive feelings associated with having fun and taking risks is, at times, more powerful than the area designed to manage behaviour and inhibit risk-taking.

The discrepancy in maturation between the two areas of the brain has been called a “developmental mismatch”. Although all parts of the brain are maturing, the areas associated with risk are out of step with the areas associated with reasoning and problem-solving. As a result, teenagers are not always able to stop themselves doing things in the heat of the moment, even if such behaviour may not be entirely sensible. This theory has also been referred to as the “dual systems model”, because of the two brain systems involved.
There have been numerous attempts to investigate this theory. Sarah-Jayne Blakemore (2019) provides good evidence to support the notion of a “developmental mismatch”. With colleagues, she looked at thousands of brain scans and carried out an analysis of the average development in three regions of the brain. The three regions she studied were the amygdala (which processes emotion), the nucleus accumbens (which processes reward) (see Figure 5.1) and the prefrontal cortex.

She reported that, indeed, there are differences in the rates of maturation between these regions. The grey matter in the amygdala increases slowly up to the age of 14 but does not change after that. The grey matter in the nucleus accumbens slowly declines during the teenage years. In contrast, the grey matter in the prefrontal cortex declines sharply during these years, losing 17% of its volume. Thus, it will be apparent that development in the three regions differs markedly (Figure 5.2).

This is not the whole story. As Blakemore points out, these findings relate to the average for a whole population. When you come to look at individuals, the picture looks rather different. As can be seen from Figure 5.3, there are very large individual differences in the way these three brain regions develop from ages 10 to 30. This is an extremely

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**Figure 5.1** Simplified image of the brain showing the position of the nucleus accumbens.
important finding and shows just how important it is to recognise that we are not all the same.

This evidence from brain imaging shows that developmental mismatch is more marked in some individuals than in others.
Furthermore, there are some young people whose brains show no indication of this feature at all. Translating these findings into our understanding of risk-taking, we can see that the links between this behaviour and brain development are far from clear. Not all teenagers
will take risks. Those who might take a risk will not do so every time an opportunity arises. Even among those who do risky things, not all will be harmful.

The “trainee adult”

It could be argued that the idea of a poorly functioning or immature brain gives a one-sided view of teenage development. Dan Romer (2003), of the Annenberg Public Policy Center in the United States, has made a powerful case for an alternative view of brain development in young people. As he writes: “Brain deficits don’t make teens do risky things: lack of experience and a drive to explore the world are the real factors” (p. 32).

Romer, and other writers who take a similar view, believe that there is a good reason why the teenage brain works as it does. These authors argue that risk-taking reflects a biological drive for exploration. This process is fundamental in allowing young people to seek novelty and acquire experience. This is a stage in the life course when learning about oneself and the world around one is vital for the transition to adulthood. Without this experimentation, it would not be possible to grow and mature.

In the work that I do, I sometimes use the phrase “trainee adult” when explaining this process. I point out that we do not expect trainees to get things right first time around. We expect, and allow for, some mistakes in the learning process. In the same way, young people are learning how to grow up. As part of this process, they are bound to make mistakes along the way. They may choose unsuitable friends, they may stay out late when that is not a wise thing to do and, of course, they may drink too much at a party. Which of us has not done so?

“Hot” and “cold” risk-taking

There have been many laboratory studies trying to understand how the teenage brain works in the context of risk-taking. One classic study (the Iowa Gambling Task) uses different packs of cards. Participants are asked to choose between different packs. The options involve using one pack that offers small but frequent rewards or to use another pack where large rewards are offered that occur only rarely. This pack also contains cards that lead to large losses. A pack such as this is classified
as the “risky” pack. Such a situation mimics a typical gambling experience. High reward with high risk or low reward with less risk.

Results show that adults and young people behave differently in such scenarios. The likelihood that participants will choose the risky pack is highest in the adolescent group. Some in this age group continue to use the risky pack, even though they lose money as a result. On the contrary, adults are more likely to select the low-risk cards. When they do start with the risky pack, they soon move over to the lower risk cards when they see they are losing money.

One important caveat should be noted here. Researchers have made a distinction between “hot” and “cold” situations. Where money is involved, this could be described as a “hot” situation. Brain imaging shows that areas of the brain associated with reward processing are more active in such situations. However, when the situation could be described as a “cold” situation, where there is no emotional content, teenagers and adults behave in ways that are much more similar.

If a young person is on their own, with time to think about a risky choice, she or he is no more likely to take that risk than an adult. On the other hand, if this teenager is at a party, surrounded by friends, in a “hot” situation, she or he might be more likely to make a risky decision.

It is essential to stress here that there are substantial individual differences in risk-taking. Indeed, some young people avoid any risky behaviour. Others might be tempted to take a risk on rare occasions, perhaps only once or twice, but would for the rest of the time stay clear of risky choices. Alternatively, there are some, perhaps those who are more impulsive, who will be risk-takers. As the work of Sarah-Jayne Blakemore has shown, it is apparent from brain scans that individuals differ hugely in the way they develop through the teenage years.

**Dopamine**

I have been talking so far as if the way the brain develops is the only factor influencing risk-taking in young people. It is time now to mention other factors. The first of these is the hormone dopamine. This hormone is known as the reward hormone. I included a short section on the role of hormones in Chapter 1. It is now time to return to this topic. We know that there are literally dozens of hormones that are
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Dopamine plays a big role in the teenage brain. There are more dopamine receptors in the young person’s brain than there are in the adult brain. Dopamine has two functions. On the one hand, it encourages behaviour that may lead to a reward or the sensation of pleasure. It also has a separate role, in that dopamine is released following a reward, causing a feeling of well-being and satisfaction.

In her book on the teenage brain, Adriana Galvan (2017) discusses the role of dopamine. She notes that many studies, using both animal and human brains, have shown a peak level of release of dopamine during the adolescent period. As she says: “Together these data suggest that, during adolescence, changes in dopamine neuro-chemistry may alter reward sensitivity in response to drugs, social interactions and consummatory behavior” (p. 155).

In other words, the fact that more dopamine is likely to be released in the teenage brain means that during this stage individuals are more sensitive to the potential rewards that come from using drugs, going to parties or eating fast food and sugary snacks.

We should keep in mind that there are individual differences in the level of dopamine in any one brain. Nonetheless, it is important to recognise that, in some situations, it may be that dopamine levels play a part in stimulating or encouraging behaviour that involves risk and reward. Readers may be interested to learn that a practice known as “dopamine fasting” has become popular among adults in the United States and the UK. In essence, this means practising calm, meditative behaviour. Awareness of dopamine and its effect on behaviour is reaching a wider public. This knowledge should extend to an awareness of the role of dopamine in the teenage brain.

The peer group

Another important factor with the potential to influence risky behaviour is the peer group. Before I begin this discussion, I wish to underline the fact that a peer group can and does play a positive role during the teenage years. There are many ways in which friends and the wider peer group contribute in a beneficial way to the lives of young people. They offer a setting for the learning of social skills. They offer support at a time in life when it may be hard to seek that support in the family. They offer companionship. They offer a context in which to discover the adult world and to explore questions of identity. All this is true, and there are many other examples of the positive role played by the peer group.
Having said this, I will now turn to an alternative perspective. There have been many studies illustrating the way in which the peer group influences teenage risk-taking behaviour. The classic investigation is the one concerning risky behaviour behind the wheel of a car. This is known as the Stoplight Task, reported first by Larry Steinberg and colleagues in 2005. Here the task is to drive in a simulator around a racetrack. The object of the task is to get around the track in the fastest time possible. During the task, various hazards are presented such as a red light appearing or a pedestrian wandering into the road.

There are two conditions. In the first condition, teenagers, young adults and older adults are all on their own when they drive around the track. In the second condition, the participants are asked to bring a couple of friends to watch them drive around the track. The results are striking. In the first condition, there are no differences between the age groups in the number of risks they take. In the second task, however, the level of risk-taking is significantly higher in the adolescent group of drivers.

These results illustrate the fact that, when in a social situation, young people are more likely to take risks than they would if they were on their own. These data are supported by information from insurance companies. If a comparison is made between traffic accidents in the under-25 age group and accidents involving older drivers, then the same result becomes apparent. Accidents involving under-25’s
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usually occur when there are other people in the car. On the other hand, accidents among older drivers are more likely to occur when the driver is alone in the car.

To conclude, many factors contribute to risky behaviour. While the “developmental mismatch” theory may provide part of the picture, there are obviously other elements to consider. We also have to keep in mind that there are wide individual differences. No two teenagers will react in the same way in a situation where there is an option to take a risk. I am also attracted to the idea that, in some senses, risk-taking is an important feature of teenage development. If we shift our perspective, some behaviours can be seen as experimentation rather than risk-taking. The brain may be constructed so that during these years the young person is encouraged to explore and seek new experiences. We need to be very careful before we fall into the trap of accepting the “broken brain” model to describe this age group.

Reward processing

It could be said that reward processing is simply the reverse of the coin we call risk. Why do people take risks? In many cases, it is because they are attracted by the rewards associated with that behaviour. Examples might include having fun at a party, the buzz associated with going on a fairground ride or eating too much chocolate. In fact, I have already referred to reward when discussing dopamine. I noted that dopamine is known as the reward hormone and that its release in the brain leads to the seeking of pleasure and enjoyment.

The question of whether the teenage brain processes reward in the same way as the adult brain has been one of the key concerns of researchers in this field. I will outline one or two studies that have looked at this topic. The findings are of great interest. I should note that this has direct relevance to the classroom. Educators are concerned with motivation. What motivates students to work hard, to concentrate in class, to do well in exams? An understanding of reward processing may contribute to this debate.

It might be worth mentioning here a point I made in Chapter 3 when I was talking about my own undergraduate experiences at McGill University. Readers will remember that I told the story of the experiments carried out in the university by Don Hebb and his colleagues, J. Olds and B. Milner (1954). Here it was shown that if rats could obtain stimulation to a certain part of the brain, they would go on doing this until they were exhausted. This site in the brain came
to be known as the reward centre. We now know that the nucleus accumbens is the site in the brain identified by Hebb and colleagues all those years ago.

It is time to consider studies of reward processing in humans. One of the earliest studies in the modern era employed a “Wheel of Fortune” task (Ernst et al., 2005). In this task, the participants are asked to spin the wheel and the number it lands on determines whether you win a reward or not. Both adults and young people take part while their brains are being scanned. The results showed that young people demonstrate more activity in the reward processing area of the brain (the nucleus accumbens) than adults when they win on the task. The task is then made more complex by varying the amount of money that can be won. Regardless of whether the reward is large or small, teenage brains are more active than those of adults.

Another study illustrating this phenomenon is that carried out by Galvan and colleagues (2006). In this study, the participants are shown three cues on a computer screen, each cue associated with a different level of reward. The goal is to identify the cue that gives the greatest reward. The earnings associated with each cue are then shown on the screen so that participants get feedback on how much reward they will receive.

![Figure 5.4](image)

Figure 5.4 Degree of activation in the ventral striatum in three age groups when offered a monetary reward. (Illustrated in Galvan, A (2017) The Neuroscience of Adolescence. Cambridge University Press. Cambridge.)
The results indicate that the areas in the brain associated with reward are activated to a greater degree in adolescents than in other groups. Furthermore, these areas continue to show a higher level of activation for a longer period after the reward in the teenage participants. This difference is illustrated in Figure 5.4.

Galvan and McGlennen (2013) also report an interesting study that compares different types of reward. In this study, the investigators offered both a monetary reward and one that consisted of a sugary drink. The results showed that young people are more responsive to the rewards of both sugary water and money than the adult participants. In addition, the teenage participants found the sugary water more pleasurable than the adults, and this difference was apparent in brain activation. We can conclude from these and other studies that the nucleus accumbens and other parts of the limbic system are hypersensitive to reward during the teenage years.

**Conclusion**

In the course of this chapter, I have covered a number of themes that have relevance for teachers. First, it is essential to remember just how much adjustment and restructuring is taking place in the teenage brain. When young people appear confused or uncertain, it is worth considering how much change is going on in their brains. Second, I have noted the area in the brain, including the amygdala, which is attuned to reward at this time. Rewards assume greater significance for this age group than they do for other age groups.

Next, and related to this, the role of the hormone dopamine has to be taken into account. There is more dopamine in the teenage brain than there is in the adult brain. Levels of hormones such as dopamine also vary to a greater degree than in other age groups. As well as dopamine I noted the importance of the peer group. In some situations, especially those that might be described as “hot” situations, young people may be more influenced by the presence of the peer group than they would be in more relaxed or neutral situations.

I mentioned the concept of the “trainee adult”. This refers to the fact that young people are learning and experimenting in all sorts of ways at this stage in their lives. Teenagers will make mistakes. Behaviour that can, at first sight, appear senseless or idiotic may occur as a result of inexperience. This is particularly important in schools, as learning does not just apply to maths or geography. Other types of learning are taking place, especially to do with behaviour in social situations.
Finally, it is worth underlining the significance of reward for teenagers. When adults are looking for factors that will influence behaviour, rewards should come top of the list. This is often overlooked. Teenagers tend to receive more criticism than praise from the adults around them. Research on the brain clearly shows that teenagers will be more motivated by reward than by any other feedback. This single fact can make a significant difference in the way teachers and pupils interact. Schools would do well to take into account these results from brain research.

**Further reading**


**References**


