

Adolescent Brain Development

Aberdeenshire Council Educational Psychology Service January 2021

Brain development occurs beyond early childhood

15 years ago, it was widely assumed that most brain development took place within the first few years of life. Back then, we did not have the ability to look inside the living human brain. We now know that your brain changes every single day in response to what you experience. Over the past 10 years, neuroscientists have been looking at the brain at different stages of life and studying brain structure and the functions of different areas using Magnetic resonance imagery scans (MRIs). We now have a rich picture of how the human brain develops and know that it is not all over in early childhood.

Instead the brain continues to develop throughout adolescence and into the 20s and 30s. **It is exciting that what you do and say to teenagers, how you respond to their behaviour, and the**

Why are the teen years amazing?

The presence of an extended adolescent period is unique to humans and teenage hormones kick-start a period of significant change. During adolescence, we are aware of the hormonal changes which occur and create physical changes. However, recent neuroscientific discoveries have shown that most changes occurring during the teen years are happening internally within the brain. These are responsible for turning the teenage years into a bit of a rollercoaster. However, this **is a time of opportunity** as the brain development which takes place results in a stronger, faster, more sophisticated brain, capable of clearer and more complex thought.

Sarah-Jayne Blakemore (2012) jokes, that: **Adolescence starts with the biological, hormonal, physical changes of puberty and ends when individuals achieve a stable, independent role within society..... it can go on a long time!**

Dr Dan Siegel (2018) talks about the following myths of adolescence which he feels are disempowering, as it sounds as though there is nothing that teens or adults can do:

They'll lose their mind

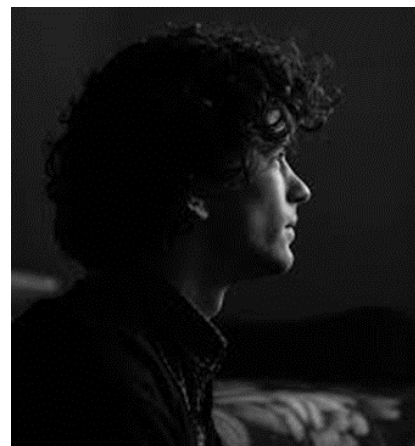
They're just immature

Raging hormones drive them crazy

Instead two main things are happening within the brain

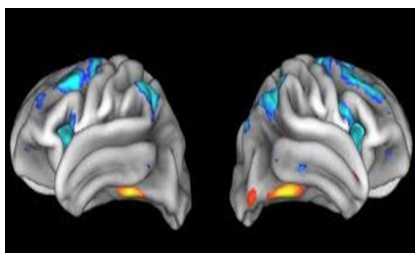
1. PRUNING: the removal of brain connections.
2. MYELIN FORMATION: the brain is producing more myelin sheath which helps the cells to communicate more effectively (3000x faster) and links up the areas of the brain you need better.

The brain is growing lots more connections and then losing lots of connections.




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This MRI image shows an adolescent brain activated during a memory task

 [Watch Dan Siegel's animation describing teenage brain development](#)



The BRAIN is like a MUSCLE: if you use a particular part repeatedly then it will grow over time and become better at performing that task.

Brain pruning – use it or lose it

The removal of unwanted brain connections, or **pruning**, happens at different rates in different brain areas and depends on what a brain is exposed to (what is going on within the environment in which the teenager lives). Think of it like a rose bush, you prune away the weaker branches so that the remaining, wanted branches can grow stronger. So, brain tissue is 'fine-tuned' and becomes more specialised to the specific environment within which a young person is growing up. The synapses (connections between brain cells) through which our neurons communicate are either lost or strengthened, depending on how much we use them. Well-used synapses grow strong, while less used weaker ones fade away.—**in the teen years if you do not use areas of your brain they will be pruned away.**

As a result of this brain plasticity teens can begin to find their passion, things they like or really love doing, and drive their development in that way.

By the teen years, the networks that communicate emotion, risk and reward are well developed. Whilst other networks that help us to plan, prioritise and think logically, and moderate our social behaviour are yet to mature. So just as our emotional and social worlds are becoming more complex and we are required to navigate these independently there is a mismatch between how well developed our abilities to process emotions and to make judgements are, which makes an increase in social anxiety quite normal at this time.

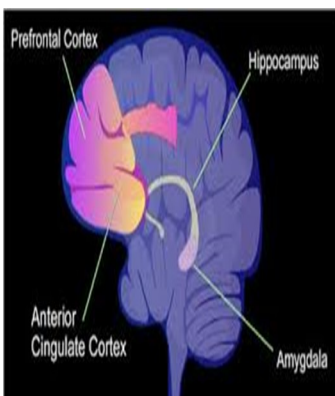
These heightened emotions and a difficulty to control them can be a struggle for some teens. However, it is also an opportunity for learning and growth as some of the most puzzling teenage behaviour may also have benefits.

Watch [Teenage brain development: Oxford Sparks](#) 

The prefrontal cortex (PFC): our emotion control centre

One of the areas which changes dramatically (and undergoes most pruning) during the teen years is the PFC at the front of the brain. The brain develops in an order; from the bottom up, and from the back to the front. The PFC is the last area to develop and is an interesting brain area as it is much bigger in humans than any other species. PFC is involved in our higher order cognitive functions (thinking processes). Studies have shown the volume of grey matter within this area peaks during the early teen years, and slightly later for males than females as they begin puberty later on.

Although we are considered adults when we turn 18, neuroscience tells us that the brain is still developing (and said to be undergoing adolescent changes) until around 25 years old. **The PFC is the part of the brain you need to be logical, calm and collected.**



Medial PFC in the mid-line of your head: our social brain

Activity within this area decreases within adolescence, which suggests teens and adults use a different thinking process to make decisions. This area supports our ability to take another person's perspective into account, in order to direct or guide our behaviour. Our social brain is still developing in mid to late adolescence, which explains why teens find it hard consider adult wishes/ views when making decisions.

Typical social brain functions:

- ♦ reading other people's behaviour – their actions, gestures, facial expressions
- ♦ knowing what other people think/ feel — their internal emotional states



The teen years: The battle of two brains

During the teenage years the limbic system, which is by now well developed and very active, can dominate responses with the PFC trying to catch up. The limbic system is deep within the brain. It's areas have been found to be hypersensitive to the rewarding feeling of taking risks. Eventually, moving into adulthood the PFC can become more influential in determining behaviour. The table below summarises the jobs that these two brain areas do and helps us to see why adolescents experience a battle between two brain areas, which can result in stronger emotions with a weaker control centre. The PFC helps teens to think rationally at times, however when the limbic system is dominating we see more emotional/irrational responses.

PFC	Limbic system
Helps make good decisions Controls impulses Stops inappropriate behaviour (e.g. saying something rude)	Emotional core of brain Produces fight, flight or freeze Makes you feel the rewarding feeling you get when you do fun things
Helps planning/ thinking about future Considers consequences/ stops us taking risks	Risk taking/ impulsive Gives you the kick out of taking risks
Provides social understanding Helps us understanding other people and develop self-awareness	Social and emotional responses are driven by senses, automatic and instinctive and not thought through
Gives us Theory of mind (View of self & understanding other people's emotions) Mediates mood and personality	Forms memories related to intense emotions (fear or pleasure) Involved in experiencing anxiety



PREFRONTAL CORTEX IS ENGAGED:



Calm, rational thought, mental flexibility: Able to make good decisions

LID IS FLIPPED --> AMYGDALA IS ENGAGED



Big emotions arise - anger, fear, anxiety, sadness. Unable to make good decisions or calm down.

Source: The Whole Brain Child

WWW.RAISINGKIDSWITHPURPOSE.COM



Refer to Understanding anger leaflet for further information and videos about the hand model of the brain/flipping your lid.

Striatum: the brain's reward centre and teenage risk taking

Teenage risk taking behaviour is not about thinking. Dopamine is a chemical produced in the brain which makes us want to do exciting things. Some teens have more, or different, dopamine activity. The urge to do something risky might be overpowering making it harder for them to use the PFC to assess the risk. The Striatum activates when you receive something which you perceive to be a reward and it releases Dopamine, in teens this area is hyper responsive to feedback. Studies have shown teens are super sensitive to certain rewards, like chocolate and money. Teens with a more reactive striatum are more likely to engage in risky behaviour and to enjoy it. (Dr Adriana Galvan, Associate Professor at UCLA, 2017).

SO WHAT?... Teenagers are going to make mistakes, they have got a brain that is encouraging them to learn, explore and push boundaries. Rather than asking teen to avoid risks think about how you can provide opportunities for them to take healthy risks (e.g – auditioning for school play even if you have never acted before, asking someone out on a date).



Typical adolescent behaviours explained

All this brain science allows us to better understand the following teenage behaviour in terms of the changes taking place

- ◆ Sometimes moody, emotions all over the place, feeling really sad or angry but not knowing why
- ◆ Very self-conscious, experience more embarrassment
- ◆ Risk taking: the brain is oriented towards taking risks
- ◆ Peer relationships become key and impact on behaviour
- ◆ Particularly when they are with their friends; there is a drive to become independent from parents and to impress friends
- ◆ Difficulties controlling what they say and do: having more problems with adults
- ◆ Viewing neutral faces as aggressive
- ◆ Difficulties getting enough sleep

It is key to know that behaviours that shape the brain are more likely to be continued if started at this age. Not all teens have difficulties however lots do.

SO WHAT? General tips based on brain science



WHAT DO WE MEAN BY NEUROPLASTICITY?

A field of neuroscience which shows how the brain responds to experience so what you do with your mind can change the activity and therefore the structure of your brain (Dan Siegel, 2018)

The flip side of this is that **THE TEENAGE BRAIN IS VULNERABLE. Alcohol and drugs damage brain cells. Teenage brains are more easily damaged by alcohol and drugs. If teens lose brain cells by being drunk those cells do not grow back. Teens will not get another brain so it makes sense to help them take care of it.**



Relationships are key: Studies show us that despite all the risky options swirling around our tweens and teens, **the strength of our relationship with them can be one of the strongest factors influencing them to make healthy decisions through it all.** A strong relationship depends on:

1. Our kids feeling like we truly know, respect and care about them.
2. Our ability to listen to them and have genuine two-way conversations about all that scary stuff "out there."

Teens are at the best age to become expert at things:

Encourage them to find their passions, continue to practise/do the things which they love and want to be good at so that they can refine their brains and become better at them.

Don't allow them to give up when things are tough as what they do now will really help them in the future:

Some skills might feel like they are being lost (as cells are pruned) or teens might feel clumsy but if they practice they can get any skill back again.

Encourage them to keep practising and view mistakes/failures as learning opportunities.

[Refer to Growth mindset leaflet for further information.](#) 


Help them to use the focus of their attention to support the parts of their brain processes which are tricky. **Help them to be aware of their own and others emotions. Help them to reflect on how their behaviour is making you feel.**

Understand the extra vulnerabilities associated with the teenage brain in order to **establish clear rules and boundaries which protect you teen and their brain.**

From around 15 years old teens are capable of much more complex deeper thinking. Such as having their own ideas and morals, making connections between things in media and things they learn at school.

Educate teens on what is going on within their brains:



Help teenagers to understand what brain influences are upon them and why they think and feel they way they do.

Understand how stress impacts performance: Develop empathy, sympathy and understanding about what is going on in your teens brain, help them label, understand and regulate/control their feelings. Refer to leaflets on [Emotion coaching](#), [Understanding feelings](#) and [Relaxation](#) 

Do not put pressure on teens to perform or do things publicly: They might feel more introverted/self conscious.



Positively Teenage: Nicola Morgan: Make your brain

 **Nicola Morgan describes a FLOURISH model of brain health** which will work for anyone of any age. The 8 things she promotes are described below. Her website has lots of helpful information for the teen years for schools, parents and young people click [here](http://www.nicolamorgan.com). 

FOOD: brains work well if they are given enough of the right foods, they do not work well if you are too hungry or eat too much sugary or fatty foods. Good brain foods include eggs, beans, nuts, seeded bread, milk/yoghurt/cheese, fruit/vegetables, oats, fish, chicken.

LIQUID: the brain needs plenty of water, other helpful liquids are tea, fruit juice and milk, sugary drinks and alcohol are unhelpful.


OXYGEN: following periods of sitting still the brain needs activity to give it an oxygen boost around every 30 minutes.

USE: brains like it when different parts of it are doing different things. Doing maths, playing an instrument, doing a sport all use different brain areas which will get stronger the more they are used.

RELAXATION: we need some stress in order to perform at our best but if you have too much pressure and do not take enough breaks our brains will suffer from symptoms of stress. Daily relaxing activities which help you unwind and forget about your stresses are important.

INTEREST: our brains learn best when we are interested, you can stimulate it by playing music whilst you work.

SLEEP: is very important for the brain, it improves mood, concentration and memory, relationships, happiness and general health.

HAPPINESS: scientists have shown that our brains work better when we are happier—there many ways to take control of our moods and emotions. To find out more about how to improve your happiness refer to '[Helping develop a positive outlook](#)' leaflet. 

Make Your Brain FLOURISH

F - Food: learn which foods fuel our brains best; don't go hungry

L - Liquid: make sure you drink enough water and avoid fizzy drinks

O - Oxygen: exercise (even a quick walk) pushes more oxygen round your brain

U - Use: use all areas of your brain by doing lots of different activities

R - Relaxation: your brain will work best if you have frequent breaks and relax properly

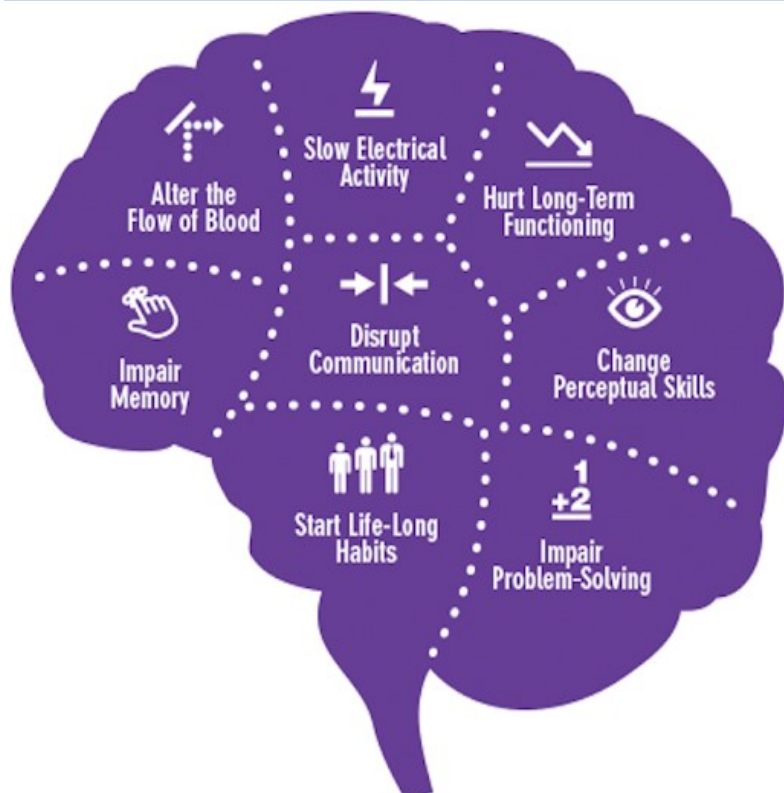
I - Interest: keep your brain interested by not spending too long on the same thing

S - Sleep: learn how to get a good sleep and you will feel happier and work better

H - Happiness: laughter is great brain medicine: have you had your daily dose?

Help for schools, parents and young people:
www.nicolamorgan.com

The impact of alcohol on the teenage brain



Alcohol affects a teen brain differently than it affects a mature adult brain due to the rapid development and "wiring" changes which are taking place.

Adolescents need only to drink half as much to suffer the same negative effects.

Drinking is more harmful to teens than adults because their brains are developing well into their mid 20's.

Underage drinking during this critical period of life can alter brain development, potentially causing lifelong damage in brain structure and function.

Drinking as a youth may cause cognitive or learning problems and/or make the brain more prone to alcohol dependence. This is especially a risk when people start drinking very young and drink heavily.

When teens drink, alcohol affects their brains in the short-term – but repeated drinking can also impact the brain down the road, especially as their brains grow and develop.

Adapted from Alcohol-and-young-people-factsheet. (alcohol-focus-scotland.org.uk)

Image from [Alcohol Impact on Young Brain – Get SMART](#)
[West Baltimore Drug Free Community Coalition](#)

10 top tips for communicating with teens



The more comfortable our kids feel talking with us, the greater chance we have of being let into and influencing how they navigate their increasingly challenging worlds. *Kyria Lendzion (2016)*

I know you think your teen's messy (slightly disgusting) bedroom is hard to look at...

But, just wait 'til it's empty.

—
Raising Teens Today

Communicating with teens is a minefield given all the changes which are taking place. However we know maintaining connection and two-way conversation is crucial as their lives get more complicated, and choices become more serious and riskier. We need to understand their worlds to help guide them healthily through all the tough and scary stuff "out there." But they're not likely to make this easy on us. It will require some serious thought and skills. Despite the dismissiveness and venom we sometimes get from our teenagers, they want more than anything to be connected to us, and for us to know who they really are.

The following tips are taken from [10 Skills for Becoming a Teen Communication Jedi](#) by Kriya Lendzion. She has been talking to teens for 18 years about how they wished their parents communicated with them and has identified her 10 top tips.

FIRST AND FOREMOST - Understand that the amygdala survival defence (fight, flight or freeze, see flip the lid diagram p3) system is extra reactive. Keep in mind, that anything registering as a 'threat' can cause a natural and quick flip into fight: arguing, defensiveness, and exploding, flight: hiding, avoiding, and withdrawing, or freeze: shutting down, faking compliance.

1. RESPECT TIME & PLACE for sensitive discussions to avoid them feeling overwhelmed, embarrassed or uncomfortable.

- ♦ **Keep it short and simple:** slotting under 5 minute conversations into everyday life rather than big talks
- ♦ **Talk while doing:** use side-by-side activity moments some kids will be more open to talking about tougher topics when not looking you in the eye. Being physical also helps thought and communication brain pathways
- ♦ **Keep it private:** to help them feel respected and teens can think everyone is watching, listening and caring about what is being said to and about them
- ♦ **Wait until you are calm, they are ready:** Avoid times when you/ they are already overwhelmed, tired, "hangry," emotionally escalated, or hurried and distracted

2. USE OPEN-ENDED QUESTIONS & STATEMENTS (questions starting with words such as **HOW, WHAT, WHEN, GIVE, DESCRIBE, EXPLAIN, TELL ME ABOUT...**): this shows you care about their internal and external worlds, and are open to talking about it *a//* with them.

Closed questions	Open-ended questions/statements
Did you have fun at the party?	How was the party?
Do you agree with that?	Tell me more about the party
Are you ok?	What do you think about that?
Did you do...?	What is going on with you today?
Are you going to drink at the party if the other kids are?	You seem upset

3. LISTEN, LISTEN, LISTEN: Stop talking so much, or thinking about what you're going to say, and truly LISTEN. Share your wisdom, real-life experience, thoughts, and feelings but make sure you leave even more room for your child to express what they are experiencing, wondering, deciding, and feeling daily. If you ask your open-ended questions then follow it with a TedX talk about how they should think and feel, you'll miss an opportunity to really know them. If you're talking more than 50% of the time, it's not a discussion; you're lecturing.



Tips for communicating with teens continued

4. CHECK YOUR TONE (Verbal & Non-verbal): Teens tend to misinterpret facial expressions and tones of voice as being aggressive, avoid hands on hips, finger-pointing/wagging, and moving into their space.

5. USE 'I STATEMENTS': Express your opinions and phrase your reactions with a focus on what you think, feel, observe, want, expect and have experienced versus accusing, assuming, judging, making them wrong by using 'You'.



You Language	I Language
"You're totally wrong about that."	"I disagree with you on that because..."
"You were being really disrespectful..."	"I felt really disrespected when..."

6. VALIDATION: Acknowledge their thoughts and feelings as valid before communicating yours. It helps to acknowledge that you hear what they are saying and that whatever question, opinion, or feeling they have is valid is valuable. This doesn't mean you have to agree. When you disagree, then you follow it with an I statement.

"That's an interesting point." "That makes sense to me." "I understand this is hard for you."

"I can see why you'd feel that way. I feel really differently about it because..."

7. REFLECTION: Reflect back not just what your teen is saying to you, but how you're hearing and seeing them feeling about it - i.e: **"You sound upset about that."** This lets them know you are genuinely listening to, empathizing, and caring about them. We're not just tuning in to what they're telling us, but also to what's "between the lines" that they may not have words to tell us.

"That sounds like a tough situation." "Seems like you were really confused about what to do." "Sounds like the party wasn't all you hoped it would be."

8. USE AND, AVOID BUT: When expressing a difference of opinion or an apology, refrain from your urge to follow it with a "but" and instead use an AND. As subtle as this is, the AND (spoken or not) serves as the glue between your opinion/experience and theirs, allowing room for both to coexist. If you use a BUT it is like taking away the first part of what you said.

"I hear that you don't think vaping is a big deal. It makes sense to me why you would think that (validating) and I disagree. I've been doing some research and getting some very different information (I statement)."

"I know you felt like I wasn't hearing you (reflection). I'm sorry I walked away. [pause] I was having a hard time listening when I felt so disrespected by the way you were speaking to me (I statement)."

9. ASK PERMISSION FOR INPUT: When your kids share their tough or confusing life experiences with you, ask them whether they'd like to hear your ideas or related experiences instead of assuming it'll be helpful for them. If it's a must-have conversation, give them room to choose when it happens. Sometimes teens just want to vent and we adults have a habit of automatically giving advice or trying to fix things. But, this can feel really disempowering at a time when they're trying to gain more trust in their own capabilities and strengthen their own problem-solving muscles. So first listen, next validate or reflect, and then simply let them know you've got some input if they'd like to hear it.

"What a tough day (validation)! I went through something really similar with my friends at your age. Would it be helpful to hear how I handled it?"

"That sounds like a difficult situation (validation). I've got some ideas if you're open to hearing them."

"I'm worried about you having unprotected sex (I-message). I totally get that's an awkward conversation for you (validation), but I'd like to talk to you about contraception. When can we do that?"

10. APOLOGISE: When we get all of the above (and more) wrong, it's important that we own it and are not hypocritical. This models an accountability, authenticity, and grace that we want our kids to have with us, others, and themselves.

"I'm sorry I spoke to you so sarcastically this morning. I feel really disrespected when you talk to me that way, so that was hypocritical of me. I promise to keep working on that."

"I'm sorry I was mocking your friends. I would've gotten pretty upset too if you did that with my friends."

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We value your feedback, please complete our short survey by scanning the QR code.



REMEMBER: Teenagers are more open to new ideas, more open to change and less set in their ways. This can lead to enormous potential.



For further information and resources



[Nicola Morgan website: Positively teenage Agnes – the life guide for girls](#)

[Solihul parenting approach. In our place.](#) To access "Understanding your teenagers brain" course use code 'tartan'

[Mind](#)—A guide to teenage well-being

[Young minds](#)

[Anna Freud: On my mind](#) mental well-being information co-produced by young people



[CAMHS Grampian webinar on adolescent brains and impact of COVID-19 lockdown](#)

[The Teenage Brain Explained](#)

[Sarah-Jane Blakemore. TED talk – The mysterious workings of the adolescent brain](#)

[Nicola Morgan talks about teenage well-being](#)

[Your special teenage brain by Nicola Morgan](#)

[Dan Siegel talks about adolescent brain development](#)

[Nicola Morgan: Overcoming challenges of teaching teens](#)

[Colleen O'Grady TED talk mum's/ teenage daughters](#)

[BBC Bitesize links/videos about mental health](#)



Galván, Adriana (2017). The Neuroscience of Adolescence

Kriya Lendzion (2016). Understanding Adolescents: Parenting teens and tweens

Nicola Morgan (2013). Blame my brain: the amazing teenage brain revealed

Dan Siegel (2014). Brainstorm: the power and purpose of the teenage brain



Pause for Thought.... Teenage sleep

Why do teenagers often find it difficult to wake up and go to sleep?

Teenagers need around 9 hours sleep a night on average, whilst adults need less.

During adolescence Melatonin (the chemical that makes you sleepy) does not tend to switch on until later at night—around the same time as adults, however they still have to wake early.

So teenagers are probably not getting enough sleep. We know that sleep affects—mood, grades/school work, concentration, relationships, and aspects of physical and mental health. Sleep problems have also been linked to causing depression. Getting a bit more sleep helps how we feel during the day and also how effectively we can work. **Nicola Morgan describes many tips for getting better sleep, here are the two most important ones:**

One hour before you want to feel sleepy:

- 1. Start to wind down, put work away, close curtains, turn off bright lights, get ready for bed, establish a clear routine.**
- 2. Turn all screens, phones and internet devices off :** Otherwise the light your screens give off is similar to daytime and keeps you awake.



Refer to leaflet on [Sleep](#) for more information and tips on teenage sleep