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What does Cupid's Arrow trigger that makes you Fall in Love?

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Abstract
Cupid is the God of desire and when people are struck with his golden tipped arrow they fall in love. This paper briefly covers potential hormones and neuronal activity that may be triggered in individuals struck by Cupid's bow to fall in love. Oxytocin and dopamine are hormones that are associated with love as they aid in bond formation and initial attraction, and acute changes occur in the brain when falling in love.

Keywords: *Mythology; Biology; Cupid; Love; Oxytocin; Dopamine*

Introduction
Cupid is the son of Mercury, the winged messenger of the Gods, and Venus, the goddess of love [1]. His Greek name is Eros and he is said to have a bow, arrow and quiver [1]. When individuals are hit by Cupid's bow, particularly the golden tipped arrows they fall in love [2]. This paper will be investigating which hormones and neuronal activity Cupid's arrow would have to trigger in humans in order for them to fall in love. Romantic love is composed of 3 stages: lust, attraction, and attachment, which are facilitated by acute changes in brain activity and high levels of various neurotransmitters and hormones [3].

Figure 1 – Cupid the God of desire with his bow and arrow in the clouds [4].

The hormones that this paper will focus on includes oxytocin, dopamine, as well as changes in the neuronal activity. The paper will investigate how to make Cupid's arrow applicable in real life and therefore, exploring the physical and emotional traits that Cupid's arrow would have to have to cause romantic love between individuals struck by his arrow.

Oxytocin
Oxytocin is a hormone produced in the hypothalamus and secreted by the pituitary gland into the bloodstream [5]. It acts as a neurotransmitter and is produced in much higher levels in romantic relationships [5]. Therefore, as this is a 'love hormone' when individuals are hit with Cupid's bow this hormone may be triggered in couples as this hormone aids in forming attachment and trust [5]. Oxytocin inhibits the adrenal cortex from releasing stress hormones which encourages relaxation and helps to build trust [6].

In a 2012 study [7] they measured oxytocin levels of both single people and those in a relationship. On comparison they found those in a relationship had higher levels of plasma oxytocin. Particularly higher during the initial stages of a relationship [7]. Oxytocin has been associated with good communication and emotional support as well as bonding. During the experiment they were able to use plasma oxytocin levels to distinguish between couples who remained together and individuals who became single [7]. They did fail to measure plasma oxytocin levels prior to falling in love, however, the levels of plasma oxytocin were still higher in individuals in romantic relationships, implying oxytocin has an involvement in romantic attachment [7]. This hormone would be important for Cupid's arrow as forming bonds and trust is important for romantic love during both the initial stages and long term.

Dopamine

Dopamine is a neurotransmitter also produced in the hypothalamus and governed by the pituitary gland [8]. This hormone is associated with feeling pleasure, motivation, and reward. When dopamine is released, it controls what is called the 'reward system' of the brain and links with areas of processing emotions [8]. As this is linked to the reward system of the brain when a rush of dopamine release is triggered in the brain, an individual moves towards what caused the rush of those feelings [8]. It directs an individual's focus and leads them to seek out the reward. Social interaction can trigger this reward pathway. Due to dopamine effects in romantic love, it plays an important role in attraction and finding romantic partners [8]. This could be applied to Cupid's arrow as if this neurotransmitter is triggered by Cupid's arrow attraction is important for the beginning and long-term formation of romantic relationships.

A study in 2005 was carried out using functional MRI (fMRI) to scan images of the brains of people when viewing pictures of their significant others [9]. These scans showed that brain activity in regions with dopamine increased; the caudate nucleus and ventral tegmental area of the brain also showed activity [9]. These parts of the brain are associated with reward detection, motivation and acquiring rewards. The ventral tegmental area is important as it is a primitive neural network that links with the nucleus accumbens and other structures that associate with the reward system [9]. This springs attraction towards individual and provides motivation to seek out the reward. During the initial stages of romantic love individuals can be very obsessive, passionate, and blinded due to such an infatuation triggered by the reward system of the brain [9].

Central Nervous System

From brain scans on people in love it has been concluded that romantic as well as maternal love triggers several parts of the brain [6]. Lust which is initial attraction affects the hypothalamus and the basal ganglia which is rich in dopamine [6]. This can be applied to Cupid's arrow as when forming a romantic connection initial attraction is required therefore these parts of the brain may be triggered in response to Cupid's arrow [6]. The amygdala which is located near the brainstem as well as regions in the frontal lobe 'switch off' during romantic love as these parts of the brain are involved in judgement and recognising danger and threats [6]. When in love you are blinded and 'fall in' not worried about the consequences which could also be triggered by Cupid's arrow this causes strangers to fall straight into love with no care for the repercussions or uncertainty.

Behavioural effects of the early stages of romantic love are almost identical to the actions exhibited by drug addicts particularly those on a cocaine high [10]. They both act on similar regions of the brain which are dopamine and opiod-rich parts which control pleasure and reward gaining particularly the nucleus accumbens and ventral tegmental area [10, 11]. Addicts and people in love share similar primary emotional reactions of obsession when exposed to their loved one or drugs. Similarly, to addicts when breaking off a relationship those in love can experience withdrawal symptoms such as anxiety, loss of appetite and irritability [11]. However romantic love has a lead up effect rather than immediate effect as seen in drugs. Therefore, Cupid's arrow could possibly be viewed as almost a love drug causes an immediate effect rather than a gradual build-up as seen in most relationships. Overtime these addictive characteristics are reduced in romantic love [11].

Conclusion

For Cupid's golden tipped arrow to potentially be plausible in causing romantic love between strangers the arrow would have to cause changes in levels of neurotransmitters and hormones which would lead to acute changes in brain activity. Some of the most impactful hormones include: oxytocin, which is important in forming attachment and trust in romantic love; and dopamine, which controls the 'reward system' of the brain. An increase in these hormones' levels would be important for Cupid's arrow to cause people to fall in love as these traits are important in the initial stages of a romantic relationship. The brain has similar activity when in love as an addiction therefore triggering these parts of the brain helps strike up the immediate effect of falling in love like a drug addiction rather than a progressive build up this could be applied to Cupid's arrow. Overall Cupid's golden arrow would need to cause an increase in oxytocin and dopamine levels to potentially cause individuals to fall in love immediately after being struck. As well as exhibiting brain activity like an addict.

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