The Science of Love; a Cocktail of Chemicals

By Aleksandra Tsytsyn

Love is one of the most powerful human emotions we face, and probably the one we think about most often. It can unite us to other people in the form of companionships, friendships, and romantic relationships. We see love throughout all of our culture; the millions of romantic comedies that are released around Valentine's day, the dire need for our daughters/sisters/selves to have a date for prom, the importance we place on marriage, commitment and friendship. Although love is traditionally thought of as having a home in the heart, we can thank our brain for the effects of love that we feel. Having a continual desire for closeness, reduction in anxiety and fear, feeling of euphoric happiness, loss in appetite, and increase in sweating and trembling can all be attributed to the signaling chemicals (neurotransmitters) in our brain. A few key neurotransmitters involved in the chemistry of love are dopamine, oxytocin, and endorphins.

Step 1: Add Dopamine.

Dopamine is known to play a major role in the reward system of the brain. This system is a collection of different brain regions that activate when a person receives a reward, and it produces a good or pleasurable feeling. Receiving a reward promotes repetition of the activity that produced that reward. Food, cocaine, water, cigarettes, sex, and positive social interactions are some of the activities that can lead to reward, and thus satisfaction. Dopamine is also associated with creativity and novelty-seeking. Another function of this neurotransmitter is that it creates a feeling of unity between two people in love (Tarlaci, 2012).

How do we know that dopamine is one of the main players in love? In 2004, Semir Zeki and Andreas Bartels did a study looking at how a person's brain reacts to a photograph of someone they love. Brain imaging was used as a measure of brain activity while participants looked at photos of their beloved, as well as photos of strangers. Various brain regions were activated when a participant would look at their beloved, one of which was the hippocampus which deals with memory. However the significant result was that parts of the brain that were most activated (ventral tegmental area and substantia nigra) are the source of 90% of the dopamine in the brain (Bartels & Zeki, 2000).

Another study was done based on these data that looked at activity of dopamine-rich brain regions in long-term romantic love. Is it really possible to love someone for an entire lifetime? Indeed people who reported long-term romantic love had brain activity in dopamine-rich regions important for motivation and reward-processing when looking at pictures of their partners (Acevedo et al., 2012).

Step 2: Add Oxytocin.

Oxytocin is another love neurotransmitter and is released in the brain and binds to various brain regions to affect social behaviors. This signaling chemical is mainly known for its release during labor to stimulate uterine contractions (Burbach et al., 2005), however it is also released during sexual intercourse (Christensson et al., 1989). In addition oxytocin plays a role in social memory and social attachment. The role of oxytocin in maternal behavior and in the formation of mother and offspring social attachment suggests that coordinated oxytocin release during labor and nursing is the mechanism through which mother and infant bonding is induced (Ross & Young, 2009; Feldman, 2012).

Oxytocin plays a role not only in parental love but also in romantic love. Oxytocin is made in the hypothalamus of the brain, which is responsible for hormone production. It is sent to and released from the back portion of a small gland in the brain, the posterior pituitary. This gland can then send oxytocin to the rest of the brain and outer parts of the body, and ultimately produce changes in social behavior. During labor, oxytocin is released peripherally (to outer parts of the body) to produce uterine contractions and induce the letdown of milk from the mammary glands. Oxytocin is released in the brain during labor to induce mother-offspring bonding (Burkett & Young, 2012). During sex, oxytocin is released in the same way, however it creates bonding between sexual partners (Young et al., 2005). The mechanism through which oxytocin is released during labor and nursing, is the same mechanism that releases oxytocin induced by nipple stimulation and sexual intercourse (Burkett & Young, 2012).

Human studies have shown that oxytocin is correlated with pair-bonding behavior in women (Walum et al., 2012). Oxytocin is not only released during sexual stimulation, but also during hugging, touching, and massage. This promotes increased attention to emotional cues, increased eye gaze and trust (Kosfeld et al., 2005; Domes et al., 2007; Guastella et al., 2008; Andari et al., 2010). Early on in a romantic relationship, more oxytocin is released. Oxytocin can actually be used as a predictor of which couples will stay together after 6 months of dating; greater oxytocin levels are correlated with a greater chance of staying together (Schneiderman et al., 2012). In human romantic relationships, the release of oxytocin throughout the brain during romantic activities forms long-term bonds between couples (Young et al., 2005; Feldman, 2012).

Step 3: Add Endorphins.

Opioids are a group of chemicals that control pain, reward, and addictive behaviors. One of these chemicals is morphine, and it is the most important painkiller in current medicine

(ScienceDaily, 2007). Endorphins, also in the opioid group, are neurotransmitters produced by the brain that are responsible for compassionate love and that head-over-heels kind of love (Kurup & Kurup, 2003). Like dopamine, endorphins play a role in social reward and social motivation and like oxytocin, these opioids also are involved in social attachment. Endorphins affect maternal behavior and opioid neurotransmitters were actually the first to be connected to social attachment in animals (Panksepp et al., 1978).

The connection between endorphins and social reward is that if there are a lot of endorphins, this signals to the brain that you are in a reward state and you feel good. An example of a reward state would be feeling the rewarding effects of social contact; you feel good when a loved one hugs you. However if there aren't a lot of endorphins, this induces the drive to seek out social rewards to be in that reward state and get that good feeling again (Burkett & Young, 2012). The correlation between endorphins and social attachment or pair bonding is seen in studies done on prairie voles. These fluffy small voles are used to study the chemicals underlying pair bonding because they, like most humans, are socially monogamous in that they mate and affiliate exclusively with one partner for life. This pair bonding is very rare in other animals. When an opioid blocker is put into prairie voles, a decrease in pair bond formation between partner prairie voles is seen as well as a decrease in mating. This study shows that endorphins are necessary for pair bond formation, and this role of endorphins is also seen in humans (Burkett et al., 2011).

Step 4: You've got yourself a Love Cocktail; Drink Responsibly.

With love being such a prevalent force in all of our lives is it important to know what happens in our brain when we are in love and what chemicals contribute to the euphoric feeling. Essentially that is what love looks like in our brain. It is dopamine that makes us cover our

notebook with the name of our crush encircled by big red hearts, and that makes us love our partner until our hair turns silver. It is oxytocin that lets mothers bond with their baby, and that makes us united with our partner. It is endorphins that make us fall head-over-heels in love, and bond with the person that we love. This cocktail of chemicals is probably the best one you'll ever have.

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