**The role of testosterone?**   
The male sex hormone **testosterone** is thought to increase levels of aggression from young adulthood onwards. It is thought that testosterone may influence areas of the brain that control behavioural reactions, such as the amygdala and the hypothalamus. Testosterone also influences the levels of other hormones which are thought to be involved in aggression, such as vasopressin.  
  
The link between testosterone and aggression may explain why **males** are generally more aggressive than females: males produce much higher concentrations of testosterone than females, and this may therefore lead to higher levels of aggression. This link also explains why aggression appears to be highest in male adolescents: testosterone levels are highest at this stage.  
  
There is a large body of research supporting this link between testosterone and aggression. One **meta-analysis** of 45 studies found a correlation of 0.14 between testosterone and aggression, showing a significant - though fairly weak - link. However, critics of this study have claimed that due to its methodological problems, an even weaker correlation of 0.08 was more appropriate.  
  
Despite many studies showing a positive correlation between testosterone and aggression, some studies have found no such relationship, particularly those that have compared testosterone levels of aggressive and less aggressive individuals. Many studies showing positive correlation have also involved small samples of men in prisons, meaning that these studies may lack population validity.  
  
Some researchers suggest that we should distinguish aggression from **dominance**. Aggression refers to the intent to inflict injury, while dominance is the desire to achieve or maintain status over another. Aggression may be just one form of dominant behaviour. The influence of testosterone on dominance is likely to be expressed in more varied and subtle ways. According to this view, much of the research into aggression was actually measuring dominance, making this research invalid.  
  
There is a **gender bias** in this research due to the differing natures and effects of testosterone in males in females. Although most research into this link has focused on males, studies suggest that the association between testosterone and aggression is higher for female samples than for male ones. Due these gender differences, research done on males should not be generalised to females, and vice versa.  
  
Research has shown that simple exposure to certain stimuli can increase testosterone levels and thus aggression. Klinesmith *et al.*found that when participants assembled a gun, their testosterone levels increased and they became more aggressive towards other participants. This has an important **real-world implication**, as some countries' governments (e.g. that of the USA) are debating whether gun ownership increases or decreases violence. This study would suggest that more guns would lead to more violent behaviour.

The hormone **cortisol** is thought to inhibit aggression. It is thought to do this by having a mediating effect on other hormones related to aggression such as testosterone. High levels of cortisol inhibits testosterone and so inhibits aggression. This may be due to the fact that cortisol increases anxiety and the likelihood of social withdrawal.  
  
**Studies** have found low levels of cortisol in habitual violent offenders and in violent schoolchildren. This suggests that although relatively high testosterone is the primary biochemical influence on aggression, low cortisol also plays an important role by increasing the likelihood of aggressive behaviour.  
  
The moderating effect of cortisol on aggressive behaviour is supported by a four-year study of boys with behavioural problem. The boys with consistently low cortisol levels began antisocial acts at a younger age and exhibited three times the number of aggressive symptoms than boys with higher or fluctuating cortisol levels. This demonstrates that cortisol levels are strongly and inversely related to aggression.  
  
An alternative explanation as to why cortisol decreases aggression has been suggested. The children with low cortisol levels in the aforementioned study appeared less afraid of **punishment** than the other children. Low cortisol levels may reduce stressful feelings towards the threat of punishment, causing individuals not to avoid stressful or negative behaviours.  
  
A criticism of these links between hormones and aggression is that they can be described as **reductionist**. The complexity of human behaviour means that biological explanations are insufficient on their own to explain the many different aspects of human aggression. For example, research by Bandura *et al.* found that social learning can be a powerful influence on the aggressive behaviour of children