Drugs and the Brain

A Beginner's Guide to Stimulants and Empathogens

DrugWatch

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Part 1: The lizard brain [1, 2]

The brain controls almost everything we do: from our first breath in the morning to our dreams at night. Very little that we do, think or feel takes place without the brain being in charge.

Much of what the brain does happens on an automatic or *subconscious* level. For example, we blink many times a day without consciously thinking about it, but it is our brain that makes us do this (to clean, protect and moisten our eyeballs).

Buried deep within the human subsconcious brain (also called the lizard brain) are survival instincts:

- To eat (to stay alive)
- To reproduce (to continue the species)
- To respond to threats or aggression (to protect yourself, your family and what you own)

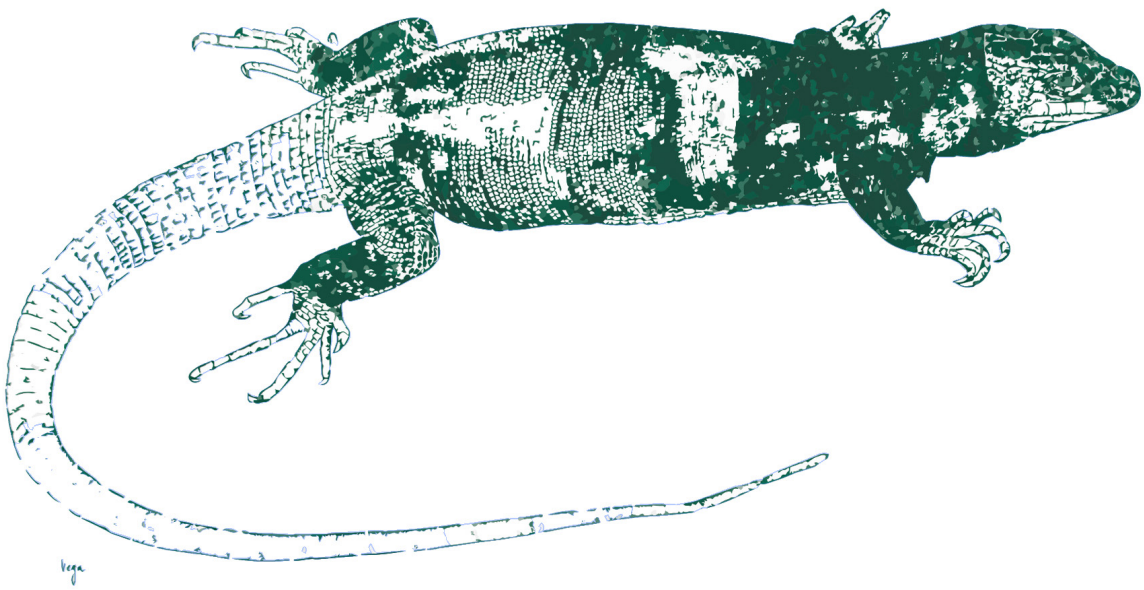
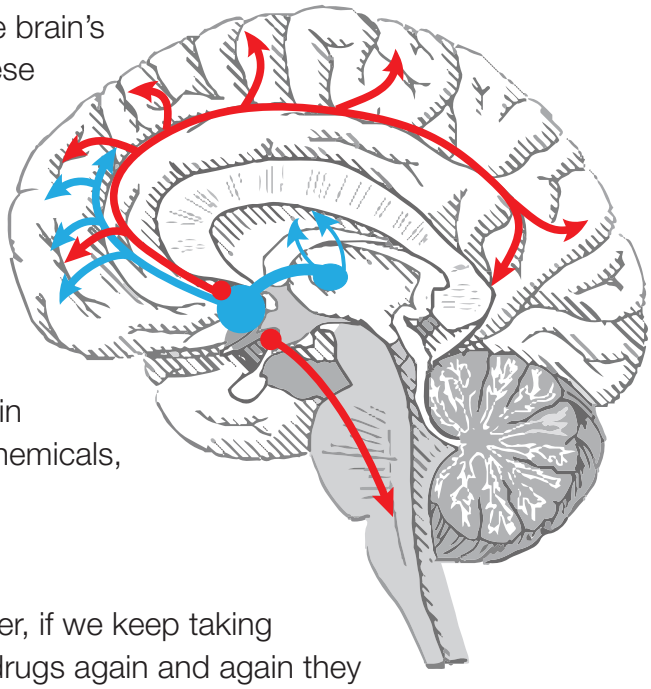


Image credits: see references section at the end of this document

There are certain areas in our brain whose job it is to make us feel good when we do these things, so when we eat, have sex or take exercise our body releases chemicals that make us feel happy or excited. These parts of the brain are connected in networks called **reward pathways** because they release **reward chemicals** when we do something that makes us more likely to survive.

The picture to the right shows two of the brain's reward pathways. There are many of these pathways in the brain; they are like phone or computer networks with information flying along wires.



Drugs that get you high use these reward pathways to make us feel good. They are like pirates taking over a ship: they hijack these parts of the brain and make them release lots of reward chemicals, which is why we feel high or stoned.

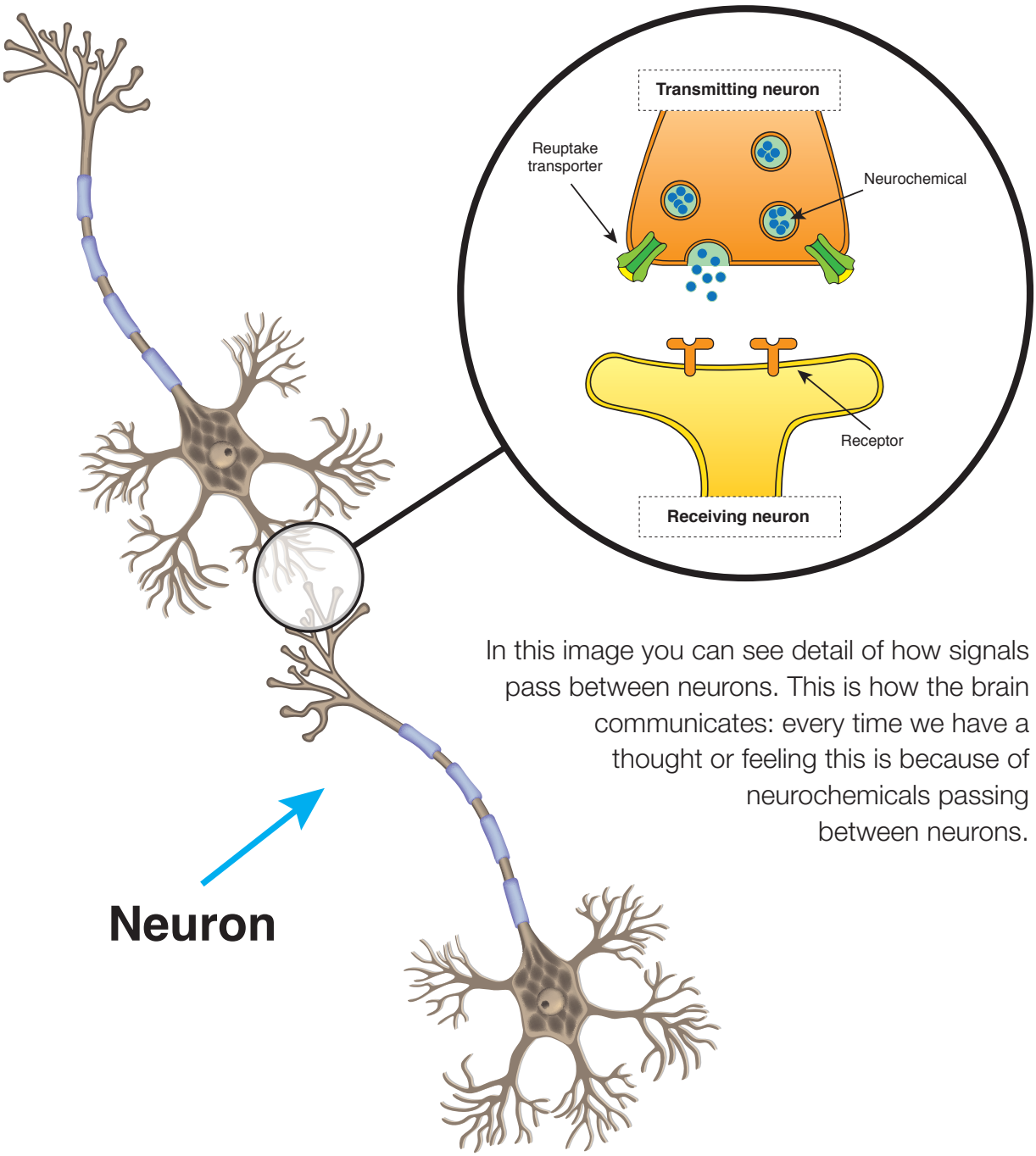
However, if we keep taking these drugs again and again they can take over the reward pathways in the brain until all we want to do is to take the drug. Nothing else makes us feel good any more apart from getting high and this can become a habit.

Once you get to this stage:

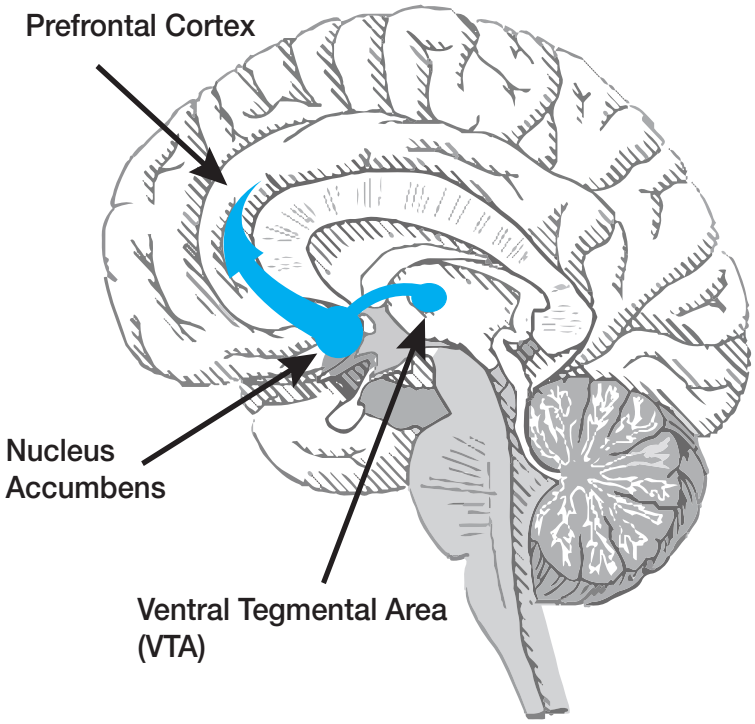
- You might have cravings
- You start to want to take the drug more than doing anything else
- You find yourself keeping using even when you want to stop
- You become more moody and irritable when you can't get hold of it.

Part 2: The reward pathways [2, 3, 4, 6, 7]

The brain is a big network made partly of **neurons** (nerve cells). It uses chemicals called **neurochemicals** (nerve chemicals) to send and receive signals between these neurons.



In this image you can see detail of how signals pass between neurons. This is how the brain communicates: every time we have a thought or feeling this is because of neurochemicals passing between neurons.



The picture to the right is a simple version of part of the brain's reward pathway that controls some of our moods and attitudes.

When this reward pathway is activated (for example by food, water or sex), information travels from the VTA to the Nucleus Accumbens and then up to the Prefrontal Cortex.

The VTA uses an important chemical called **dopamine** to send this information. Dopamine controls things like what is important to us, what gives us pleasure, how we feel, how we learn and what motivates us. Dopamine gets stimulated by many drugs and is part of what makes you feel high, and how much you feel you want or need a drug. It is often linked to stimulants, so amphetamine (speed) and cocaine are typical drugs that raise dopamine levels. As the levels of dopamine increase in the brain, other areas get stimulated, including the Prefrontal Cortex. The Prefrontal Cortex is very important, especially where drugs are concerned, as it controls a number of different functions, including:

- Behaviour *(controlling your actions, acting in an appropriate way)*
- Development of conscience *(knowing right from wrong and doing the right thing)*
- Decision making *(gathering information before making a decision)*
- Impulse control *(being able to control your feelings)*
- Focus *(being able to stay on track with a project until it's finished)*

People who have problems with the Prefrontal Cortex can experience:

- Short attention span
- Problems with impulse control *(being impatient, 'kicking off')*
- Poor organisation and planning skills
- Hyperactivity
- Emotional problems *(such as shutting down, withdrawing from people)*
- Misreading situations
- Being dishonest
- Problems with learning
- Short term memory problems
- Anxiety
- Serious mental health problems *(such as psychosis)*

Using drugs changes the way that this part of the brain grows, develops and works. Young people can develop problems with drugs more easily as the Prefrontal Cortex can still be growing and developing when people reach their early twenties.

Part 3: Neurochemicals [1, 2, 3, 4]

Dopamine is a neurochemical that the brain uses to send messages to its different parts. Different neurochemicals control different parts of the brain.

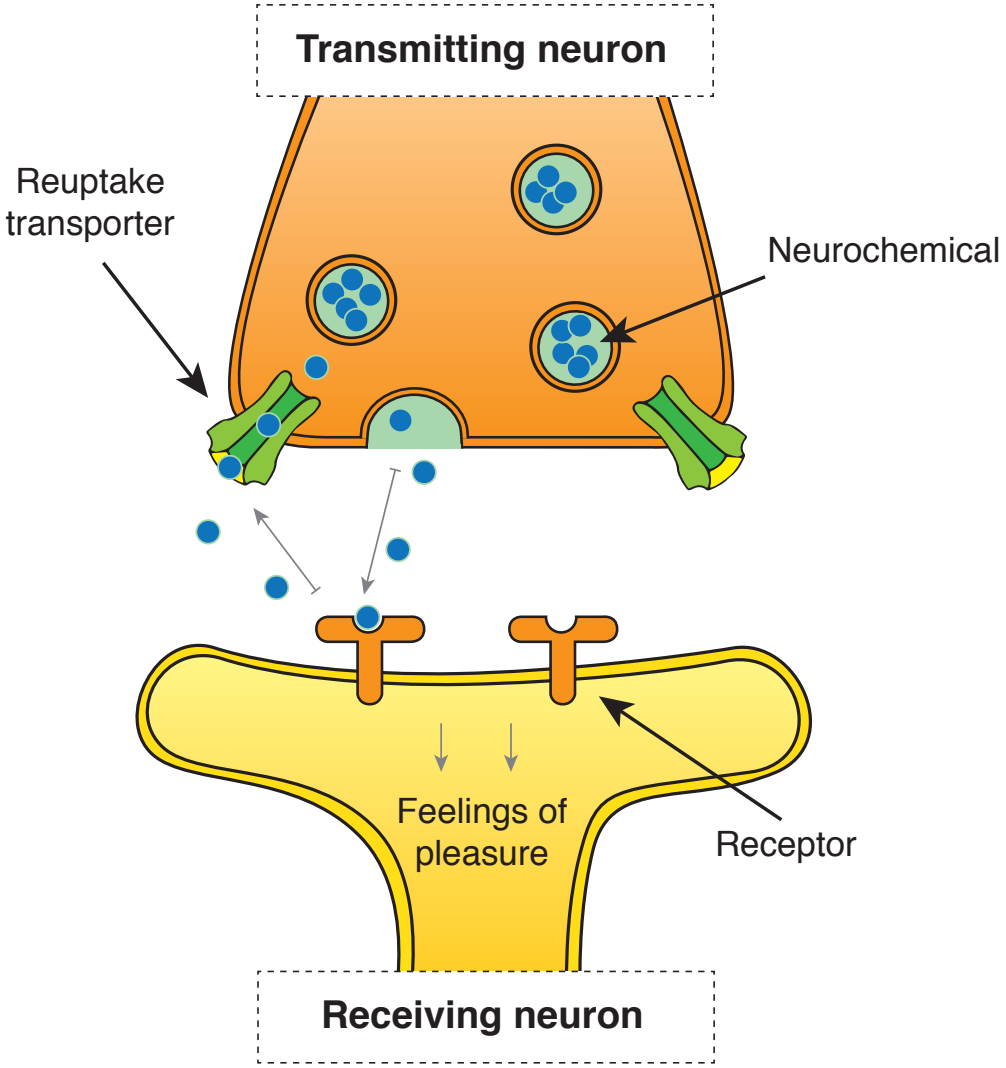
Neurochemicals are like the various types of messages found in a phone network, for example phone calls, texts, emails or instant messages.

Here are some more examples of neurochemicals:

Neurochemical	What it does
Noradrenaline	How awake or aroused you feel, attention span and confidence.
Adrenaline	Similar to noradrenaline and also controls energy.
Dopamine	Motivation, wants, pleasure, love and the reward pathway. This is a big part of what makes you want to take more of a drug.
Serotonin	Memory, emotions, wakefulness, sleep, mood (depression), sexual activity and temperature. It is associated with euphoria (happy feelings).
GABA	Controls impulses, muscle relaxation and arousal and slows down the brain. Plays a big part in sleep and 'feeling good'.
Endorphin	The senses, especially pain, emotional and physical distress. A lot of the high you get from exercise comes from endorphins.
Histamine	Involved in sleep and waking patterns and inflammatory response (for example allergic reactions).

Part 4: How a drug affects your mood [1, 2, 7, 8, 9, 10, 15]

When you do something that triggers the brain's reward pathway (for example, taking exercise), neurochemicals are released by the **transmitting neuron**.

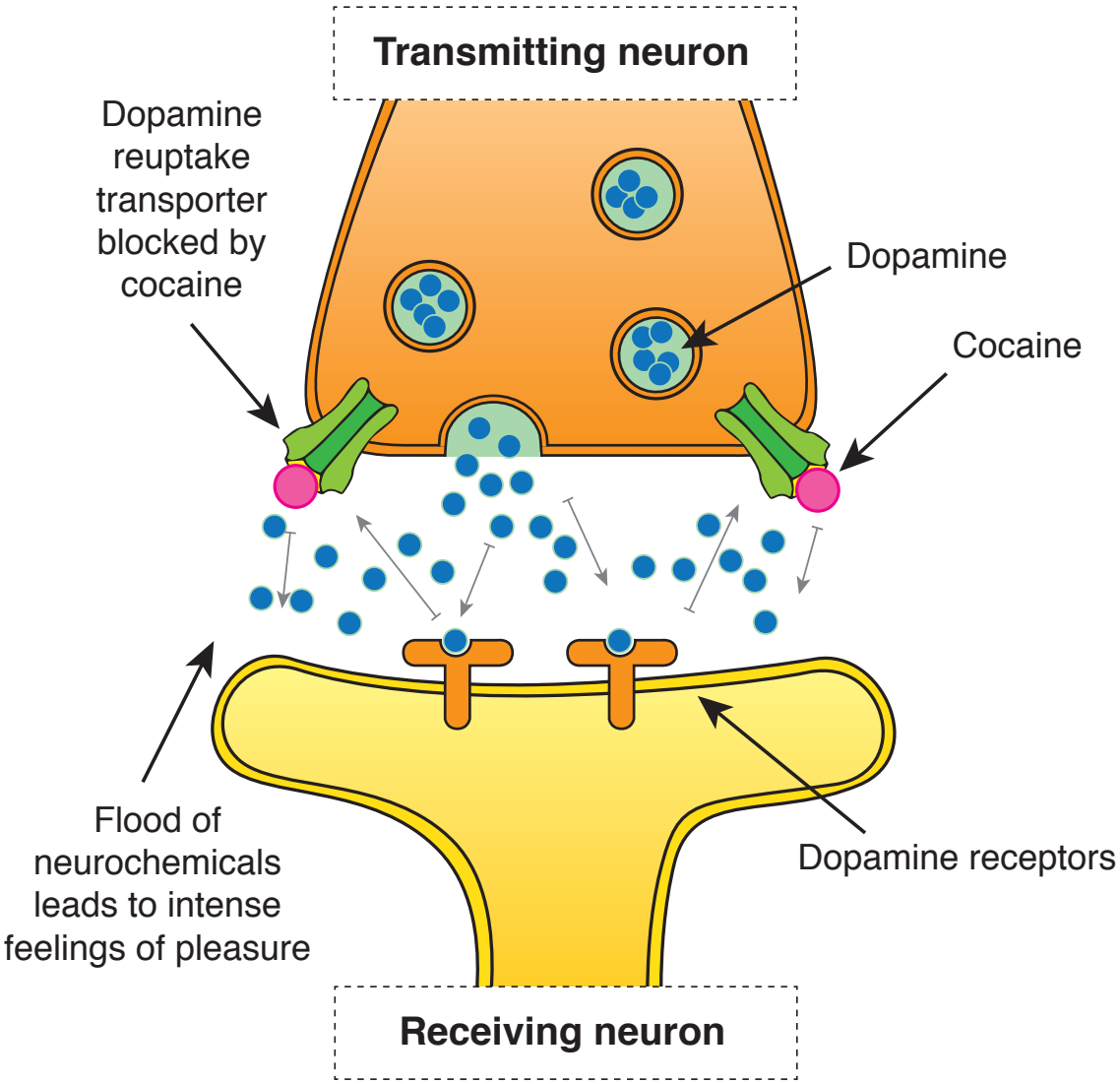


Some of the neurochemicals land on the **receptors** on the receiving neuron, and this is what sends out feelings of pleasure to other parts of the brain. Most of the extra neurochemicals are absorbed back by travelling through the **reuptake transporter**, ready to be used again if necessary. Some neurochemicals do not get absorbed, and this is thought to play a part in **drug toxicity** (poisoning, or overdose).

We will now look at what happens when you take certain stimulant and empathogenic drugs.

Cocaine

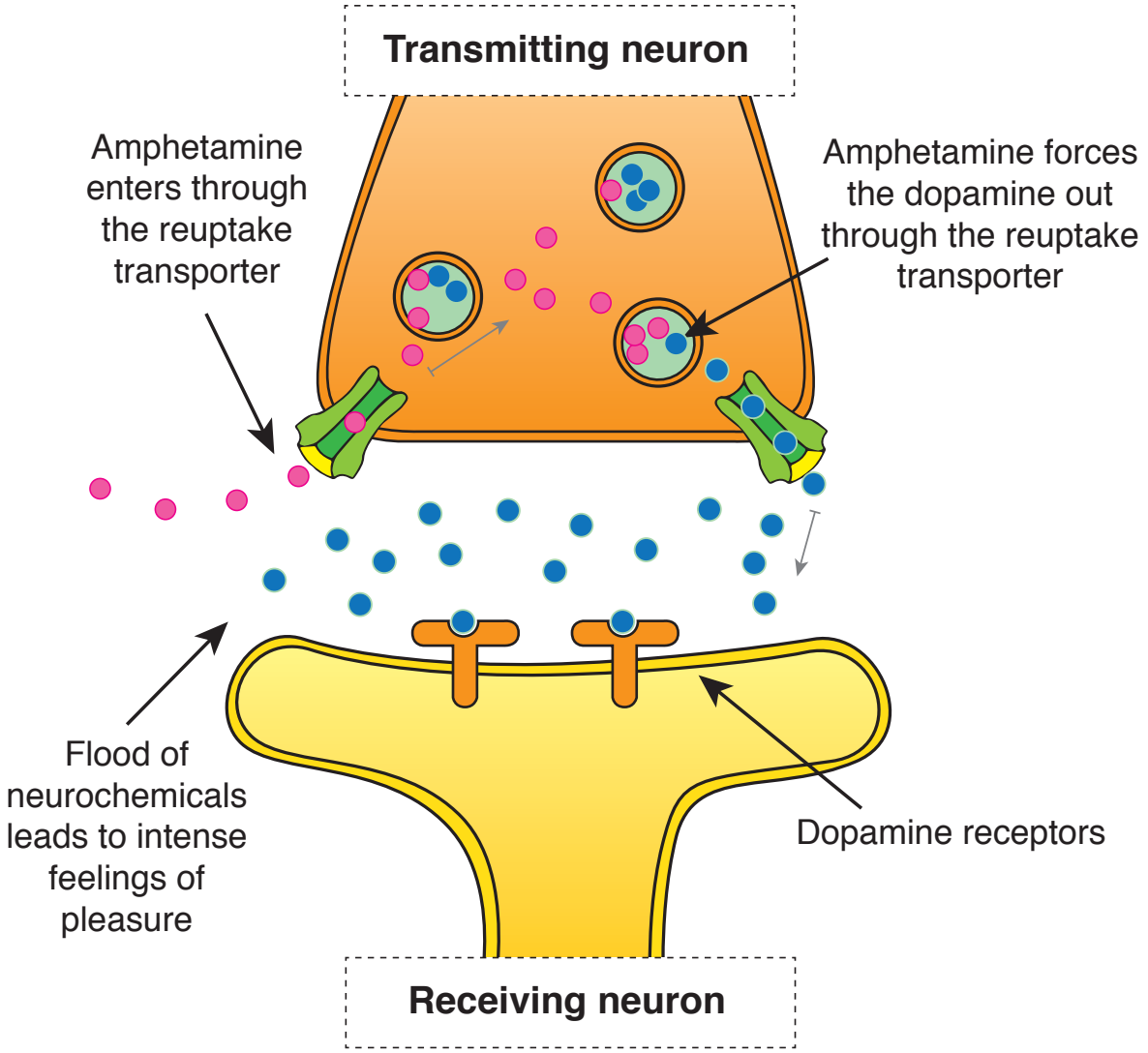
When you take cocaine it affects the neurons in two ways. Firstly it stimulates the transmitting neuron to send out lots of dopamine. It also blocks the dopamine reuptake transporter which means that the extra dopamine that has been released ends up flying around your brain, triggering and stimulating the dopamine receptors which is why you feel high.



If you keep on using stimulant drugs over and over again you can use up all your dopamine (this is called dopamine depletion). This can lead to problems including depression and other mental health issues, issues with learning, hyperactivity, cravings, dependency or addiction and problems releasing dopamine in the future.

Amphetamine (speed)

Like cocaine, amphetamine increases the amount of dopamine in the neurons, but it works in a different way. The amphetamine molecule is similar in shape to dopamine and it can enter the transmitting neuron through its reuptake transporters. It then forces the dopamine molecules out through the transporters. This can be toxic, and can lead to life-threatening hyperthermia (overheating).



If you find yourself doing stimulant drugs too often you can become tired, run down, low in mood and possibly have mood swings and some paranoid thoughts. The best thing that you can do is to **take a break** and allow your body to recharge. Plenty of sleep and food can help your body and mind to recover.

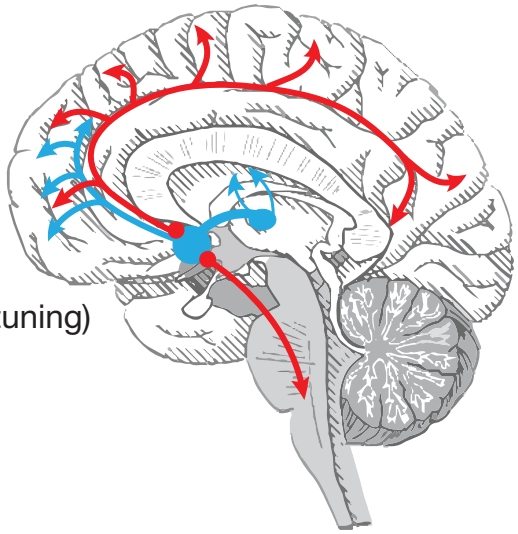
MDMA (ecstasy)

Although MDMA causes the release of dopamine, another neurochemical it stimulates is called **serotonin**. Serotonin is an important neurochemical that helps you to feel relaxed and controls mood, appetite and sleep. It is serotonin that gives MDMA a lot of its 'loved up' feeling and this is why ecstasy is called an **empathogen** (empathy is when you place yourself in someone else's shoes and feel what they are feeling).

Dopamine pathways

Functions

- Reward (motivating)
- Pleasure, euphoria
- Motor function (fine-tuning)
- Compulsion
- Re-dosing



Serotonin pathways

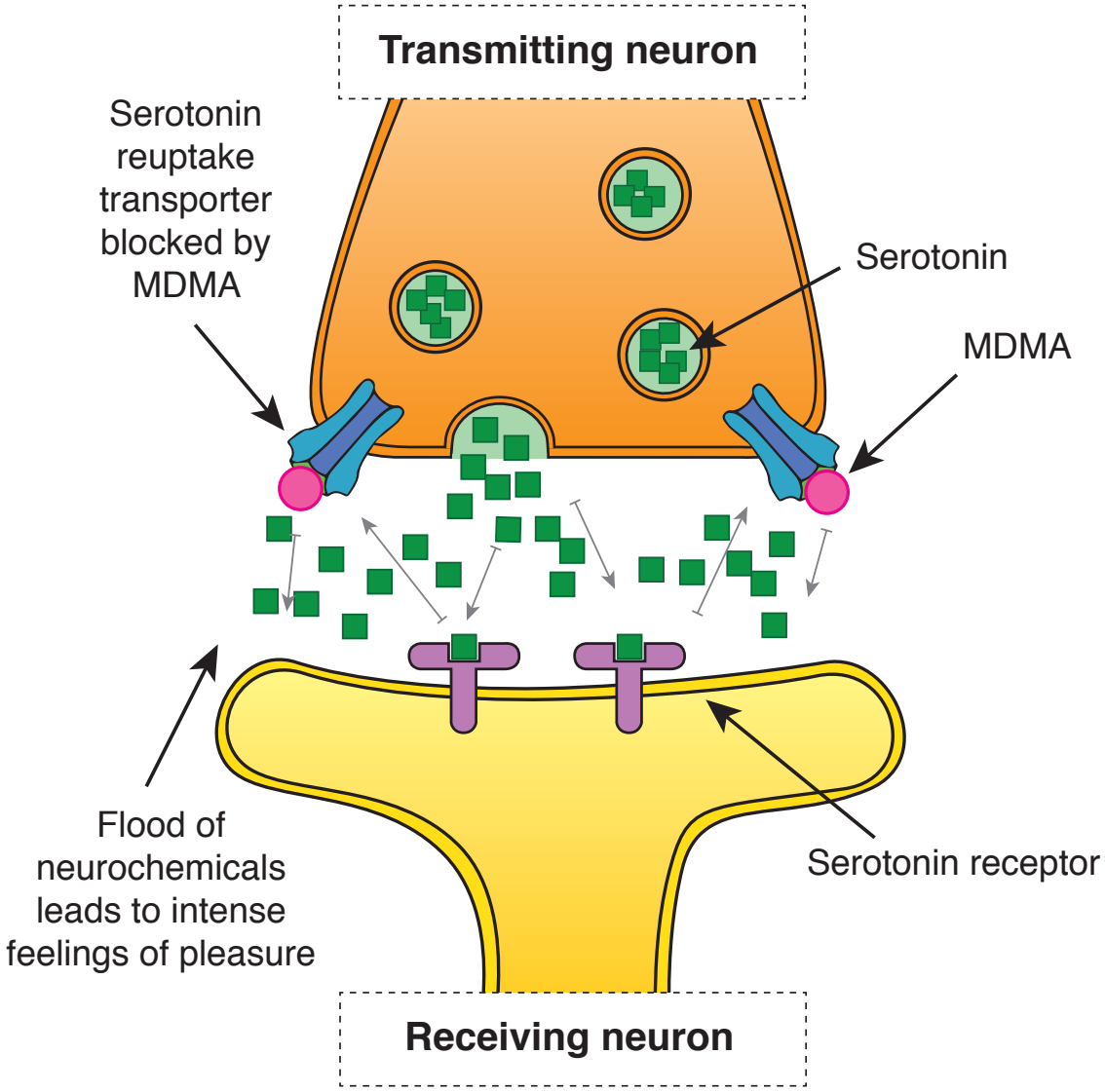
Functions

- Mood
- Memory processing
- Sleep
- Cognition/thinking
- Appetite

When you take empathogens they release serotonin in your brain, but can leave your serotonin levels very low afterwards and can also lead to life-threatening hyperthermia. If you take more drugs to try to get that good feeling back you might find your body can't produce the high, a bit like trying to flush a toilet twice in a row!

Using up your stores of serotonin is partly the reason why you might feel down, angry, sad or upset a few days after taking empathogens. And it is not just low levels of serotonin that causes problems; very high levels can lead to a medical condition called Serotonin Syndrome which can be fatal (see page 13).

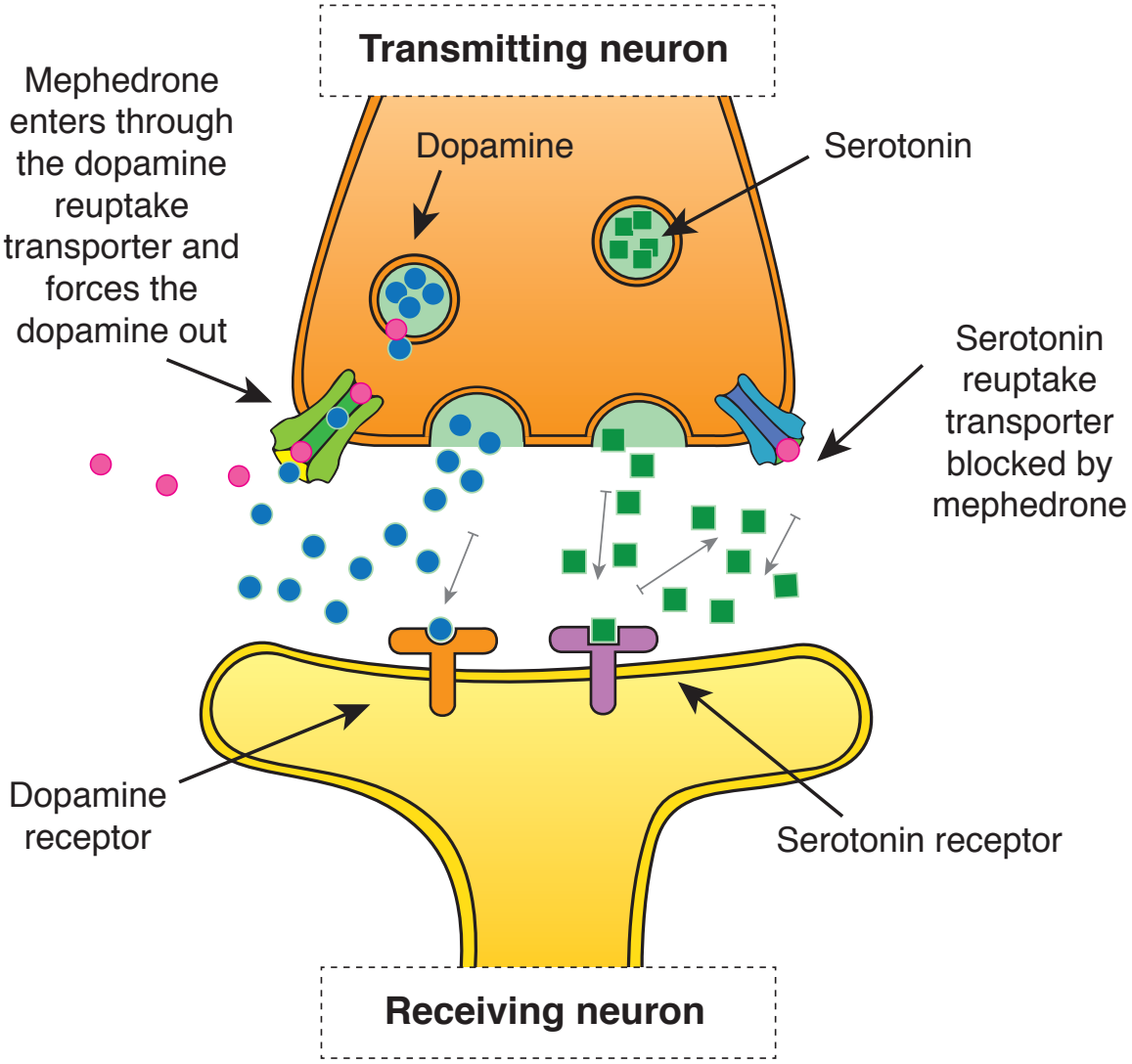
When you take MDMA it affects the neurons in two ways. Firstly it makes the transmitting neuron send out lots of serotonin. It also blocks the serotonin reuptake transporter, and it is this extra serotonin flooding the area between the neurons that leads to the 'loved up' feeling.



Mephedrone (bubble, mkat)

Mephedrone is a powerful drug that greatly increases both dopamine and serotonin levels, and in animal studies caused about a 500% increase in dopamine and a 900% increase in serotonin. This makes it both a stimulant drug and an empathogen. As the effects of the drug start to wear off, serotonin levels drop quite quickly which is why people want to take more and more of the drug (this is called 'redosing').

As mephedrone is a relatively new drug we are not completely sure what it does in the brain. It acts mostly like amphetamine, but also affects serotonin levels.



Serotonin syndrome[16]

This is a medical condition caused when your body releases too much serotonin. It can occur in a lot of different situations, one of these is when you take recreational drugs that effect your serotonin levels. It can kill you if not recognised and dealt with both quickly and effectively.

Symptoms include: agitation, anxiety, overheating, shivering, restlessness, twitching, high blood pressure, flushed skin, stomach noises, vomiting, diarrhea, dilated pupils and mental distress.

If someone you are with is showing some of these signs **call an ambulance immediately**.

While waiting for the ambulance do what you can to **cool the person down** and **calm them down**. It is dangerous to restrain people in this state.

For further information on Overdose & Emergencies see DrugWatch Information Sheet.

Part 5: How drug use can lead to dependency [2, 3, 4, 5, 7]

The drugs that have the strongest effect on your brain are stimulant drugs (like speed, cocaine and mephedrone) and opiate drugs (like heroin). The way you take a drug also affects how likely you are to become dependent. In general, the quicker and stronger the drugs affects you, the more your dopamine levels 'spike'. This is why injecting and smoking drugs can be more likely to lead to dependency than eating or swallowing them.

When you first start taking a drug you only need a relatively small amount to get you high. But if you keep on taking it your brain can get used to all the extra reward chemicals and you need to take more and more to feel that same high. This is called **tolerance**.

Your brain gets used to these extreme levels of reward chemicals, and so normal activities that you used to enjoy (like exercise, eating a nice meal or spending time with your family) no longer make you feel happy.

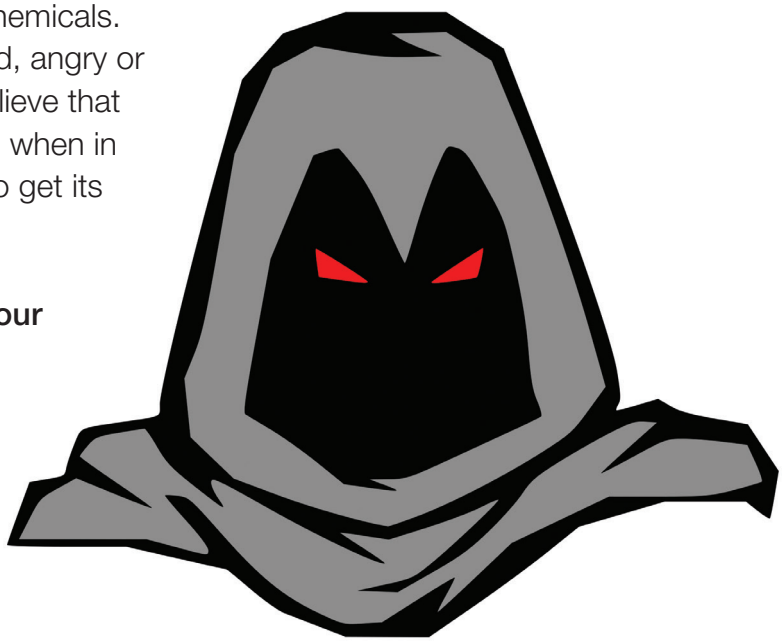
You might find yourself feeling **bored** the whole time... unless you are taking drugs. This is because your brain is getting used to the extreme 'spikes' in reward chemicals.

When you aren't taking drugs the levels of these chemicals drop and your brain starts wanting more.

It sends out warning messages around the brain and these messages get sent out to different parts of the body. You can feel these in different ways, some people feel edgy, angry, anxious, stressed, tearful, shaky, sweaty or as if they have a knot in their stomach... these feelings are called **cravings**.

Part 6: Cravings [11, 12]

Cravings can be very sneaky. They are the brain's way of trying to get you to take drugs so that it can balance out your reward chemicals. They often make you feel agitated, angry or stressed and it is very easy to believe that you are feeling upset with people when in fact it is just your brain wanting to get its happy chemicals back.

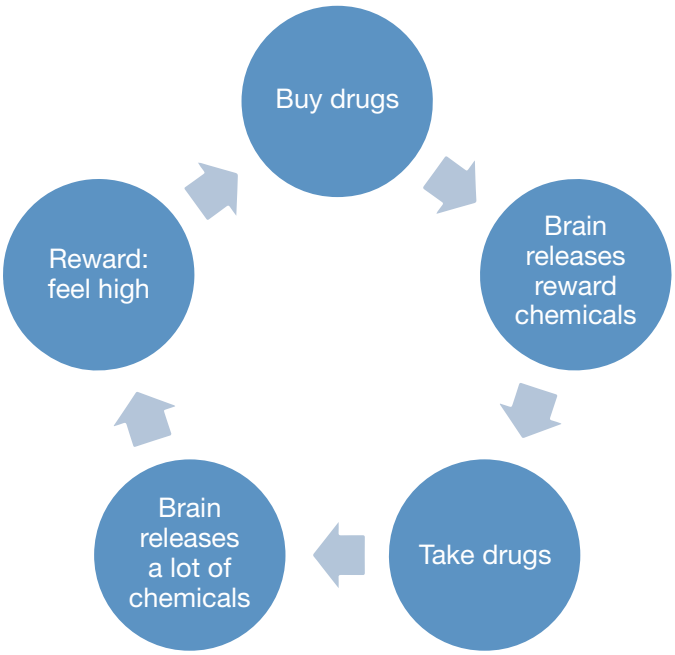


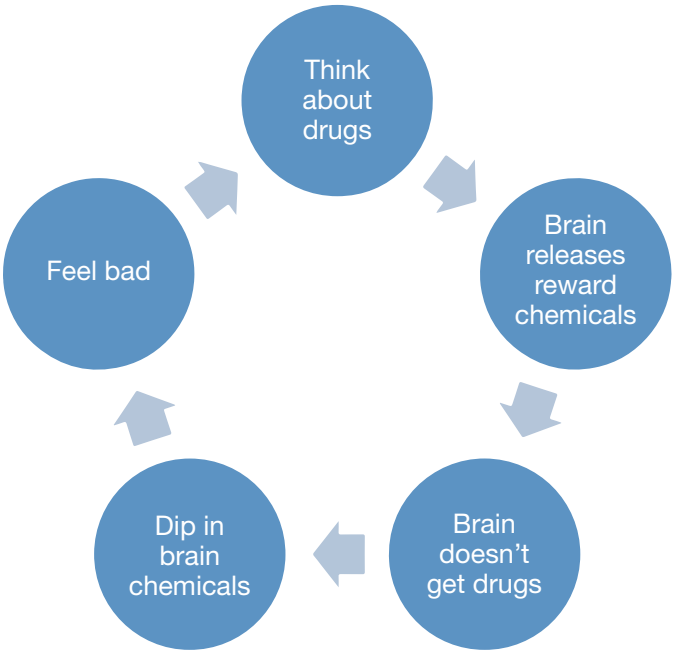
If you don't learn to **recognise your cravings** you can often behave in ways that might be out of character, for example getting into arguments with people and 'kicking off' for no reason. There are lots of reasons that people have cravings, and different people feel them in different ways. This is something that your drugs worker can help with, as we all react differently to cravings and have our own ways of coping with them.

Cravings can come in many forms: for example it can be as simple as thinking about drugs on Friday morning before you are due to go out that night, a very strong, tense, angry feeling if you can't get hold of any drugs when you were expecting them, the ache for more when your supplies are running low, or the tingle you might get in your stomach when you've been off drugs for a few days and think about them suddenly. These feelings are all caused by neurochemicals (mostly dopamine) being released in your brain.

Lots of things can make you crave drugs. These are called **triggers**. Triggers can be thoughts, feelings, sights, sounds, smells, places or situations. Examples could be: it's a hot day and you see a beer glass, or someone walks past you and you smell cannabis smoke.

When you use drugs regularly you train your brain to get a big reward when you take them. Think about how you feel when you are just about to buy drugs, and when you have just bought them. Your brain releases reward chemicals like dopamine even before you've taken the drug because you have trained it to know that it will soon get a big reward (see picture on the right).





When you have a craving your brain thinks it's going to get drugs, so it releases some reward chemicals. When it doesn't get the drugs it was expecting your levels of reward chemicals drop, and you can feel bad, stressed, frustrated, sick or angry.

If you don't learn to interrupt or control your cravings you can find them taking over your thoughts, and if you keep giving in to them it can become more and more difficult to resist taking drugs.

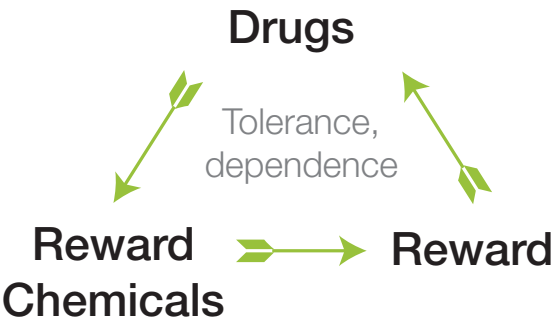
Part 7: What is dependency? [5, 6, 13, 14]

Being dependent on a drug is when you feel you *have* to take it, when you can't stop or cut down, and when you keep on using even when you know the drug is causing you problems.

If we think back to the reward system in the brain. Firstly you are motivated to do something for survival (for example, eat) and then your brain releases chemicals which are your reward. This ends the reward process.

Motivation → **Reward Chemicals** → **Reward**
food, career, sex etc.

When we take drugs we change the way this pathway works; taking drugs give us 'free' reward chemicals. This can cause problems as it can create a loop which can lead to dependency, when the drugs become the motivation and survival instinct.



Dependency is when drugs take control over your behaviour. It usually begins with casual or recreational use ('every now and then' or 'just at weekends') and ends when you feel you have to take them.

Some people can use drugs without problems, and others become dependent very easily. There are many reasons why this might happen: it might be something in your brain, something in your personality, something in your upbringing or maybe a combination of these things. At the moment, no one knows why.

Part 8: Are drugs becoming a problem? [17]

Working this out isn't simple, and admitting it isn't easy because we all want to think we're in control. Below are some of the things that can suggest that your drug use is becoming a problem. If you have answered yes to three or more of the following questions in the past year it suggests your drug use might be becoming a problem and that it might help to speak to someone about it.

Do you need more ..... to get high, or get the effect you wanted?

Do you have any signs of physical withdrawal, or do you find yourself thinking about ..... a lot when you don't have it?

Do you find yourself taking more ..... in a session than you'd originally planned, or find yourself taking it for longer sessions?

Do you find yourself wanting to cut down or stop taking ..... ?

Do you spend a lot of time scoring ..... or recovering from a ..... session?

Have you stopped, or cut down activities such as school, college, training, work, hanging out with friends or family because of your use of .....?

Have you kept on using ..... despite knowing that it is causing ongoing problems to your physical or mental health?

Has using ..... caused you troubles with the law (police, YOT, probation)?

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Pages 2, 4 & 10 *Brain pathways*: Mark Adley, based on dopamine and serotonin pathways image. Original source: http://www.drugabuse.gov/pubs/teaching/largegifs/slide-2.gif (2009), NIH [Public Domain] Accessed online 24/01/2014 http://commons.wikimedia.org/wiki/File:Dopamine_and_serotonin_pathways.gif

Page 2 *Pirate*: Pyle, Howard; Johnson, Merle De Vore (ed) (1921) *With the Buccaneers in Howard Pyle's Book of Pirates: Fiction, Fact & Fancy Concerning the Buccaneers & Marooners of the Spanish Main*, New York, United States, and London, United Kingdom: Harper and Brothers, pp. Plate facing p. 76 Retrieved on 14 April 2010. Howard Pyle [Public Domain] Accessed online 24/01/2014 http://commons.wikimedia.org/wiki/File:Pyle_pirates_burying2.jpg

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Drugs and the Brain: A Beginner's Guide

This guide was written and designed by Mark Adley, in collaboration with UK DrugWatch and N2L. Mark is a drugs worker in the North East of England and the creator of the **Drugs Wheel**, a new psychoactive substance awareness model (available at www.thedrugswheel.com) designed to illustrate the wide range of new substances that are available.

N2L (Never Too Late) is a confidential service for young people under 18 who live in North Tyneside and are experiencing difficulties in relation to the use of drugs and alcohol.
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N2L NEVERTOOLATE
Young People's Drug & Alcohol Service

UK DrugWatch is an informal online professional information network established by a group of professionals working in the UK drugs sector. The aim of the group is to raise/establish standards for drug information, alerts and warnings. It is currently an unfunded, bottom-up initiative that works in the spirit of mutual co-operation. A list of current members, and a selection of drug briefings can be found here.

DrugWatch

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