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## The Science of Love

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### ABSTRACT:

In the present article “The Science of Love”, we review love in the views of science, mainly neuroscience and psychology. Various topics and research to support those themes are discussed throughout the article, including what is love, leading to the conclusion that love is mostly related to the fulfillment of an (emotional) desire, which produces rewarding components; falling in love and the role of physical attraction in this process, as it is a component that stimulates romantic love, which is usually prompted by visual stimuli; long-term love relationships leading to the conclusion that long-term relationships require good interaction between partners, and exclude the obsession component (Mania) associated with early-stages of love; the main neuromodulators involved in love: dopamine, oxytocin and vasopressin, exploring the effects of dopamine, the love hormone (oxytocin) and vasopressin on love and the human body; the brain regions influenced by romantic love and its effects on the body, with love being associated with the decrease in activity of the frontal, parietal and middle temporal cortex and of the amygdala; the division of love in lust, attraction and attachment; and the products of a loving relationship, those being that they are able to increase self-esteem and well-being and to reduce pain and mortality.

**Keywords:** Love, Neuroscience, Neurophysiology, Psychology

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### 1. Introduction

One of the most popular views of love was proposed in 1818 by philosopher Arthur Schopenhauer (1788 - 1860). He believed that love was nothing but an illusion created by the environment to incentivize the propagation of the species (procreation) and overcome the obstacle of human selfishness that prevented this goal.

Fields like philosophy and literature have been seeking to understand this phenomenon for centuries. However, science has also attempted to explain this rare and unique occurrence through a more factual perspective. In the present article, we present and discuss relevant research that sought to understand and explain love.

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### 2. What is Love?

The word “love” derives etymologically from the old English word *lufu*, (desire, affection, satisfaction), sharing a common root with “libido”. Hence, its meaning can be associated with the satisfaction of a yearning or the acquisition of sensory stimulation.

There are various definitions of love. One of its concepts is “having an emotional bond with a person for whom one yearns, as well as having sensory stimulation that one desires” [1].

A similar conception characterizes love as “the constellation of behaviors, cognitions, and emotions associated with a desire to enter or maintain a close relationship with a specific other” [2].

Another definition defines love as the existence of an emotional state involving chemical, cognitive, rewarding, and goal-directed behavioral components [3].

Analyzing those concepts, we can conclude that love is mostly related to the fulfillment of an (emotional) desire, which produces rewarding components.

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### 3. Falling in Love

Usually, romantic love is prompted by visual stimuli. This feeling is hardly disconnected from other urges such as lust and physical desire.

Physical appearance is relevant, mainly in the setting of romantic attraction and relationships. Physical attractiveness has frequently been proved to be a powerful anticipator of attraction and partner choice. In a study that evaluated five strong indicators of what predicts romantic interest, only the responders' viewpoint of the targets' physical attractiveness anticipated romantic interest. Particularly, responders' who rated the targets' physical attractiveness as higher than themselves presented more romantic interest [4]. This is considered across cultures and for both males and females [5].

A study by psychologist Arthur Aron and colleagues that sought to determine the cause of this powerful feeling concluded that falling in love was preceded by frequent reported incidences of perceiving other's desirable characteristics (appearance and personality) or discovering other's likeness for the self; moderate incidences of noticing similarity, propinquity and "special falling-in-love processes" (readiness, specific cues, arousal, mystery, isolation); and comparatively low reported incidences of social influence and filling needs [6].

It can be inferred that one's physique and attractiveness are the factors that play the biggest role in prompting love.

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#### **4.Long-Term Love**

A five-year study [7] had 93.6% of success in predicting a couple's either divorce or stability. The study analyzed the couple's interactions, and their positive (laugh, assent, and others) and negative codes (complain, criticize, defensive, and others). The study classified two types of couples: Regulated couples (those who displayed more positive codes than negative ones), and non-regulated couples (those who displayed more negative codes than positive ones). Non-regulated couples were classified as those who tend not to have a long marriage. The study concluded that in order for a marriage to be enduring, the couple must have marital quality time. Additionally, the research suggests that marital stability needs management of interactive behavior at a ratio of positive to negative codes of roughly 5.0 to 1.0. In other words, marriage longevity requires a good interaction between partners.

Another study [8] related to long-term love examined the possibility of the existence of romantic love, or Eros (with engagement, intensity, and sexual interest but without obsession), in long-term relationships. The research found that romantic love, without the common obsession factor of early-stage relationships, can and does exist in long-term marriages, and is correlated to well-being, marital satisfaction, and high self-esteem. However, obsessive love, or Mania — in which "the lover is jealous, full of doubt about the partner's sincerity and commitment, subject to physical symptoms such as inability to eat and sleep, experiences acute excitement alternating with debilitating depression" [9] —, was negatively associated with romantic love in long-term and positively in short-term relationships.

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#### **5.The Euphoria of Love**

The regions in the brain that are activated in reply to romantic feelings are generally coincident with those that have excessive concentrations of dopamine. Also known as the "feel-good" neuromodulator, dopamine is associated with desire, reward, addiction, and pleasurable sensations, being released by the hypothalamus. It is a contributing factor in motor function, mood, and decision making. For this reason, love frequently follows a sensation of euphoria. Exogenous opioid drugs like cocaine, sexual intercourse, and exercising also activate the production of dopamine, inducing states of euphoria.

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#### **6.Love is blind**

An increase in activity in the romantic areas of the brain is followed by a decrease in activity of the frontal, parietal and middle temporal cortex and of the amygdala, a large nucleus at the apex of the temporal lobe. This cortical area is known to be involved in alarming situations and its deactivation entails a decrease of fear. The deactivation of these regions also accompanies suspension or easing of judgment. Thus, when deeply in love, one suspends those critical judgments that, otherwise, one would use to judge people. Thus, one might say that "love is blind" or irrational because, when in love, rational judgments are suspended or lightened.

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#### **7.The Love Hormone**

Most parts of the brain areas that are activated by (romantic and maternal) love are known to contain receptors of oxytocin and vasopressin. They are both associated with a connection between individuals and with memory and effective learning in social circumstances, being necessary neurobiological transmitters in love and pair bonding, with its productions being directly induced by sexual stimulation. Oxytocin is released mainly during childbirth, breastfeeding, and sexual intercourse. This neuromodulator is also known as the love hormone as its levels rise during orgasming and hugging. Oxytocin seems to decrease stress responses, such as anxiety.

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#### **8.Lust, Attraction, and Attachment**

A hypothesis proposed by researcher Helen Fisher [10] suggested that mammals developed three interdependent emotion systems for mating: lust, attraction, and attachment.

Lust (libido, or sex drive) is defined by an appetite for sexual fulfillment. It is primarily associated with estrogens and androgens, such as testosterone. Estrogens are responsible for the development of sexual organs and female secondary sexual characteristics. Though they are found in females in higher quantities, they can also be found in males. Furthermore, estrogens are linked to the regulation of the libido in both sexes. Androgens, on the other hand, are linked to increased libido and sexual arousal.

Attraction is defined by increased focused attention on potential partners. It is usually followed by sensations of exhilaration and desire for emotional union with this mate. The properties associated with attraction by Fisher and her colleagues are: inability to feel romantic passion for more than one

person at a time; intrusive thinking about the loved one; inclination to overlook the loved one's negative traits and focus on the positive ones; unstable psychological responses (euphoria, exhilaration, loss of sleep and appetite, shyness, sweaty palms, pounding heart, anxiety, etc); desire for emotional union; emotional dependency; a powerful sense of empathy and responsibility for the loved one; a desire to make an impression, like changing clothes or habits; desire for sexual exclusivity; a desire for emotional union before sexual; and sensation of an involuntary or uncontrollable passion. It is primarily associated with catecholamines (dopamine, norepinephrine, and serotonin), linked with the "reward areas" of the brain. An increase in dopamine is related to euphoria, anxiety, heightened energy, and loss of sleep and appetite. Norepinephrine is chemically derived from dopamine, having similar effects on the body. High levels of serotonin are usually linked with pleasing aspects of sexual behavior, sensations of well-being, prolonged sleep, and reduced anxiety.

Attachment is defined by the preservation of close social contact, followed by sensations of calm, comfort, and union with a mate. It is primarily associated with oxytocin and vasopressin, both associated with a connection between individuals, affecting social processes.

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## 9. Products of a Loving Relationship

Falling in love can produce various positive effects on one's body. Falling in love increases one's self-concept, leading to a change in one's perceptions of the self and also increasing self-efficacy and self-esteem [11]. Additionally, there is a positive association between experiencing higher levels of love in everyday life and greater psychological well-being [12].

There are even correlations between love and the reduction of pain. A study discovered that the activation of neural reward systems by viewing pictures of a romantic partner can reduce the experience of pain [13]. Love can also reduce the risk of mortality. Singles have a 30% increased risk of mortality relative to married people [14]. This finding remained consistent across sex, age, cause of death, initial health status, and follow-up period [15].

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## 10. Conclusion

Love is mostly related to the fulfillment of an (emotional) desire, which produces rewarding components. Physical attraction is a component that stimulates romantic love, which is usually prompted by visual stimuli. Long-term relationships require good interaction between partners, and exclude the obsession component associated with early-stages of love. The main neuromodulators involved in love are dopamine, oxytocin and vasopressin. Love is associated with the decrease in activity of the frontal, parietal and middle temporal cortex and of the amygdala. Loving relationships can increase self-esteem, well-being and reduce pain and mortality.

Love and its products can be scientifically explained. This rare phenomenon includes the action of various chemistries and regions of the brain. However, why we fall in love specifically with someone remains a mystery. Love could not be put in better words than Einstein's: "There is an extremely powerful force that, so far, science has not found a formal explanation to. It is a force that includes and governs all others, and is even behind any phenomenon operating in the universe and has not yet been identified by us. This universal force is LOVE."

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