

Pharmacology - The reward pathway

All drugs of abuse and dependence share one thing in common. They increase the activity of a neurotransmitter called dopamine in the reward pathway of the brain. Activating this reward pathway, which crosses the limbic region of the brain and connects with the cortex-- that is, it crosses the emotional centre of the brain and connects to the decision-making part of the brain-- will reinforce a behaviour. It does so because it produces a pleasurable feeling.

Dopamine is a monoamine. Our mood is affected by the monoamines. There's an association between the altered function of monoamine neurotransmitters such as dopamine in the brain, and disorders such as depression and anxiety. Indeed, drugs that increase the amount of these neurotransmitters are the major medical approach to treating disorders such as depression.

Dopamine pathways commence in the brainstem, and project diffusely to the cortex. So that is, they're taking us through parts of the brain associated with feelings, and thoughts, and cognition, and memory, and movement. So dopamine is important in the control of mood and emotion, thought patterns, and the laying down of memories. It's also important in the control of sleep, feeding behaviour, and the control of body temperature.

Dopamine is the fuel for intentional behaviours. And it's the fuel for desire. Dopamine says, I want and I desire. Dopamine production is turned on when we're cued by a stimulus paired with a reward, when we're doing something that is good for our survival.

For this lecture, there are three main dopamine pathways that we're most interested in. These dopamine pathways are associated with several brain disorders, such as movement disorders, psychosis, schizophrenia, attention deficit disorder, and for us, what we're most interested in, drug addiction.

The nigrostriatal pathway is important in our movement and our behaviours. When this pathway doesn't work properly, we see stereotyped behaviours and movement disorders such as Parkinson's disease.

The mesolimbic and mesocortical pathways run from a region of the brain called the ventral tegmental area through the pleasure centre of the brain, the nucleus accumbens, and then on to the frontal cortex. The mesolimbic pathway is associated with our emotions and the control of our behaviour. It's the reward pathway. The mesocortical pathway is associated with higher level thoughts of planning and deciding.

Let's look a little bit more closely at two structures of the brain that this dopamine pathway cross. The first is the limbic region. This region gives meaning to our reality. It's the emotional centre of the brain, tells us what is good and what is important.

Structures associated with this limbic region include the nucleus accumbens, the pleasure centre of the brain, the hippocampus, which is useful or important for the memory of facts and events and time, and the amygdala, which records the emotional colour, the intensity of our experiences.

The dopamine pathways communicate between the limbic system and the cortex.

The cortex, and particularly the prefrontal cortex, is associated with thinking, and planning, and deciding. It gives us a sense of recent events through working memory. Working memory is the memory that you're using to remember what I said at the beginning of the sentence. And that is, working memory gives us a sense of recent events. It permits us to make comparisons, to make decisions, to make a plan. This is what we're going to do.

Now, the prefrontal cortex gets its meaning from the reward system. So the brain is being told, this is what we're going to do and this is why it's important. By working in these areas so effectively, drugs of abuse convince us that they feel good - and that they're important.

Just before I move on, there's an important portion of the cortex called the orbito-frontal cortex. Now this structure of the cortex, the orbito-frontal cortex, evaluates information that's been through the limbic region. That is information that has some sort of meaning, emotional meaning, attached to it. It determines what is to be done, whether we approach or avoid a temptation.

New research is showing that damage to this section of the brain, the orbito-frontal cortex, by drugs of abuse, makes us unable to resist our impulses. And so our decision making isn't as good as it should be. We're going to look more closely at these structures of the brain in further lectures.

So where are we now? We've discussed what happens when we take a drug, how it travels to the brain, and how it produces its effects upon our emotions, upon our thoughts, and upon our behaviours. We've discussed how drugs will either imitate a neurotransmitter or overstimulate the so-called reward pathway.

We now need to turn to how drug abuse and drug dependence can be explained by putting these biological processes together.