

Neuroenhancement of Love and Marriage: The Chemicals Between Us

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Abstract This paper reviews the evolutionary history and biology of love and marriage. It examines the current and imminent possibilities of biological manipulation of lust, attraction and attachment, so called neuroenhancement of love. We examine the arguments for and against these biological interventions to influence love. We argue that biological interventions offer an important adjunct to psychosocial interventions, especially given the biological limitations inherent in human love.

Keywords Relationships · Love · Marriage · Pair bonding · Divorce · Enhancement · Bioethics

“Adrenaline means more than fear,” said Fireweed. “And divine love is more than adrenaline and dopamine.”

“Certainly. There’s phenylethylamine and oxytocin. Love is a most complex and difficult problem.”
Joan Slonczewski, *Brain Plague* (2000) [67]

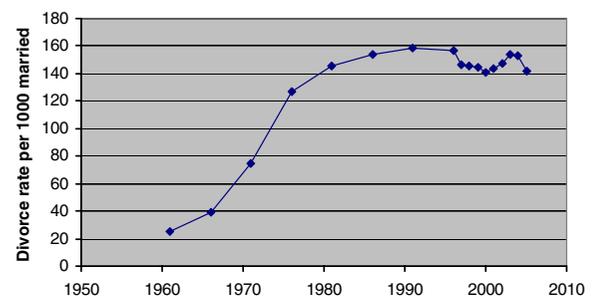
Introduction

According to the Yusufzai Pukhtun the most powerful love potion in Northern Pakistan is water that has washed the body of a dead leatherworker [47]. In

Swedish folklore, to capture the love of someone you should carry an apple in your armpit for a day, and then give it to the intended lover. Since Roman times a long list of foodstuffs and drugs have been supposed to stimulate lust, love and good relationships [78]. Chemically helping love on its way has a long history. While in the past this was based on symbolism and wishful thinking, today the biological underpinnings of love are beginning to be elucidated, enabling science-based interventions into *amour’s* domain.

Trends in divorce, as well as findings in evolutionary psychology, suggest that love might need a helping hand. The issue is more general than marriage and divorce: what factors make human pair bonding last and can (and should) we do something about it? This paper will discuss the potential for enhancing human love and marriage in the light of the problems of maintaining lasting relationships.¹

Breakup—“Til Death Do Us Part”



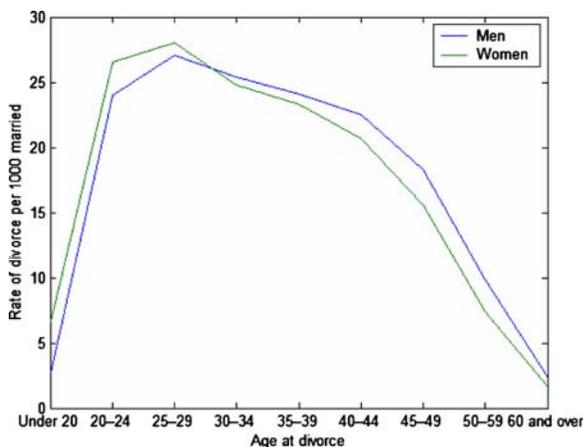
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¹ In the following we will call a stable pair bond a marriage, regardless of its social framing, the genders involved etc.

Marriages appear to have become more unstable in recent times. In 2003, there were 166,700 divorces in the UK, around 1.4% of marriages each year (all UK statistics from [56, 57]). Divorce rates rose steeply in the 1960s and 1970s, reaching a plateau at the current level in the 1990s (see figure). At current levels, about two in every five marriages will end in divorce (and in the US divorce has replaced death as the most common end of marriage [60]).

The divorce rates peak among younger couples, declining with age. Most marriage break ups occur between 5 and 9 years, with the median duration in 2003 at 10.7 years—up from 9.8 in 1990, but still far shorter than till death do us part. This pattern appears to recur worldwide, both in industrial, agrarian and hunter-gatherer societies with high or low divorce rates [18].



In a 1985 study among Americans, where multiple choices could be made, communications problems was the most common given reason for divorce in women (69.7%). It was followed by unhappiness (59.9%), incompatibility with spouse (56.4%), emotional abuse (55.5%) and financial problems (32.9%), sexual problems (32.1%), spousal alcohol abuse (30.0%), spousal infidelity (25.2%) and physical abuse (21.7%). In men the structure was roughly similar, but fewer simultaneous problems were reported and unfaithfulness was an uncommon reason for divorce (10.5%) [13]. British data also suggests that emotional effects correspond to a large fraction of uncontested divorces.

This rise in divorce has occurred together with a rise in attempts to study marriage scientifically as well as treat it therapeutically. Divorce is usually seen as undesirable, a “social disorder,” despite increasingly

becoming a normal state [60]. We will not question this assumption, though plainly when divorce should occur is an important ethical issue.

Why Does Divorce/Breakup Happen?

The independence hypothesis claims that marriages will remain stable as long as the joint utility of staying together outweighs the utilities of being single [7]. Bao et al. [4] found that UK women with a greater degree of economic independence face a higher divorce risk. They did not find much evidence for an impact of gender-role attitudes or of the domestic division of labor, but found a robust effect of children raising the hazard of divorce.

However, existing theories leave out something most people find highly relevant for marriage: love. The Western concept of marriage is heavily based on the assumption of shared love: today it is seen as primarily love-driven. Economic, social and political considerations still play a role but are no longer viewed as legitimate causes for marriage (or divorce). Marriage is expected to express the desires, goals and interests of the partners rather than outside groups [60]. While economic models of divorce rates have been fairly successful and such utilitarian calculations might be going on subconsciously or intuitively, the reasons given for divorce (although possibly rationalizations) seem to point at emotional issues as being important. Our main interest in this paper is the breakup of pair relations, i.e. the failure of love to bond two people.

Evolutionary considerations give us a clue to the emotional aspects of non-attachment. Evolution does not promote human happiness except as a side effect. Pleasure, joy and love all appear to have evolved as adaptations to promote fitness rather than ends in themselves. To us humans, however, they (and many other life goals) are often far more important than the survival of our genes. If human relations could be modified in such a way as to promote love at the expense of the number of children, it seems likely many people would take the chance despite the break with evolutionary imperatives. Indeed, most people forego having as many children as possible to make their own lives go better. An evolutionary ‘is’ does not imply a moral ‘ought’.

Evolution can interfere with marital bliss in three main ways: through conferring different goals on men and women, through evolving relationship structures

that promote inclusive fitness rather than happiness, and by way of a mismatch between current possibilities (e.g. lifespan) and evolved adaptations.

Evolutionary theory predicts that genes promoting psychological and physiological traits that lead to a greater number of successful offspring will become more common over time. It has been described as being powered by “selfish genes” that only seek to ensure their own survival, using our bodies as vehicles for their spread [15]. In some situations, this leads to divergent goals for males and females. Due to the difference in effort and risk that having a child represents to the father and mother respectively, the sexes may evolve different and possibly conflicting reproduction (and hence relationship) strategies. If a mutation increases the chance of spreading the affected gene in males and does not have any major negative impact on females it will tend to become more common. This has been a broad (and often fiercely debated) stream of investigation in evolutionary psychology for a long time.

The classic claim is that males would tend towards higher levels of promiscuity since the cost of having many and possibly illegitimate children is small for the father while females, having a greater investment in each child, would be motivated to be more selective in partners and have a stronger incentive to retain their mate. This in turn may lead to differing levels of sexual interest (possibly changing with the duration of the relationship).

Studies have shown that female desire for sexual intimacy decreases as a relationship continues, while the male desire appears constant. Conversely, desire for tenderness declines in men and rises in women. Sexual activity and satisfaction declines in both genders [41, 42]. This discrepancy is likely to cause friction in a relationship and increase the risk of male infidelity over time. Klusmann [42] explains these changes as the product of an evolved design that is fine-tuned to the different life situations of females and males. Males desire sex in this model as a safeguard against cuckoldry, while females seek to maintain a pair bond to ensure male resources.

Adult attachment may be based on the same (neuro) psychological systems as the parent–child bond after the initial infatuation period has passed. In both cases, close physical contact, kindness and understanding help form the bond, separation produces the same negative feelings, closeness gives a sense of security

and the different bonds have the same physiological regulation. According to Zeifman and Hazan [85], the high rate of divorce in the first years of marriage reflect failures to form a pair bond as the original state of infatuation declines. There may exist an evolutionary pressure (at least in males) for serial monogamy, making males more willing to break off relations than females. In preindustrial cultures, the reproductive success of remarried men was higher than the success among remarried women [35]. Serial monogamy due to short-lasting marriages has the effects of polygyny. Males remarry more than females and tend to marry younger partners [35]. Since desirable (often high status) men can more easily remarry young and desirable women they can gain greater access to sexual resources, leaving less fortunate men in the cold. This increases disparities in reproductive success and might even increase the risk of rape as an alternative reproductive strategy [68].

The rapid changes in human culture and environment, in particular those brought about over the last century, have led to discrepancies between our adaptation to a past environment (the “environment of evolutionary adaptiveness” (EEA), roughly corresponding to the Pleistocene hunter–gatherer existence), and our current environment.

In particular, human lifespan is far longer today than in the EEA (≈ 20 – 35 years). This is both due to a reduction in risk and to better health. Given the high risks of giving birth in the EEA and, high accident risks for all, many marriages ended by one of the partners dying. Given a life expectancy on the order of 30 years and assuming marriages in the teens, at least 50% of marriages would have ended within 15 years, usually due to the death of one of the partners. This is surprisingly close to the current median of about 11 years.

In a high mortality society, a mutation predisposing towards permanent marriages would rarely have an effect, since most marriages ended with one partner dying. There is no selection pressure for very long-term maintenance, a situation similar to that suggested by genetic theories of ageing [39, 44]. A mutation making relations last a short time on the other hand would be self-defeating since the chances of survival of abandoned mothers and children are significantly lowered (among the Ache, a modern hunter–gatherer society, orphaned children were especially likely to be deliberately killed [30]). Evolution would favor relations

just long enough to make the chances of children surviving to adulthood high, yet not much longer than the expected survival of one of the spouses.

Monogamy

Are humans a monogamous species at all? It should also be noted that even in animal species that do ‘mate for life’ extra-pair mating is a common occurrence and ‘divorce’ sometimes occur [9].

However, even in human societies that allow polygamy it is usually relatively rare (less than 20%) and tied to high economic status [51, 79]. Thus, even when almost 80% of surveyed societies allow polygamy, monogamy is practiced by 80% of their inhabitants. The largest populations mostly belong to officially monogamous societies [80]. It is possible that polygamy is a function of the resources of male and the freedom of the females to select the best partners, even if having to share that partner with others.

The amount of extramarital sex varies significantly between cultures. In some the practice is nearly universal, in others uncommon [52]. In the US 10–15% of women and 20–25% of men report having been unfaithful while married or cohabiting implying more than 80% monogamy throughout marriages. The likelihood of having had extramarital sex increases with having been divorced, with the length of a relationship and in less happy relationships [3, 70, 81].

The conclusion supported by these results suggests that humans so far in human history have had a strong tendency towards monogamy.

Do We Need Marriages?

From a purely hedonic perspective love is (often but not always) desirable. Close relationships promote many forms of human well-being and being married has a strong positive effect on happiness [53], a happy pair bond being one of the most important determinants of happiness.

Love is healthy: it provides continuing social support, something which in turn reduces cardiovascular reactivity to stress [71]. Strong supportive social ties improve life satisfaction and reduce stress and depression more than ambivalent or weak ties [72]. Interaction with spouses and family members reduce blood pressure [31]. Conversely, social isolation increases the risk of depression [75] and mortality

[8, 32]. In long-lasting couples marital conflicts are correlated with poorer immune status [38].

Breakup/divorce is also unhealthy. The loss of social contact not only extends to the partner but often to many friends and relatives. Needless to say, happiness ratings suffer and depression risk increases among the separated and divorced [53].

However, this should not be interpreted as implying that being unmarried is bad. In fact, happiness statistics seems to imply that it is better to belong to the ‘never married’ group than to the separated and divorced groups [53]. Some people may feel suffocated by close relationships and should not be forced into them, despite society’s overwhelming pro-relationship bias [22].

Relationships may also be viewed as good in themselves, either as something valuable in addition to the joy they bring the partners or as something that even transcends their well-being (e.g. as a means of self-development, self-realisation or even duty to a divine plan). While often regarded as overly individualistic in their outlook, aiming just for the well-being of their clients, marital and family therapists in general do appear to value relationships [74].

Conventional Methods of Helping Relationships

Marital therapy has been one conventional way of helping marriage. While therapy no doubt can help many marriages, one or both of the partners need to notice that something is wrong before it is used. Since the slow fading of emotion is almost undetectable, there is a risk that therapy will not be sought until it is too late.

In the past, marriages have also been kept together through social sanctions or economic need. If the cost of divorce is high, pairs would likely have stronger incentives to keep together and might make an extra effort to love each other. Couples can choose to be married within a contract with “high exit costs” if they decide to part. One strategy employed by some US states, such as Louisiana, is to offer the opportunity to enter a contract (“covenant marriage”) at the time of marriage, with more limited grounds for divorce. Other variants are also possible, such as requiring the partners to undergo counselling if their marriage fails. But creating rules making divorce harder may not only impair personal freedom, it might also merely prevent relationships from becoming legally recognized marriages if the risks of being “tied together” are perceived

as great. Engineering economic constraints to promote marriage is also risky for the same reasons, and has all the ethical problems of social engineering. Making divorce harder would also trap more people in loveless or toxic marriages.

Hence other ways of promoting attachment might be useful or useful adjuncts to these.

The Neuroscience of Love

Underlying human love is a set of basic brain systems for lust, romantic attraction and attachment that have evolved among mammals. Lust promotes mating with any appropriate partner, attraction makes us choose and prefer a particular partner, and attachment allows pairs to cooperate and stay together until their parental duties have been completed [19, 20]. The evolutionary systems form a ground on top of which the cultural and individual variants of love are built. They represent human universals which are expressed in different cultural ways [23, 34].

Neuroimaging studies of romantic love have shown activations in regions linked to the oxytocin and vasopressin systems, activation in reward systems, as well as systematic deactivation in regions linked with negative affect, social judgement and assessment of other people's emotions and intentions. Contrasting maternal and romantic love show overlap in many areas, with some specific differences [5, 6]. The different aspects of love involve widely dispersed systems rather than any particular "love centers." Brain systems involved in visceral perception, attention and imagination clearly become involved in any romantic or erotic thought.

Much work in social neuroscience has gone into studying the mating habits of monogamous prairie voles (*Microtus ochrogaster*) and the closely related but polygamous montane voles (*Microtus montanus*). The vole pair bonding systems are based on the neurohormones oxytocin and vasopressin, which also modulates other social interactions such as infant-parent attachment and social recognition. The receptors for the hormones are distributed differently in monogamous and polygamous voles [54]. Infusion of oxytocin into the brains of female prairie voles and vasopressin in males facilitated pair bonding even in the absence of mating (while the non-monogamous montane voles were unaffected) [12, 33, 82, 83]. The different systems

usually act in concert but can also function independently. In humans, attachment can be non-exclusive and unrelated to targets of sexual drive, just as being in love does not require sexual desire/intimacy or attachment.

In one striking experiment, researchers used gene therapy to introduce a gene (the vasopressin receptor gene) from the monogamous male prairie vole, a rodent which forms life-long bonds with one mate, into the brain of the closely related but polygamous meadow vole [46]. Genetically modified meadow voles became monogamous, behaving like prairie voles.

Attachment is characterized in birds and mammals by mutual territory defence, shared nest building and parenting, mutual feeding and grooming. Attached individuals keep in close proximity and experience separation anxiety. Humans experiencing this kind of companionate love feel calm and secure and experience social comfort and emotional union. This is very different from the driven and excited states of lust and infatuation, and likely based on different neurochemical systems. In particular, long-term attachment is tied to neuropeptides such as oxytocin and vasopressin, as well, possibly, as noradrenaline causing strong learning [20].

Modulation of Love

The different love-related systems can be modulated by chemical stimuli:

	Lust	Attraction	Attachment
<i>Role</i>	Seek sexual union with any appropriate partner	Choosing and preferring a partner	Stay together with partner
<i>Mediators</i>	Hypothalamus, sex hormones	Corticolimbic, dopamine, lowered serotonin, epinephrine	Oxytocin, vasopressin, corticotropin-releasing hormone (CRH)?
<i>Ways of modifying</i>	Pheromones, testosterone	Pheromones, stimulants, oxytocin?	Oxytocin, vasopressin, entactogens, CRH?

Pheromones

Pheromones, odor chemicals that trigger behavioral responses, are important for indicating sexual availability in many species. Smells are important for

human sexual attraction [29] and it appears likely that humans have pheromones [24, 84] and that they can act as attractants [62], although their exact function and attractive effects are contested [28]. That has not prevented the cosmetics industry from selling many products purporting to contain pheromones.

There is also evidence that people learn to recognize each other chemically, possibly based on their immune antigens. People describe body odors as pleasant when they come from people with dissimilar immune systems [76, 77]. This may play a role in the non-conscious detection of relatedness or in giving offspring resistance to parasites.

Smells are likely to be able to affect mood and possibly attraction, but are relatively non-specific. While odor might be used to promote lust and attraction, it may be less useful for pair bonding. Merely dousing the partner in attractive pheromones will not support relationships since equally doused and attractive people are likely to be encountered elsewhere. On the other hand, tailoring immune-related smells might strengthen ties between people.

Testosterone

Administration of testosterone can increase sexual desire in men and women. Subjects report an increase in sexual thoughts, activity and satisfaction [10, 64–66] but do not report increased romantic passion or increased attachment to their partners [65].

Given the observed growing disparities in sexual interest between men and women as a relationship continues [41, 42] synchronizing the levels of desire—heightening it or lowering it in one or both partners—might help strengthen relationships.

Oxytocin

Oxytocin and vasopressin are the two most discussed pair bonding-related substances. They are important for the formation of mother–infant and other affiliative bonds [55]. Oxytocin is a pro-social hormone released during body contact. It is involved in nursing behavior, trust and “mind-reading” [17, 43] as well as counteracting stress [45] and fear [40].

While the role of oxytocin and vasopressin has been particularly well studied in voles where they play a clear role in the formation of partner

preferences [54] this system appears to be conserved among mammals for pair bonding and mate selection [21]. In humans, brain regions activated by seeing beloved people (either partners or children) appear to correspond to regions with oxytocin, vasopressin and dopamine receptors [5, 6].

Adding extra oxytocin would at the very least promote trusting pro-social behaviors that might reduce the negative feedback in some relationships and help strengthen the positive sides.

The strong dopamine and oxytocin signals elicited during the early romantic phase of a relationship and during sexual interaction are likely to act as learning signals: they help imprint details of the partner, positive emotional associations and relationship-related habits [2, 48]. Heightened arousal can also facilitate social bonding [49]. It might be possible to trigger this imprinting artificially [82]. This could be used to reinforce pair bonds by giving the right drugs to subjects while they are in close contact with their partner.

CRH

Love is also linked to fear of separation and sadness when it occurs. This may be the stick rather than the carrot in the maintenance of the pair bond. There is some evidence this feeling may be due to the hormone CRH [16, 54]. Upregulating the CRH receptor might promote partner attachment, but may also risk causing depression and anxiety.

Entactogens

Entactogen drugs such as 3,4-methylenedioxy-*N*-methylamphetamine (MDMA; ‘ecstasy’) promote increasing sociability and an experience of connection with other people [25], emotional openness and reduction of anxiety [73]. MDMA does not appear to act as an aphrodisiac, but does appear to promote a desire for emotional closeness. This may be due to oxytocin release [69]. There has been therapeutic use of MDMA to develop emotional communications skills [26], and it is not implausible that it, or similar drugs, could be used to deepen pair bonding.

Given the demonstrated effects of these substances and the rapidly growing knowledge of the cognitive neuroscience of love, it appears likely that far more specific treatments affecting the lust, attraction and

attachment systems will become possible in the near future. Drugs affecting particular brain systems at particular times would enable more fine-tuned marital therapy but possibly also modulation of the strength of pair bonding, mate selection and levels of sexual (or emotional) desire.

Love Drugs: Ethics

At present, there have only been crude attempts at interfering in the biology of human attraction and mating. Convicted pedophiles in California are offered “hormonal castration” with hormonal therapy to reduce sex drive as an alternative to imprisonment.² In the near future, as our understanding of the neuroscience of love grows, there will be more opportunities to modify lust, attraction and attachment. We may be able to modify these factors either by blockers or enhancers to achieve a variety of valued outcomes: greater attractiveness to others, initiation of relationships, prevention or termination of relationships and improvement in the quality of relationships, for personal, couple-centered, child-centered or social reasons. We will only consider the use of neuroenhancement to promote love and marriage. There are several strong arguments in favour of the biological enhancement of love and marriage.

Consistency

There is a long history to the use of love potions. Alcohol is the commonest love drug. We have always tried to use chemistry to influence the chemistry between people. Neurolove potions will just be more effective. There is no morally relevant difference between marriage therapy, a massage, a glass of wine, a fancy pink, steamy potion and a pill. All act at the biological level to make the release of substances like oxytocin and dopamine more likely.

Liberty and “Marital Autonomy”

Western societies are founded on the value of personal autonomy: the freedom to form and act on one’s own conception of the good life. As the father of liberalism, John Stuart Mill [50] put it,

“...If a person possesses any tolerable amount of common sense and experience, his own mode of laying out his existence is the best, not because it is the best in itself, but because it is his own mode.”

Mill [50] valued originality, people discovering what was the best mode of existence for themselves:

“...individuality is the same thing with development, and... it is only the cultivation of individuality which produces, or can produce, well-developed humans...” (p. 121)

The value of personal autonomy extends to human relationships. Couples in a relationship should have privacy and freedom to form and act on their conception of what a good relationship is for themselves. We have called this “marital autonomy” but it applies to all close relationships which constitute a partnership. The use of love drugs and other biological interventions is as a part of the opportunity for “original existence” as having a glass of wine or a cup of tea together, watching a thriller or employing a marital aid. People should be free to shape their relationship in the way which best fits them.

Reasons to Enhance Love

There are many good reasons to take love drugs. In the section “[Do We Need Marriages?](#),” we reviewed the hedonic, health, life satisfaction, social and other benefits of marriage and other stable close partnerships/relationships. We discussed the intrinsic value of love. There are other reasons to promote stable partnerships of relationships. These are a source of sex. This itself is hedonically enjoyable and would tend to maintain relationships in the following way:

- An equal desire for the act reduces relationship friction
- Helps the relationship through stronger imprinting of the bond.
- Assuming that humans are similar to voles in this respect, the simultaneous release of oxytocin/vasopressin from intimate contact and the dopamine from rewarding pleasure might help re-imprint the partner bond.

Marriage is good for children especially if it is happy. There is evidence that stepchildren are abused and even killed at rates 40–100 times greater than children residing with their genetic parents [14].

² California Penal Code section 645.

Another reason might be one justice. Currently, the natural lottery creates inequality. Some men are successful and some women are attractive, having the widest choice of mates. Others are less desirable. Chemically inducing lust and attractiveness might give those lower on the tree of life a chance to climb higher. This could create a more level playing field and allow those less attractive to compete on other traits.

Religious and Cultural Norms

Adherence to religious and cultural norms provides a special reason to consider love drugs. Most societies in the world are monogamous. For those societies, like Christian societies, where a life-long monogamous relationship is the ideal, love drugs have much to offer. Indeed, such religions are often against human enhancement but the prospect of increasing the probability of a marriage staying together, through targeted biological manipulation, must provide a strong reason to consider love enhancements. Imagine that we could retain the attraction to our life-long partner that we had in the first stages of relationship. Or imagine a long-term couple using drugs to stimulate sexual appetite for each other rekindling intimacy and all the relationship stabilizing effects of sex. Alternatively, in those couples where interest in sex is different, desire could either be dampened or increased in one partner.

Religions that value monogamy should embrace those technologies which promote stronger, more stable bonds. The US religious conservatives who introduced the option of covenant marriages with high exit costs should, if they are to be consistent, offer the option of committing to the use of love drugs as well as counseling during troubled marriage to promote its stability.

Duty to Love?

Kant [37] famously based his argument against a duty to love on the lack of commandability of love:

“Love is a matter of *feeling*, not of willing, and I cannot love because I *will* to, still less because I *ought* to (I cannot be constrained to love); so a *duty to love* is an absurdity.”

Understanding the biology of love calls into question Kant’s famous claim that love is not under voluntary control. While it is true that we cannot will to love, we can make love more probable by manipulating its biological determinants, in the same

way as setting the lighting to a romantic level. If there is a duty to be faithful to one’s partner, or a duty to do the best for one’s children (and so remain in a stable relationship), these could ground a duty to try to influence love through biological enhancement³.

Maintaining vs. Enhancing Love

Many people see the use of love drugs to maintain an existing previously loving relationship as acceptable, but are more troubled by the idea of using love drugs to initiate love. This view may be mistaken.

Imagine John and Betty are in love and have been for 10 years. But John becomes prone to mild depression. This affects their relationship adversely. He starts to lose interest in Betty, becomes absorbed in himself, grumpy, withdrawn and painful to be around. He takes an antidepressant and their love is maintained. From the point of view of their relationships and his life, he has good reason to take the drug.

Jack and Gill are not in love. Jack is depressed and this prevents love developing. They stay together because Gill became pregnant by accident and they have a child. They intend to stay together for the sake of their child. Jack could take a drug which would facilitate them falling in love—Prozac. He has the same reason as John, but in this case it creates rather than maintains love. His taking the pill seems as acceptable as John’s.

Objections

Adaptation and Addiction

To what degree the brain would adapt to these exogenous substances is an open question. This, however, represents an important concern when one begins interfering in parts of the pleasure pathways and rewards systems of the brain. Addiction is well documented to all substances and activities which stimulate these primitive reward centers, including sex. It would be important to ensure that such substances were used in a manner which prevented

³ There are many different kinds of love: love for one’s partner, love for one’s children, friends, pets etc. We have focussed on love for one’s partner. But these other kinds of love might also be capable of enhancement. For example, it may be possible to influence attachment of mothers to their children, combating the effects of postnatal depression. There would be strong reasons to influence love in this way, for the sake of the child.

addiction, which one of us has argued is a very strong desire for pleasure [63].

Wrong Attachment and Bad Relationship

It is possible to reinforce or create attachment to the wrong person, a person to whom one is not suited in terms of shared values. There could be the illusion of shared values, when there are none. This would be an objection only to using love drugs to initiate a relationship, but not to their use in an established, committed relationship.

A stronger version of this objection is that neuro-enhancement of love may foster or protect a bad relationship. Imagine a man who beats his wife. They might both agree to take love drugs and so remain in a relationship which is abusive and bad.

In order to judge whether love drugs are initiating or promoting a bad relationship, one must judge the quality of a relationship. This can be done in two ways.

Firstly, marital autonomy expresses the idea that two people go forwards together, both autonomously choosing how their relationship will develop. To be autonomous, a decision to take love drugs must be freely made by both partners, with full knowledge of their foreseeable consequences, their risks as well as benefits.

Secondly, we judge the value of a relationship in three ways, which mirror the three basic theories of well-being [27, 59]. Hedonistic theories of well-being are defined in terms of mental states. The simplest view is that happiness, or pleasure (understood broadly as a mental state) is the only intrinsic good and unhappiness or pain the only intrinsic bad. On this view, provided a couple is happy, their relationship is good. According to desire fulfillment theories, well-being consists in having one's desires fulfilled. Economic theory commonly employs a related notion of value, and such accounts are widespread in philosophy and the social sciences in general. On the most plausible desire fulfillment theories, desires should be informed (of the relevant facts) and freely formed to count towards our well-being. On a desire fulfillment theory, whether a decision to take love drugs is good is determined by whether both parties desire, in the presence of the facts, to take such drugs.

According to objective list theories of well-being (sometimes called substantive good or perfectionistic

theories), certain things can be good or bad for a person and can contribute to well-being, whether or not they are desired and whether or not they lead to a "pleasurable" mental state. Examples of the kinds of things that have been taken as intrinsically good in this way are gaining knowledge, having deep personal relationships, rational activity and the development of one's abilities. So, whether a relationship is good in objective terms turns on whether the couple together flourish objectively, developing within the relationship, developing their talents outside, maintaining deep friendships outside of the relationship as well as in, raising children and achieving worthwhile things.

Each of the three theories of well-being outlined above seems to identify something of importance but all have problems. Because of this, many philosophers opt for a composite theory in which well-being is seen as requiring aspects of all three theories. On this composite view, a good marital relationship is one which both parties desire and which gives each pleasure, and allows or facilitates each to lead lives which are objectively valuable.

Thus, consider the hypothetical example of Joan, who takes such drugs in order to tolerate her husband Peter's promiscuity. If the relationship is one which Joan and Peter both endorse, which gives them pleasure, and if it also allows Joan to develop as a person, exercising her talents, having other deep personal relationships and achieving worthwhile things, then it is a good relationship, despite Peter's promiscuity. If, however, Peter constrains her development, prevents her from developing friendships or having children, will not allow her to exercise her talents and keeps her unhappy in a relationship which represents a prison, then the drug merely serves to perpetuate a bad relationship.

Authenticity

Concerns over whether enhancements threaten authenticity have been prominent in recent debates [58]. Would chemical enhancement of relations render love inauthentic?

It is important to recognise that we are not suggesting that such biological interventions would cause love to occur, like some *magic* love potion. Biological interventions can simulate or produce the phases of the evolution of a loving relationship: lust, attraction and attachment. They can increase the

probability of a loving relationship occurring but they cannot by themselves cause love.

Love is both an emotional feeling and a social relationship between two people involving important cognitive elements. It has an intentional object combined with evaluative judgements of that object. These evaluative judgments are heavily influenced by the nature of a person. The nature of attraction makes us blind to the flaws and appreciative of the individuality of the loved one, but how this blindness and appreciation are expressed differs from person to person. One person may adore a particular little personal habit; another may make grand analogies between the loved one and nature. If an intervention removed this personal aspect of love it would make love inauthentic, or not even love at all.

In the case of love between two people, there is usually some form of compatibility, some shared values, some event or aspect of personality that enables and leads to the love. The feeling has an “autobiographical anchor,” making it authentic.

Again, it is important to distinguish between the use of love potions to create new love and to foster existing love. The use of drugs to instill a new love is more likely to create inauthentic love, since the causal reasons for the love may lie in the drug (and external events surrounding the situation), rather than the particular person loved. This would not be the case in an established loving relationship that is losing its momentum.

Yet even in the case of initially inauthentic falling in love, an authentic pair relation may develop over time as shared interaction and experiences construct a relation that is tied to the unique persons involved. This is similar to how arranged marriages can produce stable and caring pair relations that appear to be authentic. The authenticity of a lasting relation is based on the social and emotional interactions between the partners, not on their origin.

This argument suggests that drugs that help maintain or even deepen the bond between the partners may not face the authenticity objection at all. The authenticity already exists there. It is not unlike how a careful restoration of a classic artwork preserves its authenticity while strengthening its colors. There will always be a debate on how far one can go without going too far, as many current art debates show, but restoring it to a state closer to the original appears relatively uncontroversial.

Even if love were not authentic, authenticity is not an overriding or exclusive value. People can trade a degree of authenticity for other values in their lives. Thus, for people who must enter arranged marriages, or marry in order to have children, or for economic reasons, the ability to have control over one’s feelings, including feelings of love, is empowering.

Moreover, authenticity may not be a problem for some of the phases of love. For example, lust often appears outside voluntary control, and an artificially strengthened (or weakened) libido would not seem to change much of value. The change in intensity is not different from what is normally experienced due to natural hormonal variations, ageing, immune status, subconscious reactions or the other myriad factors determining it. Lust does not appear targeted towards a particular unique individual like attraction and attachment, instead only urging sex with a suitable partner. This frees lust enhancement from the issues surrounding authenticity in social relationships.

Coercion

One form of bad relationship is where one party is coerced into remaining in it. This is a breach of marital autonomy. A milder form would occur if one spouse wants to deepen the attachment and the other either thinks it is strong enough or that the treatment is undesirable and it would be better to let the relationship fade. While it is simple to appeal to autonomy and say that any use of love drugs should be voluntary on the part of both parties, the ties of a relationship limit the ability and will to disagree.

Untangling these conflicts is, however, no different from conflicts over joining marriage therapy. Principles such as those espoused in professional codes of ethics of marriage and family therapists of informed consent, avoiding exploitation, respecting and strengthening autonomy, beneficence and confidentiality [1] may help, but in practice this is where the craft of human interaction and empathy come into play. Even if pair bonding enhancements turn out to be safe and effective, it is likely that for best effect their use should be guided by professionals and that they (then, as now) would act as a safeguard against problems in the self-understanding or goals of the pair.

Such initially regulated use would also address the concern of such drugs leading to harm to others. Just as alcohol increases the risk of sexual abuse, so too

might the indiscriminate use of such drugs cause social problems. Regulated use within a professional setting, the use of short acting interventions and the developments of contracts creating personal liability for misuse might reduce these risks.

Change Relationships/Environment, Not People

One standard objection to human enhancement which applies with great force to neuroenhancement of love is that we should change social relations between people, not change people. In the disability debate, this goes under the slogan: “change society, not people.” In terms of suboptimal relationships, this objection holds it is desirable to undergo marital therapy, or individual psychotherapy, or some other social or environmental intervention, rather than undergo biological interventions.

One of us has argued elsewhere [36] that how well our lives go is determined by four factors: natural environment, social environment, our psychology and our biology. Which of these we should alter depends on which we have most reason to alter. We should consider all modifications, and choose the modification, or combination of modifications, which is best or most effective. The same applies to human relationships. As our review of the biology of human relationships indicates, there may be many inherent biological obstacles to a good and enduring marriage. There may be good reasons to prefer psychological or social interventions, rather than biological interventions:

- They are safer
- They are more likely to be successful
- Justice requires their employment (based on the limitations of resources)

But absent such reasons, we should consider biological interventions. Indeed, such reasons may speak in favour of the employment of love drugs.

Value of Suffering, Effort and Mystery

One of the major concerns over human enhancement which applies to love drugs is that these represent a cheat, a short cut that will render life meaningless. As the President’s Council [61] expresses this,

“...there appears to be a connection between the possibility of feeling deep unhappiness and the prospects for achieving genuine happiness. If one

cannot grieve, one has not truly loved. To be capable of aspiration, one must know and feel lack.” (p. 299)

On this view, we must strive to attain what is valuable and such potions deny us the opportunity to work together. They remove the mystery of love and reduce it to a cocktail of chemicals.

The simple fact, however, is that relationships are failing despite marital therapy and efforts to support them. Moreover, these objections all ignore the basic fact that we live in a probabilistic world, the effects of which ensure that neuroenhancement will never eliminate difficulty or guarantee the success of a relationship.

Conclusion

Evolution has not created us to be happy, but rather created happiness to keep us alive and reproducing. But from our human perspective our—and our loved ones’—happiness and flourishing are the primary goals. We might desire children, but the desire is very seldom based on a conscious decision to promote the survival of the species or to further our genes. In a conflict between human values and evolution, we might very well ignore what evolution would promote. There is no human moral imperative to obey evolution. Yet evolution has constructed our motivational systems and emotions, making any ethics or social system that goes counter to these constraints unstable. Our evolutionary adaptations are based on an ancestral environment utterly unlike our present, and some adaptations promote competitiveness and unhappiness rather than happiness [11].

Chemical and other biological manipulation of our emotion is a way to circumvent this bind, allowing human desires to influence the underlying biology. This represents an important move towards “biological liberation,” that is, to us being liberated from the biological and genetic constraints evolution has placed on us and that now represent impediments to us achieving a good life or other valued goals.

Love can be like a three legged race between a fat tall man and a skinny small woman. Targeted neuroenhancements can allow men and women to synchronise and co-ordinate their drives and desires, to better work together as a couple. Just as there is physical and intellectual disability, there can be “marital disability” where a close relationship between two people becomes an impediment rather than a support

to their search for meaning and well-being. Many relationships are disabled. Indeed, nearly 40% of them so disabled they terminate. We should utilize neuroscience as well as folk wisdom, crude drugs, history and literature to address this problem.

Love is one of the fundamental aspects of human existence. It is to a large part biologically determined. We should use our growing knowledge of the neuroscience of love to enhance the quality of love by biological manipulation.

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