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# Can you wake up by True Love's Kiss?

Merian Alit
*Natural Sciences (Life and Physical Sciences), School of Biological Sciences, University of Leicester*
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**Abstract**
Fairy tales have been around for many years and the Disney version of fairy tales often portray "true love's kiss" as a magical force that can overcome any spell. While this is fiction, there are biological and neurobiological responses to kissing and romantic love, which have real scientific implications. This paper explores the neurobiological basis of romantic attraction, particularly focusing on the neurotransmitters, hormonal responses, and brain activity associated with kissing. This paper further examines the physiological responses that can theoretically contribute to the reawakening of a person in a coma, offering a different perspective on the interaction between external stimuli and brain function.

**Keywords:** *Fairy Tale; Biology; Love; Sleeping Beauty; Kiss*

**Introduction:**
Fairy tales often feature "true love's kiss" as a way of breaking magical enchantments, famously depicted in Sleeping Beauty and Snow White as seen in figure 1 below [1, 2]. This idea originates from 16$^{th}$ century literature, when William Shakespeare referenced the concept when he wrote "Bear her my true love's kiss" in the play Richard III [3]. This paper explores the possibility of a person in a coma being able to wake up from a kiss by examining the neurobiological reactions that occur when people in early-stage romantic relationships kiss and how this would stimulate brain activity.

Figure 1 – Prince Charming approaches Princess Aurora to kiss her while she remains in an enchanted deep sleep [4].

**Dopamine:**
Dopamine is a key neurotransmitter, which regulates motivation, pleasure, and cognitive function. Increased dopamine levels are associated with heightened alertness and a behaviour of seeking reward [5]. Dopamine is a key modulator of cognition and motor function, if pathways are disturbed, a significant reduction can contribute to a person falling into a coma. Depletion of monoamine systems contributes to consciousness. The act of kissing stimulates dopamine production and an overstimulation can cause oxidation to produce noradrenaline, this in turn can trigger cognitive function [6].

**Oxytocin:**
Oxytocin, often referred to as the "love hormone", plays a crucial role in social bonding and emotional connection. Kissing increases oxytocin levels, promoting relaxation and positive emotional response. The hormone has been linked to trust, attachment and it can influence neural plasticity and cognitive function [7, 8].

**Serotonin and Emotional Regulation:**
Serotonin is another neurotransmitter involved in mood regulation. Increased levels of serotonin are associated with romantic attraction, obsessive thoughts and emotional intensity. The interaction of

serotonin with dopamine and oxytocin could influence neural pathways responsible for wakefulness [6, 8].

**Role of Nerve Growth Factor (NGF):**
A study by Emanuele et al. (2006) found that nerve growth factor (NGF) levels were significantly elevated in individuals who were experiencing early-stage romantic love. NGF levels in individuals who recently fell in love had a mean value of 14 pg/ml compared to subjects in long term relationships who had lower mean value of 10 pg/ml. NGF supports neurogenesis and synaptic plasticity, suggesting that emotional attachment may enhance brain function [9, 8]. While NGF alone is unlikely to wake someone from a coma, it highlights the connection between emotions and neural activity.

**Brain Activity in Response to Kissing:**
Comatose individuals have low-frequency delta waves (<4 Hz), suggesting minimal brain activity. However, EEG patters in coma vary depending on the underlying cause. In contrast, kissing synchronizes brainwave activity between partners, typically in the theta-alpha range (5-10 Hz) [10]. Since early-stage romantic relationships have been associated with increased NGF levels, it is possible that kissing activates brain regions linked to monoamine neurotransmitter systems, which could increase brainwave activity. Neural activation may be possible through external stimuli involving emotional engagement and influence brainwave patterns.

**Could a Kiss Wake Someone from a Coma?**
Research on sensory stimulation suggests that external cues, such as touch, voice and smell can influence neural activity in unconscious individuals. Cases of coma patients responding to familiar voices or physical touch indicate that sensory stimulation plays a role in consciousness recovery. Medical literature shows that emotional stimuli provided by family members compared to unfamiliar personnel is more efficient in sensory stimulation [11]. Overall, familiar voices, emotional interactions and some scents are associated with increased brain activity. While a kiss alone is not likely to be sufficient, external stimuli from loved ones may aid in neural reactivation.

**Limitations and Considerations:**
Recovery from a coma is a very complex process, which extends beyond a single stimulus. Factors such as the brain injury severity, duration of unconsciousness, and overall health significantly influence the likelihood of awakening [11]. While kissing can activate specific neural pathways, there is no evidence to suggest that it is sufficient to revive an individual from a coma.

Additionally, research on the effects of kissing an unconscious person have not been studied, making it unclear whether changes in nerve growth factor levels or brain activity would mirror those observed in conscious individuals. Although, some studied have explored the role of neurotransmitter in coma, it remains uncertain how they could be effectively stimulated to induce awakening. Further research is necessary to understand potential mechanisms for restoring consciousness in comatose patients.

**Conclusion:**
Kissing triggers multiple biochemical reactions, including increased dopamine, oxytocin and NGF, but these alone do not provide enough emotional stimuli. However, the role of sensory stimulation in coma recovery is well documented and is indicative that external stimuli from loved ones may contribute to consciousness recovery. The concept of "true love's kiss" as a way to wake someone from a coma remains a romanticised myth. While a kiss may not be the cure, the broader implications of emotional and sensory engagement in neural activity remain an area of scientific interest.

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