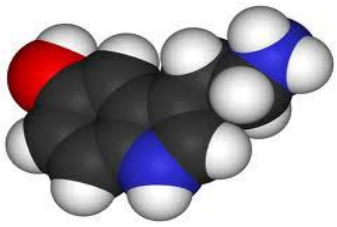
NEURAL MECHANISMS IN AGGRESSION

Two **neurotransmitters** are believed to be particularly important in the regulation of aggressive behaviour. These are **serotonin** and **dopamine**.

Serotonin and aggression

Serotonin is a neurotransmitter that exerts an *inhibitory* effect on neurons. In the **pre-frontal cortex**, certain neurons prevent activity in a sub-cortical structure called the **amygdala**. The amygdala is involved in controlling emotional responses, such as aggression. It has been proposed that if there are lower levels of serotonin in the pre-frontal cortex, it has less control over the amygdala, and consequently our impulsive and aggressive behaviours are less inhibited.



Serotonin

The serotonin theory of aggression is supported by a large number of studies. For example, research has consistently found *lower* serotonin levels in anti-social children and adults. This is especially the case in people who had attempted suicide, suggesting that serotonin depletion makes impulsive behaviour (including suicide) more likely. There are also *lower* levels of serotonin metabolites in the cerebrospinal fluid of more aggressive people. The lack of these metabolites is indicative of lower serotonin levels in the brain.

Experimental research also supports serotonin theory. For example, if men are given drugs which deplete levels of brain serotonin (e.g. *Dexfenfluramine*), they show increased hostility and aggression. Equally, drugs which increase serotonin levels (e.g. *Fluoxetine*) decrease aggression.

Serotonin appears to be involved in non-human aggression as well. Rats that have been conditioned to fight at a certain time of day show decreased serotonin levels just before it is time to fight. Blood samples from dogs referred to veterinary hospitals because of their aggression

towards humans show lower serotonin levels than samples from non-aggressive dogs.

However, critics point to the fact that not *all* people with low serotonin levels display aggressive behaviour. So, whilst men show increased hostility and aggression if they are given drugs which deplete serotonin levels, *women* do not. Likewise, whilst acute alcohol consumption depletes serotonin levels, not everyone who uses abuses alcohol behaves aggressively. These findings suggest that psychological and cognitive factors must also play a role in the moderating the aggressive behaviour that is associated with low serotonin levels.

Acute alcohol consumption does not *always* lead to aggression

Dopamine and aggression

The link between dopamine and aggression is less-well established. However, it has been suggested that *increases* in dopamine activity lead to increases in aggression. It is argued that like sex, drugs and alcohol, aggression is a behaviour the brain finds *rewarding*. Whenever we perform a rewarding activity, dopamine is released, which creates a pleasure circuit that is rewarding. We are then motivated to perform the behaviour again. In the case of drugs, this would lead to an addiction. In the case of aggression, it would lead to repeated aggressive behaviour.

Dopamine

Dopamine's involvement in aggression is also supported by several findings. For example, amphetamines increase dopamine activity, and controlled laboratory studies show that aggression increases following amphetamine consumption. Additionally, substances which *reduce* dopamine activity (dopamine *antagonists*) have been used successfully to reduce aggression in violent delinquents. In non-humans, rats conditioned to fight at a certain time of day show increased dopamine levels just before it is time to fight.

Two serial killers whose murderous behaviour was fuelled by amphetamines

However, there is the issue of *cause and effect* in this area of research. As noted above, studies indicate that when we have a rewarding experience, dopamine levels increase. Research with rats shows that dopamine levels are increased *after* an aggressive encounter with another rat, but *not before* the aggressive encounter. This would suggest that increased dopamine levels are a consequence of aggressive behaviour rather than a cause of it. Humans might therefore seek aggressive encounters because of the rewarding sensations, caused by dopamine increases, which these encounters provide. This would make aggression an example of a *learned* behaviour.

There is also a major methodological problem with studying the relationship between dopamine and aggression. Dopamine plays an important role in co-ordinating movement. If mice (for example) are given drugs which reduce dopamine activity, it is difficult for them to move. So, any reduction in aggression could be a result of a lack of motivation to behave aggressively, but it could also be because the mice find it difficult to move and hence difficult to be aggressive.