

113. Hatfield, E. & Rapson, R. L. (2009). The neuropsychology of passionate love . In D. Marazziti (Ed.) *Neuropsychology of social relationships*. Nova Science.

The Neuropsychology of Passionate Love

Elaine Hatfield and Richard L. Rapson
University of Hawaii

Throughout history, artists, poets, and writers have been interested in the nature of passionate love, sexual desire, and sexual behavior. In the 1960s, social psychologists and sexologists began the systematic investigation of these complex phenomena (see Berscheid & Hatfield, 1969; Hatfield & Rapson, 1993; Hatfield & Rapson, 2005, for a review of this research). Yet, only recently have neuroscientists and biochemists begun to explore these complex phenomena.

In this entry, we will review what these distinguished theorists and researchers have learned about these processes.

I. Defining Passionate Love

Passionate love is a powerful emotional state. It has been defined as:

A state of intense longing for union with another. Passionate love is a complex functional whole including appraisals or appreciations, subjective feelings, expressions, patterned physiological processes, action tendencies, and instrumental behaviors. Reciprocated love (union with the other) is associated with fulfillment and ecstasy. Unrequited love (separation) is associated with feelings of emptiness, anxiety, and despair (Hatfield & Rapson, 1993, p. 5).

People in all cultures recognize the power of passionate love. In South Indian Tamil families, for example, a person who falls head-over-heels in love with another is

said to be suffering from *mayakkam*—dizziness, confusion, intoxication, and delusion. The wild hopes and despairs of love are thought to “mix you up” (Trawick, 1990).

The *Passionate Love Scale (PLS)* was designed to tap into the cognitive, emotional, and behavioral indicants of such longings (Hatfield & Sprecher, 1986). The *PLS* has been found to be a useful measure of passionate love for men and women of all ages, in a variety of cultures, and to correlate well with certain well-defined patterns of neural activation (see Bartels & Zeki, 2000, 2004; Doherty, Hatfield, Thompson, & Choo, 1994; Fisher, 2003; Landis & O’Shea, 2000). Sexual desire (the desire to merge sexually) is assumed to be a closely related construct. A facsimile of the PLS appears below.

II. The Passionate Love Scale

We would like to know how you feel (or once felt) about the person you love, or have loved, most *passionately*. Some common terms for passionate love are romantic love, infatuation, love sickness, or obsessive love.

Please think of the person whom you love most passionately *right now*. If you are not in love, please think of the last person you loved. If you have never been in love, think of the person you came closest to caring for in that way.

Try to describe the way you felt when your feelings were most intense. Answers range from (1) Not at all true to (9) Definitely true.

Whom are you thinking of?

- Someone I love *right now*.
- Someone I *once* loved.
- I have never been in love.

Possible answers range from:

1	2	3	4	5	6	7	8	9
Not at all true				Moderately true				Definitely true

	Not at all true								Definitely true
	1	2	3	4	5	6	7	8	9
I would feel deep despair if _____ left me.	1	2	3	4	5	6	7	8	9
Sometimes I feel I can't control my thoughts; they are obsessively on _____.	1	2	3	4	5	6	7	8	9
I feel happy when I am doing something to make _____ happy.	1	2	3	4	5	6	7	8	9
I would rather be with _____ than anyone else.	1	2	3	4	5	6	7	8	9
I'd get jealous if I thought _____ was falling in love with someone else.	1	2	3	4	5	6	7	8	9
I yearn to know all about _____.	1	2	3	4	5	6	7	8	9
I have an endless appetite for affection from _____.	1	2	3	4	5	6	7	8	9
For me, _____ is the perfect romantic partner.	1	2	3	4	5	6	7	8	9
I sense my body responding when _____ touches me.	1	2	3	4	5	6	7	8	9
_____ always seems to be on my mind.	1	2	3	4	5	6	7	8	9
I want _____ to know me—my thoughts, my fears, and my hopes.	1	2	3	4	5	6	7	8	9
I eagerly look for signs indicating _____'s desire for me.	1	2	3	4	5	6	7	8	9
I possess a powerful attraction for _____.	1	2	3	4	5	6	7	8	9
I get extremely depressed when things don't go right in my relationship with _____.	1	2	3	4	5	6	7	8	9

Total _____

On this scale, the higher the score, the more wildly in love a person is said to be.

III. The Neuropsychology of Passionate Love

A. The Ancients

Since antiquity, court physicians and social observers have searched for methods to detect “lovesickness.” In the 2nd century A. D. Appian of Alexandria (1899) recounted this “case history.”

During the last years of his life, King Seleucus, appointed his son Antiochus King of upper Asia in place of himself. Appian notes:

If this seems noble and kingly on his part, even nobler and wiser was his behavior in reference to his son's falling in love and his self-restraint in suffering; for Antiochus was in love with Stratonice, the wife of Seleucus, his own step-mother, who had already borne a child to Seleucus.

Recognizing the wickedness of this passion, Antiochus did nothing wrong, nor did he show his feelings, but he fell sick, took to his bed, and longed for death. Nor could the celebrated physician, Erasistratus, who was serving Seleucus at a very high salary, form any diagnosis of his malady. At length, observing his body was free from all the symptoms of disease, he conjectured that this was some condition of the mind, through which the body is often strengthened or weakened by sympathy. Grief, anger, and other passions disclose themselves; love only is concealed by the modest. As Antiochus would confess nothing when the physician asked him in confidence, he took a seat by his side and watched the changes of his body to see how he was affected by each person who entered his room. He found that when others came the patient was all the time weakening

and wasting away at a uniform pace, but when Stratonice came to visit him his mind was greatly agitated by the struggles of modesty and conscience, and he remained silent. But his body in spite of himself became more vigorous and lively, and when she went away he became weaker again (pp. 317-318).

Insert Illustration #1 here

Antiochus and Stratonice. In this painting, Jean Auguste Dominique Ingres (1780-1867) depicts the moment in which Erasistratos diagnosed Antiochus' love for his stepmother. Musée Condé (Photographie Giraudon), by permission.

Plutarch (1st century, A.D./1920), more medically oriented, detailed

Antiochus' symptoms:

Accordingly, when any one else came in, Antiochus showed no change; but whenever Stratonice came to see him, as she often did, either alone, or with Seleucus, lo, those tell-tale-signs of which Sappho sings were all there in him—stammering speech, fiery flashes, darkened vision, sudden sweats, irregular palpitations of the heart, and finally, as his soul was taken by storm, helplessness, stupor, and pallor (pp. 93 and 95).

Appian of Alexandria (1899) continued:

So the physician told Seleucus that his son had an incurable disease. The king was overwhelmed with grief and cried aloud. Then the physician added, "His disease is love, love for a woman, but a hopeless love." (pp. 317-318).

King Seleucus, however, was not one to be stopped by obstacles. Appian of Alexandria (1899) notes:

Seleucus was overjoyed, but it was a difficult matter to persuade his son and not less so to persuade his wife; but he succeeded finally. Then he assembled his army, which was perhaps expecting something of the kind, and told them of his exploits and the extent of his empire, showing that it surpassed that of any of the other successors of Alexander, and saying that as he was now growing old it was hard for him to govern it on account of its size. "I wish," he said, "to divide it and so at the same time to provide for your safety in the future and give a part of it now to those who are dearest to me. It is fitting that all of you, who had advanced to such greatness of dominion and power under me since the time of Alexander, should cooperate with me in everything. The dearest to me, and well worthy to reign, are my grown-up son and my wife. As they are young, I pray they may soon have children to be an ample guarantee to you of the permanency of the dynasty. I will join them in marriage in your presence and will send them to be sovereigns of the upper provinces now. And I charge you that none of the customs of the Persians and other nations is more worthy of observance than this one law, which is common of them, "That what the king ordains is always right." When he had thus spoken the army shouted that he was the greatest king of all the successors of Alexander and the best father. Seleucus laid the same injunctions on Stratonice and his son, then joined them in marriage, and sent them to their kingdom, showing himself even stronger in this famous act than in his deeds of arms (pp. 319-320).

For a review of the speculations of ancient Greek physicians such as Avicenna, Erasistratos, and Galen, see M.-Marsel Mesulam and J. Perry (1972).

In ancient China, classical scholars possessed a great deal of scientific information about sexual response. For example, the 4th century classic, *Secret Instructions Concerning the Jade Chamber*, provided information concerning the selection of sexual partners, foreplay, and positions for intercourse. The text taught men and women how to identify the stage their partner had reached in the sexual response cycle (Ruan, 1991).

Recently, neuropsychologists have assembled information from neuroanatomical and neurophysiological investigations, ablation experiments, pharmacologic explorations, clinical investigations and behavioral research as to the social psychophysiology of passion. These scientists document that the observations of the ancients are, in part, correct. Passionate love does produce the autonomic nervous system and skeletal-muscular reactions Plutarch and his fellow physicians described (Hatfield & Rapson, 1987; Kaplan, 1979; Liebowitz, 1983.) The early Chinese physicians appear to have been careful observers, too. Their descriptions of the stages of sexual response sound much like those described by Alfred Kinsey and his associates (1948 and 1953) and by William Masters and Virginia Johnson (1966).

The ancients provide a beginning. In spite of the valuable insights that their observations provide, however, folklore is often wrong-headed or incomplete. Today's neuropsychological research into passionate love and sexual desire makes it clear that men and women's cognitions, emotions, and behaviors interact in ways only dreamed of by early court physicians and scientists.

B. Modern Day Neuropsychological Explorations into Passionate Love

1. The Pioneering EEG Research of Niels Birbaumer and his Tübingen colleagues

The first modern-day neuroscientists to study passionate love were Niels Birbaumer and his Tübingen colleagues (1993). These authors argued that cortical processes in imagery do not differ from “actual” processing, storage, and retrieval of information. As part of a larger research project, they interviewed 10 men and women. Participants were asked to complete six different tasks, which ranged from imaging tasks (imaging a time in their past in which they had been joyously in love [without sexual imagery] and imaging the same scene [with sexual imagery]) to sensory tasks (such as determining which of two pieces of sandpaper was the smoothest). The authors observed:

Subjects in love carry their emotional “burden” like a snail’s house into the laboratory of the physiologist. The vividness and readiness of their emotional imagery is particularly intense and easy to create under laboratory conditions (p. 133).

While participants performed these tasks, EEG (electroencephalogram) recordings were obtained from 15 different brain locations. The authors discovered (on the basis of their EEG assessments) that the frontal and posterior groupings showed similar dimensions on the romantic imagery tasks, whereas smaller dimensions were found in the frontal as compared to the posterior electrode sites on the four sensory tasks. The authors concluded that passionate imagery involves a significantly higher

brain complexity than does sensory stimulation at all brain sites, but particularly at frontal regions.

In a second experiment, Birbaumer and his group (1993) focused primarily on erotic images—comparing 10 people who were passionately in love (as assessed by the *Passionate Love Scale* described earlier) with a matched group of 10 people who were not emotionally involved with anyone. Participants were asked to imagine a joyous scene with a beloved partner, a scene of intense jealousy, and a neutral scene (an empty living room). During these visualizations, the scientists recorded EEG responses from the midline (Fz, Cz, Pz) and its fractal dimensions were estimated (using the method described by Graf & Elbert, 1988).

On the bases of these analyses, the authors concluded that passionate love is “mental chaos.” Passionate imagery employed anatomically more complex and more widespread (less localized) brain processes than did sensory tasks. Frontal lobe mechanisms, in particular, seemed to add to imagery-related chaos compared to tactile or visual stimulation. Images, they note, may be “more than just pictures in the head” p. 134.

The authors concluded this preliminary study by calling for more research. It was a full decade before anyone responded to their pleas.

2. Recent fMRI Research: Andreas Bartels and Semir Zeki

In 2000, two London neuroscientists, Andreas Bartels and Semir Zeki, attempted to identify the brain regions associated with passionate love and sexual desire. The scientists put up posters around London, advertising for men and women who were “truly, deeply, and madly in love.” They also recruited participants via the internet.

Seventy young men and women from 11 countries and several ethnic groups responded. Respondents were asked to write about their feelings of love and to complete the *Passionate Love Scale (PLS)*. Seventeen men and women, ranging in age from 21-37, were selected for the study. Participants were then placed in an fMRI (functional magnetic imagery) scanner. This high-tech scanner constructs an image of the brain in which changes in blood flow (induced by brain activity) are represented as color-coded pixels. Bartels and Zeki (2000) gave each participant a color photograph of their beloved to gaze at, alternating the beloved's picture with pictures of a trio of casual friends. They then digitally compared the scans taken while the participants viewed their beloved's picture with those taken while they viewed a friend's picture, creating images that represented the brain regions that became more (or less) active in both conditions. These images, the researchers argued, revealed the brain regions involved when a person experiences passionate love and/or sexual desire.

Bartels and Zeki discovered that passion sparked increased activity in the brain areas associated with euphoria and reward, and decreased activity in the areas associated with sadness, anxiety, and fear. Activity seemed to be restricted to foci in the *medial insula* and the *anterior cingulated cortex* and, subcortically, in the *caudate nucleus*, and the *putamen*, all bilaterally. Most of the regions that were activated during the experience of romantic love were those that are active when people are under the influence of euphoria-inducing drugs such as opiates or cocaine. Apparently, both passionate love and those drugs activate a "blissed-out" circuit in the brain. The *anterior cingulated cortex* has also been shown to be active when people view sexually

arousing material. This makes sense since passionate love and sexual desire are generally assumed to be tightly linked constructs.

Among the regions where activity decreased during the experience of love were zones previously implicated in the areas of the brain controlling critical thought (i.e., the sort of mental activity involved when people are asked to make social judgments or to “mentalize”—that is, to assess other people’s intentions and emotions.) Such brain areas are also activated when people experience painful emotions such as sadness, anger and fear. The authors argue that once we fall in love with someone, we feel less need to assess critically their character and personality. (In that sense, love may indeed be “blind.”) Deactivations were also observed in the posterior cingulate gyrus and in the amygdala and were right-lateralized in the prefrontal, parietal, and middle temporal cortices. Once again, the authors found passionate love and sexual arousal to be tightly linked.

Not surprisingly, the Bartels and Zeki (2000, 2004) research sparked a cascade of fMRI research.

3. Helen Fisher, Arthur Aron, and Lucy Brown

In *Why We Love* Helen Fisher (2004) argued that people possess a trio of primary brain systems designed to deal with close, intimate relationships. These are: attraction (passionate love), lust (sexual desire), and attachment (companionate love).¹

Presumably, this trio of systems evolved during humankind’s long evolutionary history;

¹ You will notice that while most social psychologists (see Hatfield & Rapson, 2005) and neuroscientists such as Birbaumer and his colleagues (1993) and Bartels and Zeki (2004) assume that the emotion of passionate love and sexual desire are closely linked, Fisher (2004) assumes that passionate love and sexual desire are fueled by very different brain systems. We will discuss this difference in greater length in a later section.

each is designed to play a critical role in courtship, mating, and parenting. In theory, attraction evolved to persuade our ancestors to focus attention on a single favored courtship partner. Sexual desire evolved to motivate young people to seek a *wide range* of sexual partners. Attachment evolved to insure that devoted parents would remain together during the first crucial four years of a child's life.

According to Fisher (2004) attraction (passionate love) is characterized by a yearning to win a preferred mating partner. She speculated that three chemicals—dopamine, norepinephrine, and serotonin—play a crucial role in romantic passion. *Sexual desire* (lust), on the other hand, is typified by a *general* craving for sexual gratification and may be directed toward many potential partners. In men and women, she observed, the androgens, particularly testosterone, are central to sparking sexual desire. Attachment (companionate love) is comprised of feelings of calm, social comfort, emotional union, and the security felt in the presence of a long-term mate. It sparks affiliative behaviors, the maintenance of close proximity, separation anxiety when closeness disappears, and a willingness to participate in shared parental chores. Animal studies suggest that this brain system is primarily associated with oxytocin and vasopressin in the nucleus accumbens and ventral pallidum.

a. The Joys of Love.

In focusing in on passionate love, Fisher (January 19, 2000) observed:

I speculated that the feelings of euphoria, sleeplessness and loss of appetite as well as the lover's intense energy, focused attention and increased passion in the face of adversity might all be caused in part by heightened levels of dopamine or norepinephrine in the brain. Similarly,

I believed that the lover's obsessive thinking about the beloved might be due to decreased brain activity of some type of serotonin. I also knew these three compounds were much more prevalent in some brain regions than in others. If I could establish which regions of the brain become active while one is feeling romantic rapture, that might confirm which primary chemicals are involved (p. 77).

To test these notions, Fisher (2004) and her colleagues Arthur Aron and Lucy Brown (along with graduate students Deborah Mashek and Greg Strong) conducted a series of fMRI studies. "Have you just fallen madly in love?" asked the announcement posted on a bulletin board on the SUNY Stony Brook campus. She received a flood of replies. On the basis of interviews, Fisher selected 17 young lovers. All of these men and women scored high on the *Passionate Love Scale*.

To test her notions, Fisher followed the prototype described by Bartels and Zeki (2000). She asked lovesick men and women to view pictures of their beloved and "a boring acquaintance," while an fMRI imager recorded the activity (blood flow) in the their brains.

Fisher (January 19, 2004) found that when lovesick men and women gazed at their beloved, activity was sparked in many brain areas. (This should come as no surprise since as Acevedo, et al., 2008, and Carlson & Hatfield, 1992, noted, passionate love is associated with a wider array of related feelings and emotions [guilt, sadness, anger, jealousy, sexual desire, etc.] than is any other basic emotion.) Two areas, were found to be critically important: the caudate nucleus (a large, C-shaped region deep in the center of the brain) and the ventral tegmental area (VTA), a group of neurons at the

very center of the brain. “I was astonished,” Fisher said. The caudate is “a key part of the brain’s ‘reward system,’ the mind’s network for general arousal, sensations of pleasure and the motivation to acquire rewards” (p. 79). The VTA is a central part of the reward circuitry of the brain.

Insert Illustration 2 about here

fMRI pictures of “The brain in Love.”

Fisher (January 19, 2004) observed:

I had hypothesized that romantic love is associated with elevated levels of dopamine or norepinephrine. The VTA is a mother lode for dopamine-making cells. With their tentacle-like axons, these nerve cells distribute dopamine to many brain regions, including the caudate nucleus. And as this sprinkler system sends dopamine to various parts of the brain, it produces focused attention as well as fierce energy, concentrated motivation to attain a reward, and feelings of elation—even mania—the core feelings of romantic love.

No wonder lovers talk all night or walk till dawn, write extravagant poetry and self-revealing e-mails, cross continents or oceans to hug for just a weekend, change jobs or lifestyles, even die for one another. Drenched in chemicals that bestow focus, stamina and vigor, and driven by the motivating engine of the brain, lovers succumb to a Herculean courting urge (p. 79).

Lucy Brown added: “That’s the area that’s also active when a cocaine addict gets an IV injection of cocaine. It’s not a craving. It’s a high” (Quoted in Blink, 2007, p. 3.)

Blink (2007) observes:

You see someone, you click, and you’re euphoric. An in response, your ventral tegmental area uses chemical messengers such as dopamine, serotonin, and oxytocin to send signals racing to a part of the brain called the nucleus accumbens with the good news, telling it to start craving.

[Certain regions] are deactivated—areas as within the amygdala, associated with fear (p. 3).

(For more detailed descriptions of this research, see Aron, et al, 2005, and Fisher, et al, 2005). Fisher (2004) concluded by observing that the chemistry of romantic attraction generally elevates sexual motivation.

Alas, other neuroscientists (such as Bartels & Zeki, 2000, who studied the fMRI responses of joyous lovers), have secured slightly different results than those described by Fisher and her colleagues (2002). (Bartels & Zeki considered (1) passion to be an emotion and (2) finding a close connection between passionate love and sexual desire). Fisher speculates that such differences may be due to the fact that while she and her colleagues studied young people who are in the first throes of love of love, her critics have focused on men and women who fell in love some time ago. (Fisher’s participants had been in love for an average of seven months; Bartels and Zeki’s participants for 2.3 years.) In addition, Fisher studied a homogeneous group of SUNY students, while

Bartels and Zeki studied people from different cultural backgrounds and of a variety of ages.

Whether or not these differences adequately account for these differing results is as yet unknown.

b. The Dark Side of Love: Anger, Sadness, and Misery.

Joyous passionate love is only one-half of the equation, of course. Love is often unrequited. What kind of brain activity occurs when passionate lovers are rejected?

In a second study, Fisher and her colleagues (2004) studied 15 men and women who had just been jilted by their beloved. First, they hung a flyer on the SUNY at Stony Brook bulletin board. “Have you just been rejected in love. But can’t let go?” Rejected sweethearts were quick to respond. In initial interviews, Fisher found that heartbroken men and women were caught up in a swirl of conflicting emotions—they were still wildly in love, yet feeling abandoned, depressed, angry, and in despair.

But what was going on in their brains? To find out, Fisher and her colleagues (2004) followed the same protocol they’d utilized in testing happily-in-love men and women—i.e., they asked participants to alternately view a photograph of their one-time beloved and a photograph of a familiar, but emotionally neutral individual. The authors found that when contemplating their beloved, rejected lovers displayed greater activity in the right nucleus accumbens/ventral putamen/pallidum, lateral orbitofrontal cortex and anterior insular/operculum cortex than they did when contemplating neutral images. In short, jilted lovers’ brains “lit up” in the areas associated with anxiety, pain, and attempts at controlling anger as well as addiction, risk taking, and obsessive/compulsive behaviors. Jilted lovers did, indeed, appear to experience a storm

of passion—passionate love, sexual desire, plus anguish, rejection, rage, emptiness, and despair.

Other neuroscientists who have studied the fMRI responses of lovers who are actively grieving over a recent romantic breakup, have secured slightly different results than those secured by Fisher and her colleagues (see Najib, et al., 2004). Fisher (2004) speculates that her critics may have focused on men and women who broke up some time ago and have presumably adapted to their losses. Instead of at the grief stage, they may have been at a subsequent stage in the grieving process—experiencing resignation and despair.

In conclusion: Psychologists' opinions may differ on whether romantic and passionate love are emotions (Shaver, Morgan, & Wu, 1996) or are not emotions (Reis & Aron, 2008) and whether passionate love, sexual desire, and sexual motivation are closely related constructs (psychologically, neurobiologically, and physiologically) (Fehr & Russell, 1991; Hatfield & Rapson, 1987; Hendrick & Hendrick, 1987a; Regan, 1998, 2004) or very different in their nature (Diamond, 2004; Reis & Aron, 2008). In addition, scientists have sharply criticized the widespread use of fMRI techniques to study the nature of love, claiming that currently the fMRI studies track only superficial changes and lack reliability and validity (Cacioppo, et al., 2003; Movshon, 2006; Panksepp, 2007; Wade, cited in Wargo, 2005). Nonetheless, this pathbreaking research (as it grows ever more sophisticated) has the potential to answer age-old questions as to the nature of culture, love, and human sexuality.

Adrenalin makes the heart grow fonder
 —*Elaine Hatfield & Ellen Berscheid*

Dopamine. God's little neurotransmitter. Better known by
 its street name, romantic love.
 Also norepinephrine. Street name, infatuation.
 —*Neely Tucker*

IV. The Bio-Chemistry of Love

Researchers are beginning to learn more about the chemistry of passionate love and a potpourri of related emotions. They are also learning more about the way that various emotions, positive and negative, interact.

A. The Ancients

A number of researchers have focused on the chemistry of love—searching for (in effect) the elusive “Love potion #9.” In 18th century London physicians crafted love nostrums and aphrodisiacs from a variety of substances, combining:

. . . crushed toads, salt of vipers, ground garden snails “bruised to a perfect paste,” *pulvis humani cranum* (powdered human skull), “volatile salt of millipedes,” *sal vitrioli* (hydrochloric acid), and copious amount of alcohol (Madeira was favored), rhubarb, and that luckily easily available substance *acqua pluvialis* (rain water) (Hunt, 2000-2001, p. 46.)

B. Pioneering Research: Michael Liebowitz and Helen Singer Kaplan

Psychiatrist Michael Liebowitz (1983) was one of the first to speculate about the chemistry of love. He argued that passionate love brings on a giddy feeling, comparable to an amphetamine high. He contended that it was phenylethylamine (PEA), an amphetamine-related compound, that produces the mood-lifting and energizing effects of romantic love. He observes that “love addicts” and drug addicts have a great deal in

common: the craving for romance is merely the craving for a particular kind of high. The fact that most romances lose some of their intensity with time, may well be due to normal biological processes.

The crash that follows a breakup is much like amphetamine withdrawal. Liebowitz speculates that there may be a chemical counteractant to lovesickness: MAO (monoamine oxidase) inhibitors may inhibit the breakdown of PEA, thereby "stabilizing" the lovesick.

Liebowitz also offered some speculations about the chemistry of the emotions which criss-cross lovers' consciousness as they plunge from the highs to the lows of love. The "highs" include euphoria, excitement, relaxation, spiritual feelings, and relief. The "lows" include anxiety, terrifying panic attacks, the pain of separation, and the fear of punishment. His speculations were based on the assumption that non-drug and drug highs and lows operate *via* similar changes in brain chemistry.

In excitement, Liebowitz proposed that naturally occurring brain chemicals, similar to the stimulants (such as amphetamine and cocaine), produce the "rush" lovers feel. In relaxation, chemicals related to the narcotics (such as heroin, opium and morphine), tranquilizers (such as Librium and Valium), sedatives (such as barbiturates, Quaaludes and other "downers"), or alcohol, which acts chemically much like the sedatives, and marijuana and other cannabis derivatives, produce a mellow state and wipe out anxiety, loneliness, panic attacks, and depression. In spiritual peak experiences, chemicals similar to the psychedelics (such as LSD, mescaline and psilocybin) produce a sense of beauty, meaningfulness, and timelessness.

In the same era, Helen Singer Kaplan (1979) provided some information as to the

chemistry of sexual desire. In both men and women, testosterone (and perhaps LH-RF, luteinizing hormone-releasing factor) are the libido hormones. The neurotransmitter dopamine may act as a stimulant, serotonin or 5-HT (5-hydroxytryptamine) as inhibitors, to the sexual centers of the brain.

Kaplan (1979) observed:

When we are in love, libido is high. Every contact is sensuous, thoughts turn to Eros, and the sexual reflexes work rapidly and well. The presence of the beloved is an aphrodisiac; the smell, sight, sound, and touch of the lover—especially when he/she is excited—are powerful stimuli to sexual desire. In physiologic terms, this may exert a direct physical effect on the neurophysiologic system in the brain which regulates sexual desire. . . .

But again, there is no sexual stimulant so powerful, even love, that it cannot be inhibited by fear and pain. (p. 14).

Kaplan ended by observing that a wide array of cognitive and physiological factors shape desire. Although passionate love and the related emotions we have described may be associated with specific chemical neurotransmitters (or with chemicals which increase/decrease the receptors' sensitivity), most emotions have more similarities than differences. Chemically, intense emotions do have much in common. Kaplan reminds us that chemically, love, joy, sexual desire, and excitement, as well as anger, fear, jealousy, and hate, are all intensely arousing. They all produce an ANS sympathetic response. This is evidenced by the symptoms associated with all these emotions—a flushed face, sweaty palms, weak knees, butterflies in the stomach, dizziness, a pounding heart, trembling hands, and

accelerated breathing.

For a survey of modern research on the biological substrates of human sexuality, see Hatfield & Berscheid (1971; Hyde (2005); Kauth (2007); and Regan (1999).

Falling in love is a bit like going crazy.
—Donatella Marazziti

C. Modern Day Neurobiological Research: Donatella Marazziti

Italian psychiatrist Donatella Marazziti (the editor of this collection) has done some of the most intriguing work on the nature of passionate love. In the popular press, one of Marazziti's observations—"Love is insanity"—has sparked intense scientific and journalistic interest:

In the late 1990s, Donatella Marazziti and her colleagues (1999) speculated that passionate lovers and patients suffering from obsessive-compulsive disorders (OCD) might have something in common: both may be lacking in a neurotransmitter (serotonin) that has a soothing effect on the brain. Too little serotonin has been linked to anxiety, depression, and aggression. Drugs in the Prozac family fight these conditions by boosting the chemicals presence in the brain.

To test this notion, the authors selected 20 men and women who were passionately in love, 20 unmedicated OCD patients, and 20 normal controls. Tracking chemicals inside the brain is difficult (to say the least!), so the authors settled on a simple technique: they calculated the amount of serotonin in platelets—tiny cells that are easily retrieved from an ordinary blood sample. The 5-HT transporter was evaluated with the specific binding of ^3H -Pparoxetine (^3H -Par) to platelet membranes. The results supported

Marazziti and her colleagues' notion. The density of ^3H -Par bonding sites was indeed significantly lower in lovers and those suffering from OCD disorders than in normal controls (people who were either single or in monogamous, long term relationships) (see also Marazziti & Canale, 2004).

Marazziti and her colleagues (2003) have also investigated the dark side of love—passionate jealousy. The authors selected 21 Italian university students consumed by jealous thoughts, 14 OCD patients (whose main obsession was jealousy), and 21 control subjects, not plagued by jealous concerns. They discovered that men and women who were excessively jealous suffered from a number of psychopathological traits (as well) and produced reduced density of ^3H -Par binding compared with their healthy peers.

It was these findings that led the Marazziti group to conclude that love is a kind of insanity.

For additional information, see Marazziti (2005) and chapters XXX in this text.

Odi et amo (I hate and I love)
—Catullus

D. The Cross-Magnification Process

Scientists have long contended that men and women are most susceptible to passionate love and sexual desire when their lives are turbulent. It is assumed that although each basic emotion has its basic chemical signature that an additional supply of adrenalin and noradrenalin may help fuel the intensity of emotional reactions (Kaplan, 1979; Schachter & Singer, 1962). Social psychologists have called this

phenomenon “the cross-magnification process” (Carlson & Hatfield, 1992) or the “excitation transfer process” (Zillmann, 1984).

An array of theorists (Freud, 1953; Reik, 1972), for example, have proposed that it is precisely when people are *not* at their best—when their self-esteem has been shattered, when they are anxious and afraid, when their lives are turbulent and stressful—that they will be especially vulnerable to falling head-over-heels in love. This makes some sense. After all, infants' early attachments (which motivate them to cling tightly to their mother's side in panic when danger threatens and to go their own way when it all is safe) are thought to be the initial prototype of passionate love (Hatfield, Brinton, & Cornelius, 1989; Hatfield, Schmitz, Cornelius, & Rapson, 1988; Hazen & Shaver, 1987).

Several researchers have demonstrated that children and adults are especially prone to seek romantic and sexual ties when they are anxious and/or under stress. In a duo of studies, Hatfield and her Hawaii colleagues (Hatfield, Brinton, & Cornelius, 1989; Hatfield, Schmitz, Cornelius, & Rapson, 1988), for example, found that children and teen-agers who were either momentarily or habitually anxious were especially vulnerable to passionate love. Young people who varied in age from 12 to 16 years of age, and who were of Chinese-, European-, Japanese-, Korean-American, or mixed ancestry, were asked to complete the *Child Anxiety Scale* (Gillis, 1980) or the *State-Trait Anxiety Inventory for Children* (Spielberger, Gorsuch, & Lushene, 1970). These scales were designed to measure both state anxiety (how anxious young people happen to feel at the moment) and trait anxiety (how anxious they generally are). The authors

found that children and adolescents who were high on either trait or state anxiety received the highest scores on the *Passionate Love Scale*.

Donald Dutton and Arthur Aron (1974) also tested the notion that anxiety and fear can deepen desire in a series of ingenious experiments. In one experiment, they compared reactions of men who crossed one of two bridges in North Vancouver. The first bridge (the Capilano Canyon Suspension Bridge) is a five-foot wide, 450-foot-long bridge, composed of wood slats and wire cable, which is suspended 230 feet above dangerous rocks and shallow rapids. As people walked over it, the bridge sway, wobbles, and tilts in a frightening manner. The second bridge was a solid, safe cement structure.

As each young man crossed one of the bridges, a good-looking college woman approached him. She explained that she was doing a class project and asked if he would fill out a questionnaire concerning his attitudes toward conservation. When the man had finished, she offered to explain her project in greater detail. She scribbled her telephone number on a scrap of paper, so he could call her if he wanted more information. Which men called? Nine of the 33 men on the suspension bridge called her; only two of the men on the solid bridge called!

In subsequent years, researchers have collected a great deal of experimental and correlational evidence for the intriguing contention that, under the right conditions, a variety of awkward and painful experiences can deepen passion. These include anxiety and fear (Brehm et al., 1978; Dienstbier, 1978; Hatfield & Rapson, 1996; Hoon et al., 1977; Meston & Frohlich, 2003; Riordan & Tedeschi, 1983), embarrassment (Byrne, Przybyla, & Infantino, 1981), the discomfort of seeing others involved in conflict

(Dutton, 1979), jealousy (Clanton & Smith, 1987), loneliness (Peplau & Perlman, 1982), anger (Barclay, 1969 and 1971; Driscoll, Davis, & Lipetz, 1972), horror (White et al., 1981), or even grief.

E. The End of the Affair

Fisher (2004) closes her analysis of the brain systems sparking attraction, lust, and attachment by observing that passionate attachments are by their nature time-bound. She contends that in the course of evolution our ancestors came to be genetically programmed to meet, mate, and move on—a strategy designed to create optimal genetic variety in the young. When she examined the data from 58 human societies selected from the *Demographic Yearbook of the United Nations*, she discovered that in the majority of societies, couples tend to separate and divorce around the fourth year of marriage. Fisher notes that: (1) many socially monogamous species form pair-bonds that last only long enough to rear the young through infancy; and (2) in hunting/gathering societies, it generally takes four years to rear a child. (Children in such societies join in multi-age play groups soon after being weaned, becoming the responsibility of relatives and older siblings.) (3) Thus she hypothesizes that it may be “natural” for young couples to meet, court, marry, reproduce, and remain together only long enough to raise a child. After that period, the chemistry of attraction (the stew of increased dopamine, decreased serotonin, and increased norepinephrine) swings into action and men and women begin to feel ancient tugs of attraction, sexual desire, and finally attachment yet again.

V. Major Issues

In reviewing this literature, two questions stand out: (1) Is love an emotion? (2) How tightly linked are passionate love and sexual desire? We will close with a final question: (3) How useful are cyber-matching sites based on neuroscience models—like Chemistry.com and ScientificMatch.com?

A. Is Passionate Love an Emotion?

Most social psychologists would probably agree that passionate love is an emotion.

In a seminal article, Kurt W. Fischer and his colleagues (1990) characterized emotions this way:

Emotions are complex functional wholes including appraisals or appreciations, patterned physiological processes, action tendencies, subjective feelings, expressions, and instrumental behaviours (p. 85).

Scholars have interviewed men and women from a variety of cultures and of different ages. They have conducted surveys and experiments, utilized prototype analyses, and taken a social categorical approach in order to determine whether or not love should be classified as a basic emotion, and if so, what people mean by the terms “in love” and “love.” When Shaver and his colleagues (1996 and 1991) reviewed all the evidence, pro and con, they concluded that love is indeed a basic emotion.

In cross-cultural research—in languages as different as English, Italian, Basque, and Indonesian—ordinary people are able to identify five distinct emotions: love, joy, anger, sadness, and fear—as prototypic emotions. Generally, passionate love is associated with the terms “arousal,” “desire,” “lust,” “passion,” and “infatuation.

Companionate love is associated with “love,” “affection,” “liking,” “attraction,” and “caring” (see Shaver et al., 1987; Shaver, et al., 2001).

After discussing the criteria that various theorists have used to classify emotions, they concluded that given these criteria, love (which includes passionate and companionate love) must be classified as an emotion. They observe:

. . . a number of controversies over the status of love can be resolved by distinguishing between the momentary surge form of love, a basic emotion having properties similar to joy, sadness, fear, etc., and relational love, a bond that develops between people, associated with states that include not only surge love, but many other emotions such as distress and anxiety (p. 81)

In another set of studies, Beverly Fehr and James Russell (1991) used the techniques of prototype analysis to find out how ordinary people classified emotions. They found that throughout the world, men and women generally assume that happiness, love, anger, fear, sadness, and hate are basic emotions. They also discovered that people tend to draw a sharp distinction between passionate love (i.e., “being in love”) and companionate love (i.e., “loving.”) Similar results were secured by Berscheid & Meyers (1996), Fehr (1994), Hatfield & Rapson (1993), Regan, 1998; Regan & Berscheid (1999); Regan et al. (1999), among a host of others.

Social psychologists, then, generally assume that love (passionate or companionate) is indeed a basic emotion.

Yet, some scholars have argued that “being in love” and “loving” are *not* emotional experiences. They prefer to call love “a plot” or “script” (as in a story you

tell yourself), “a sentiment,” “a feeling,” “a disposition,” a “syndrome,” or “a motivational state.” (For a review of these positions, see Shaver, et al., 1996.)

Neuroscientists themselves are sharply divided as to whether or not love is an emotion (see Bartels & Zeki, 2000; Birbaumer, et al., 1996; Hatfield & Rapson, in press) or is not an emotion (see Diamond, 2003 and 2004; Gonzaga, et al., 2006; Reis & Aron, 2008).

Only subsequent research can answer this question. In part it seems like a semantic question. If forced to hazard a guess, however, we would argue that in the future, love in all its varieties *will* be classified as an emotion. When so many scientists and ordinary people classify love as an emotion, insist they feel the “emotion” of love, and behave emotionally when in love, it may be impossible for scientists to produce a paradigm shift.

What is love? . . . [I end by] confessing that, in the case of romantic love, I don't really know. If forced against a brick wall to face a firing squad who would shoot if not given the correct answer, I would whisper “It's about 90% sexual desire as yet not sated.

—Ellen Berscheid

B. How Tightly Linked are Passionate Love and Sexual Desire?

Are “passionate love” and “sexual desire” the same thing? Forty years ago, when Ellen Berscheid and I began our research into the nature of love, we weren't certain. Some social commentators insisted that the two were one. In the 18th century French erotic novel *Histoire de Dom Bougre*, for example, a cynical nun disclosed the true meaning of the expression: “to be in love.” It meant, she said, to be “in lust”:

When one says, the Gentleman . . . is in love with the Lady . . . it is the same thing as saying, the Gentleman . . . saw the Lady . . . the sight of her excited his desire, and he is dying to put his Prick into her Cunt. That's truly what it means (as quoted in Ellrich, 1985, p. 222).

Others insisted that the two were very different. In the 18th century, the Marquis de Sade (1797/1968) violently opposed the equation of love and pleasure:

I do not want a woman to imagine that I owe her anything because I soil myself on top of her I have never believed that from the junction of two bodies could arise the junction of two hearts: I can see great reasons for scorn and disgust in this physical junction, but not a single reason for love (p. 148).

In the Victorian era, romantic love was considered to be a delicate, spiritual feeling—the antithesis of crude, animal lust. Freudians, of course, mocked such pretensions. They irritated romantics by insisting that chaste love was simply a sublimated form of carnal love, which lay bubbling just below the surface.

What about today? In the West, most college students make a sharp distinction between “being in love” (which embodies sexual feelings) and “loving” someone (which is not necessarily associated with sexual desire). Ellen Berscheid and her colleagues (Meyers & Berscheid, 1995) found that most students assumed that although you could “love” someone platonically, you could only be “in love” with someone you were sexually attracted to and desired sexually. They concluded: “Thus, our findings suggest that although sexuality may not be a central feature of love, it is most definitely a central feature of the state of being in love” (p. 24). In a national survey, Andrew

Greeley (1991) interviewed newly married couples who said they were still in the “falling in love” stage of marriage. He found that passionate love is a highly sexual state. He described the falling in love stage of marriage this way:

When one is in love, one is absorbed, preoccupied, tense and intense, and filled with a sexual longing which permeates the rest of existence, making it both glorious and exhausting . . . Those who are falling in love seem truly to be by love possessed (pp. 122-124).

In the end, Ellen Berscheid and I concluded that passionate love and sexual desire were “kissing cousins.” Passionate love was defined as “a longing for union” while sexual desire was defined as “a longing for *sexual* union” (Hatfield & Rapson, 1987).

Today, this debate seems settled. As Susan and Clyde Hendrick (1987b) noted: It is apparent to us that trying to separate love from sexuality is like trying to separate fraternal twins: they are certainly not identical, but, nevertheless, they are strongly bonded. . . . Love and sexuality are strongly linked to each other and to both the physical and spiritual aspects of the human condition. For romantic personal relationships, sexual love and loving sexuality may well represent intimacy at its best (pp. 282 and 293).

There is abundant social psychological evidence in support of the contention that in most people’s minds, love and sex are tightly related—in fact, most people find it hard to imagine passionate love absent sexual desire (Hatfield & Rapson, 2005; Regan et al., 1999, 2004; Regan & Berscheid, 1999; Ridge & Berscheid, 1989). (Naturally,

men and women can easily imagine the converse—sexual desire without passionate love.) As Pamela Regan (2004) observes:

Theoretical discourse from a number of disciplines suggest that sexual desire is a distinguishing feature of the passionate love experience . . .

Empirical research substantiates this hypothesis. People believe that sexual desire is part and parcel of the state of being in love, assume that couples who desire each other sexually are also passionately in love, and report a similar association when reflecting on their own dating relationships (p. 115).

Of course, culture surely has a powerful impact on how likely young couples are to link passionate love, sexual desire, and sexual *expression* (Hatfield & Rapson, 2005). Many men, for example, are taught to separate sex and love, while many women are taught to connect the two. The different meanings attributed to sexual activity have been known to cause lovers much distress (Hatfield & Rapson, 2006).

Neuroscientists and evolutionary psychologists, however, are still in sharp disagreement as to whether love and lust are very different systems (Diamond, 2003 and 2004; Gonzaga, et al., 2006) or are tightly linked (Bartels & Zeki, 2000). These neuroscientists do agree, however, that all of the brain systems for passionate love, sexual desire, and attachment do in fact communicate and coordinate with one another.

When the dust settles, we suspect neuropsychologists will come to acknowledge that although love and lust may possess a few distinct features, they are tightly linked. It is hard to imagine that two phenomena so linked in the public mind could be such

disparate entities. Thus, the contention that love and sexual desire are “kissing cousins” seems to be an appropriate one.

C. The Commercialization of Love and Sex Research: The BusinessofLove.com?

Any time a new form of communication is invented—the penny newspaper, Morse code and the telegraph, the ham-radio, TV, or computers—men and women find ways to use that technology to find love. In the 1950s, for example, almost as soon as computers appeared, commercial matchmaking services sprang up (CBC Archives, 1957). Recognized as the first widespread computer matching service was Operation Match, which was created in the mid 1960s by Harvard students after a discussion of the evils of blind dates and mixers. They distributed thousands of questionnaires to college students at several universities and asked them to rate themselves on looks, intelligence, and other dimensions and also to indicate what they would desire in a partner on these same dimensions. In return for the completed questionnaire and a fee of three dollars, they were promised a list of compatible matches. Data were entered on punch cards and analyzed with an Avco #1790 computer (which was probably the size of a small room). According to media reports, it took the computer six weeks to generate the lists. Not surprisingly, the business failed miserably (for a description of this experiment, see Leonhardt, 2006).

Today, while some sites, such as Match.com, are designed for the general population of singles, other sites target special niches of the population. There are those designed to appeal to various age groups (HookUp.com, SilverSingles.com), political groups (ConservativeMatch.com, LiberalHearts.com), religious groups

(CatholicSingles.com, ChristianCafe.com, HappyBuddhist.com, Jdate.com), and sexual orientation (GayWired.com, superEva.com). Dating sites also exist for people who possess mental and physical disabilities, unusual sexual preferences, and so forth. Even people who wish to find dates for themselves and their favorite pets can sign on to a site (DateMyPet.com). At the time this chapter was written, there had sprung up almost 1,000 dating websites servicing the U.S. (e.g., Thompson, Zimbardo, & Hutchinson, 2005), and the technology available to create another one in an afternoon.

Recently, neuroscientists and biochemists have joined the gold rush. They have set up sites like ScientificMatch.com (people are matched on the basis of DNA) or Chemistry.com (where scientists use indicators (such as finger length) to classify and match up people, among a host of others.

What scientific principles are being used to match people on the major relationship websites, such as eHarmony.com and Perfectmatch.com? Or on the “scientific” websites? Do people sign up for these services just for fun or do they truly believe that scientists can match them with their ideal Prince Charming or Sleeping Beauty?

Almost all of the sites make fantastic claims. ScientificMatch.com, for example, promises:

DNA Matching and the Magic of Chemistry

When you share chemistry with someone, you significantly increase your chances of realizing these amazing benefits:

1. You'll love their natural body fragrance—they'll smell "sexier" than other people.
2. You'll have a more satisfying sex life.
3. If you're a woman, you'll have a higher rate of orgasms.
4. There will be less cheating in your exclusive relationship.
5. As a couple, you'll be more fertile.
6. Your children will be healthier.

In support of these contentions, the authors cite a slew of articles published in prestigious social psychological, neuroscience, evolutionary psychology, and neurobiochemistry journals.

Chemistry.com asks men and women to answer 56 questions—things like: "Which image most closely matches your right hand?" The assumption is that people possess different levels of dopamine, serotonin, norepinephrine, and testosterone. The scholars assume that these differences in brain chemistry have a powerful effect on people's personalities—determining which of four categories they fit: the explorer, the builder, the negotiator, and the director. (The site purports to tell you what type you are, based on physical characteristics (i.e., finger length, etc.) For common folk, these matching sites have the imprimatur of Science (with a capital S).

In the scientific community there are mixed reactions to such claims. Some argue that no one takes the claims of these sites seriously. People access the sites in fun. They also point out that commercial matching services are still in their infancy. Since social psychologists, neuroscientists, and neurobiologists are working for these sites, in time—given the money that is being lavished on these commercial

enterprises—it is reasonable to hope that in the future, the *businessoflove.com* sites will craft more complex versions of relationship science to inform their questionnaire construction, website construction, and matching algorithms. Thus, in time these matching sites will provide increased opportunities for men and women to find dating and marital relationships that are fulfilling.

Other scientists cringe, arguing that these sites can't possibly fulfill their promises of the perfect match. Currently, these matching sites—arguing that they are businesses not scientific enterprises—are reluctant to explain in any detail how they match people and how successful such matches are.

Critics point out that only charlatans, crooks, and con men sell “elixirs” that cure nothing. People who join these sites looking for love are being cheated. Worse yet, false claims make people who get burned skeptical about the scientific enterprise itself. When people are disappointed—and they are bound to be—they will blame science for their disappointment (see Sprecher, et al, in press, for a longer discussion of these issues.)

Our personal opinion is that an appreciation of science and its methods is a fragile blossom, easily trampled underfoot, and that scientists participating in these commercial enterprises should tread with care. They can potentially inflict serious damage to the whole neuroscientific enterprise when they promise what they cannot deliver. Love may be wonderful or painful because it is no simple matter.

References

Acevedo, B., Aron A., Xu, X., & Gross, J. (2008) *Romantic love: basic emotion or motivation?* Unpublished manuscript. Stony Brook: State University of New York at Stony Brook.

Appian of Alexandria. (1899). The Syrian wars. *The Roman history*, Vol. 2. Horace White (Trans.). (pp. 317-320). New York: Macmilian: Loeb Classical Library.

Aron, A., Fisher, H. E., Mashek, D. J., Strong, G., Li, H-F, * Brown, L. L. (2005). Reward, motivation, and emotion systems associated with early-stage intense romantic love. *Journal Neurophysiology*, 94, 327-337.

Barclay, A. M. (1969). The effect of hostility on physiological and fantasy responses. *Journal of Personality*, 37, 651-667.

Barclay, A. M. (1971). Linking sexual and aggressive motives: Contributions of “irrelevant” arousals. *Journal of Personality*, 39, 481-492.

Bartels, A. & Zeki, S. (November 27, 2000). The neural basis of romantic love. *Neuroreport*, 11, 3829-3834.

Bartels, A. & Zeki, S. (2004). The neural correlates of maternal and romantic love. *Neuroimage*, 21, 1155-1166.

Berscheid, E. & Hatfield, E. (1969). *Interpersonal attraction*. New York: Addison-Wesley.

Berscheid, E., & Meyers, S. A. (1996). A social categorical approach to a question about love. *Personal Relationships*, 3, 19-43.

Birbaumer, N., Lutzenberger, W., Elbert, T., Flor, H., & Rockstroh, B. (1993) Imagery and brain processes. In Niels Birbaumer and Arne Öhman (Eds.) *The structure of emotion* (pp. 132-134). Göttingen, Germany: Hogrefe & Huber Publishers.

Blink, S. (July 30, 2007). This is your brain on love. *Los Angeles Times* latimes.com. <http://www.latimes.com/features/health/la-he-attraction30jul30.1.68965446.story?coll=la-headlines-health&ctrack=1&cset>.

Brehm, J. W., Gatz, M., Goethals, G., McCrimmon, J., & Ward, L. (1978). Psychological arousal and interpersonal attraction. *JSAS Catalogue of Selected Documents in Psychology*, 8, 63 (ms. #1724).

Byrne, D., Przybyla, D. P. J., & Infantino, A. (1981, April). *The influence of social threat on subsequent romantic attraction*. Paper presented at the meetings of the Eastern Psychological Association, New York.

Cacioppo, J. T., Berntson, G. G., Lorig, T. S., Norris, C. J., & Nusbaum, H. (2003). Just because you're imaging the brain doesn't mean you can stop using your head: A primer and set of first principles. *Journal of personality and Social Psychology*, 85, 650-661.

Carlson, J. G. & Hatfield, E. (1992). *Psychology of emotion*. New York: Harcourt, Brace, Jovanovich.

Carter, C. S., Lederhendler, I. & Kirkpatrick, B. (1999). (Eds.) *The integrative neurobiology of affiliation*. Cambridge, MA: The MIT Press.

CBC Archives. (July 17, 1957). Clip: Computer matchmaker.

<http://archives.cbc.ca/400i.asp?IDCat=75&IDDos=710&IDCli=4199&IDLan=1&NoCli=3&type=clip>.

Clanton, G., & Smith, L. G. (Eds.) (1986). *Jealousy*. Lanham, MA: University Press of America.

de Sade, Marquis. (1797/1963). *Histoire de Juliette*, in *Oeuvres complètes du marquis de Sade* (Vol. 9). Paris, France: Cercle du Livre Précieux.

Diamond, L. M. (2003). What does sexual orientation orient? A biobehavioral model distinguishing romantic love and sexual desire. *Psychological Review*, *110*, 73-192.

Diamond, L. M. (2004). Emerging perspectives on distinctions between romantic love and sexual desire. *Current Directions in Psychological Science*, *13*, 116-119.

Dienstbier, R. A. (1978). Emotion-attribution theory: Establishing roots and exploring future perspectives. In H. E. Howe & R. A. Dienstbier (Eds.). *Nebraska Symposium on Motivation*, Vol. 26, pp. 237-306). Lincoln: University of Nebraska Press.

Doherty, R. W., Hatfield, E., Thompson, K., & Choo, P. (1994). Cultural and ethnic influences on love and attachment. *Personal Relationships*, *1*, 391-398.

Driscoll, R., Davis, K. E., & Lipetz, M. E. (1972). Parental interference and romantic love: The Romeo & Juliet effect. *Journal of Personality and Social Psychology*, *24*, 1-10.

Dutton, D. (1979) *The arousal-attraction link in the absence of negative reinforcement*. Meetings of the Canadian Psychological Association, Toronto, Canada.

Dutton, D., & Aron, A. (1974). Some evidence for heightened sexual attraction under conditions of high anxiety. *Journal of Personality and Social Psychology, 30*, 510-517.

Ellrich, R. J. (1985, May). Modes of discourse and the language of sexual reference in eighteenth-century French fiction. In R. P. Maccubin (Ed.), *Unauthorized sexual behavior during the Enlightenment*, a special issue of *Eighteenth-Century Life, 9*, p. 222.

Fehr, B. (2001). The status of theory and research on love and commitment. In G. Fletcher & M. Clark (Eds.) *Blackwell handbook of social psychology: Interpersonal processes*. (pp. 331-356). New York: Wiley.

Fehr, B. (1994). Prototype-based assessment of laypeople's views of love. *Personal Relationships, 1*, 309-331.

Fehr, B., & Russell, J. A. (1991). Concept of love viewed from a prototype perspective. *Journal of Personality and Social Psychology, 60*, 425-438.

Fischer, K. W., Shaver, P. R., & Carnochan, P. (1990). How emotions develop and how they organize development. *Cognition and Emotion, 4*, 81-127.

Fischer, K. W., Wang, L., Kennedy, B., & Cheng, C. (1998). Culture and biology in emotional development. In D. Sharma & K. W. Fischer (Eds.), *Socioemotional development across cultures. New Directions for Child Development, 81*, 21-43. San Francisco: Jossey-Bass.

Fisher, H. E. (July 16, 2003.) *The brain chemistry of romantic attraction and its positive effect on sexual motivation*. Paper presented at the 29th annual meeting of the International Academy of Sex Research. Bloomington, IN.

Fisher, H. E. (2004). *Why we love: The nature and chemistry of romantic love*. New York: Henry Holt.

Fisher, H. E. (January 19, 2004). Your brain in love. *Time Magazine*, p. 77.

Fisher, H., Aron, A., & Brown, L. L. (2005). Romantic love: an fMRI study of a neural mechanism for mate choice. *The Journal of Comparative Neurology*, 493, 58-62.

Fisher, H. E., Aron, A., Mashek, D., & Brown, L. L. (2002). Defining the brain systems of lust, romantic attraction, and attachment. *Archives of Sexual Behavior*, 31, 413-419.

Freud, S. (1910/1953). Contributions to the psychology of love: A special type of choice of objects made by men. In E. Jones (Ed.), *Sigmund Freud: Collected papers* (Vol. 4, pp. 192-202). (Trans. Joan Riviere). New York: Basic Books.

Gillis, J. S. (1980). *Child anxiety scale*. Champaign, IL: Institute for Personality and Ability Testing.

Gonzaga, G. C., Turner, R. A., Keltner, D., Campos, B., & Altemus, M. (2006). Romantic love and sexual desire in close relationships, *Emotion*, 6, 163-179.

Graf, K. E., & Elbert, T. (1989) Dimensional analysis of the waking EEG. In E. Basar & T. H. Bullock (Eds.) *Brain dynamics*, (Vol. 2). (pp. 174-191).

Berlin/Heidelberg: Springer-Verlag.

Greeley, A. (1991). *Faithful attraction: Discovering intimacy, love, and fidelity in American Marriage*. New York: St. Martin's Press.

Hatfield, E., & Berscheid, E. (1971). Adrenaline makes the heart grow fonder. *Psychology Today*, 6, 46-50 and p. 62.

Hatfield, E., Brinton, C., & Cornelius, J. (1989). Passionate love and anxiety in young adolescents. *Motivation and Emotion, 13*, 271-289.

Hatfield, E., & Rapson, R. L. (1987b). Passionate love: New directions in research. *Advances in Personal Relationships, 1*, 109-139.

Hatfield, E., & Rapson, R. L. (1993). *Love, sex, and intimacy: Their psychology, biology, and history*. New York: HarperCollins.

Hatfield, E., & Rapson, R. L. (1996). Stress and passionate love. In C. D. Spielberger & I. G. Sarason (Eds.), *Stress and Emotion: Anxiety, Anger, and Curiosity, 16*, 29-50.

Hatfield, E., & Rapson, R. (2005). *Love and sex: Cross-cultural perspectives*. Needham Heights, Lanham, MD: University Press of America.

Hatfield, E. & Rapson, R. L. (2006). Love and passion. In Irwin Goldstein, C. M. Meston, S. R. Davis, & A. M. Traish (Eds.) *Women's sexual function and dysfunction: Study, diagnosis and treatment*, (pp. 93-97). London: Taylor and Francis, UK.

Hatfield, E. & Rapson, R. L. (in press). Passionate love and sexual desire: Multidisciplinary perspectives. In J. P. Forgas (Ed.). *Personal Relationships: Cognitive, Affective, and Motivational Processes*. 10th Sydney Symposium of Social Psychology. New York: Psychology Press.

Hatfield, E., Schmitz, E., Cornelius, J., & Rapson, R. L. (1988). Passionate love: How early does it begin? *Journal of Psychology and Human Sexuality, 1*, 35-52.

Hatfield, E., & Sprecher, S. (1986). Measuring passionate love in intimate relations. *Journal of Adolescence, 9*, 383-410.

Hazan, C., & Shaver, P. (1987). Romantic love conceptualized as an attachment process. *Journal of Personality and Social Psychology*, *52*, 511-524.

Hendrick, S. S., & Hendrick, C. (1987a). Love and sex attitudes: A close relationship. In W. H. Jones & D. Perlman (Eds.), *Advances in personal relationships*, *1*, (pp. 141-169). Greenwich, CT: JAI.

Hendrick, S. S., & Hendrick, C. (1987b). Love and sexual attitudes, self-disclosure, and sensation-seeking. *Journal of Social and Personal Relationships*, *4*, 281-297.

Hoon, P. W., Wincze, J. P., & Hoon, E. F. (1977). A test of reciprocal inhibition: Are anxiety and sexual arousal in women mutually inhibitory? *Journal of Abnormal Psychology*, *86*, 65-74.

Hunt, C. (2000-20001). Concoctions, potions, poisons . . . *San Francisco Opera Performing Arts Magazine*, pp. 17-46.

Hyde, J. S. (Ed.) (2005). *Biological substrates of human sexuality*. Washington, D. C.: American Psychological Association.

Kaplan, H. S. (1979). *Disorders of sexual desire*. New York: Simon & Schuster.

Kauth, M. R.. (Ed.) (2007) *Handbook of the evolution of human sexuality*. Binghampton, NY: The Hayworth Press.

Kinsey, A. C., Pomeroy, W. B., & Martin, C. E. (1948). *Sexual behavior in the human male*. Philadelphia: Saunders.

Kinsey, A. C., Pomeroy, W. B., Martin, C. E., & Gebhard, P. H. (1953). *Sexual behavior in the human female*. Philadelphia: Saunders.

Landis, D. & O'Shea, W. A. O. III, (2000). Cross-cultural aspects of passionate love; An individual difference analysis. *Journal of Cross-Cultural Psychology*, 31, 754-779.

Leonhardt, D. (March 28, 2006). The famous founder of operation match. *The New York Times*. Retrieved December 22, 2007 from www.nytimes.com/2006/03/28/business/29leonside.html

Liebowitz, M. R. (1983) *The chemistry of love*. Boston: Little, Brown, and Co.

Marazziti, D. (2005). The neurobiology of love. *Current Psychiatry Reviews*, 1, 331-335.

Marazziti, D., Akiskal, H. S., Rossi, A., & Cassano, G. B. (1999). Alteration of the platelet serotonin transporter in romantic love. *Psychological Medicine*, 29 (3), 741-745.

Marazziti, D. & Canale, D. (2004). Hormonal changes when falling in love. *Psychoneuroendocrinology*, 29 (7) 931-936.

Marazziti, D., Di Nasso, E., Masala, I., Baroni, S., Abelli, M. Mengali, F., Mungai, F., & Rucci, P. (2003). Normal and obsessional jealousy: a study of a population of young adults. *European Psychology*, 18, 106-111,

Masters, W. H., & Johnson, V. E. (1966). *Human sexual response*. Boston: Little, Brown.

Meston, C. M. & Frohlich, P. F. (2003). Love at first fright: Partner salience moderates roller-coaster-induced excitement transfer. *Archives of Sexual Behavior*, 32, 537-544.

Mesulam, M.-M., & Perry, J. (1972). The diagnosis of love-sickness: Experimental psychophysiology without the polygraph. *Psychophysiology*, *9*, 546-551.

Meyers, S., & Berscheid, E. (1997). The language of love: What a difference a preposition makes. *Personality and Social Psychology Bulletin*, *23*, 347-362.

Movshon, J. A. (February 5, 2006). Searching for the person in the brain. *The New York Times. Week in Review*. P. 1-4.

Najib, A., Loberbaum, J. P., Kose, S., Bohning, D. E., & George, M. S. Regional brain activity in women grieving a romantic relationship breakup. *American Journal of Psychiatry*, *161*, 2245-2256.

Panksepp, J. (2007). Neurologizing the psychology of affects: How appraisal-based constructivism and basic emotion theory can coexist. *Perspectives on Psychological Science*, *2*, 281-312.

Peplau, L. A., & Perlman, D. (1982). *Loneliness*. New York: Wiley-Interscience.

Plutarch. Demetrius. (1920). In *Plutarch's Lives*, B. Perrin (Trans.). (pp. 93-97). Cambridge, MA: The Loeb Classical Library. Vol. 9. cap. Xxxviii.

Regan, P. C. (1998). Of lust and love: Beliefs about the role of sexual desire in romantic relationships. *Personal Relationships*, *5*, 139-157.

Regan, P. C. (1999). Hormonal correlates and cases of sexual desire: A review. *The Canadian Journal of Human Sexuality*, *8*, 1-16.

Regan, P. C. (2004). Sex and the attraction process: Lessons from science (and Shakespeare) on lust, love, chastity, and fidelity. In J. H. Harvey, A. Wenzel, & S. Sprecher (Eds.) *The handbook of sexuality in close relationships*. (pp. 115-133). Mahwah, NJ: Lawrence Erlbaum.

Regan, P. C. & Berscheid, E. (1999). *Lust: what we know about human sexual desire*. London: Sage.

Regan, P. C., Kocan, E. R. & Whitlock, T. (1999). Ain't love grand! A prototype analysis of the concept of romantic love. *Journal of Social and Personal Relationships*, *15*, 411-420.

Reik, T. (1972). *A psychologist looks at love*. New York: Holt, Rinehart & Winston.

Reis, H. T. & Aron, A. (2008). Love: What is it, why does it matter, and how does it operate? *Psychological Science*, *3*, 79-86.

Ridge, R. D. & Berscheid, E. (May, 1989). *On loving and being in love: A necessary distinction*. Paper presented at the annual convention of the Midwestern Psychological Association, Chicago, IL.

Riordan, C. A., & Tedeschi, J. T. (1983) Attraction in aversive environments: Some evidence for classical conditioning and negative reinforcement. *Journal of Personality and Social Psychology*, *44*, 683-692.

Ruan, F. F. (1991). *Sex in China: Studies in sexology in Chinese culture*. New York: Plenum.

Schachter, S., & Singer, J. (1962). Cognitive, social, and physiological determinants of emotional state. *Psychological Review*, *69*, 379-399.

Shaver, P. R., Morgan, H. J., & Wu, S. (1996). Is love a "basic" emotion? *Personal Relationships*, *3*, 81-96.

Shaver, P. R., Murdaya, U., & Fraley, R. C. (2001). Structure of the Indonesian emotion lexicon. *Journal of Social Psychology*, *4*, 201-224.

Shaver, P., Schwartz, J., Kirson, D., & O'Connor, C. (1987). Emotion knowledge: Further exploration of a prototype approach. *Journal of Personality and Social Psychology, 52*, 1061-1087.

Shaver, P. R., Wu, S., & Schwartz, J. C. (1991). Cross-cultural similarities and differences in emotion and its representation: A prototype approach. In M. S. Clark (Ed.), *Review of Personality and Social Psychology, (Vol.13)* (pp. 175-212). Newbury Park, CA: Sage.

Spielberger, C. D., Gorsuch, R. L., & Lushene, R. E. (1970). *STAI manual for the State-Trait Inventory*. Palo Alto, CA: Consulting Psychologist Press.

Sprecher, S., Schwartz, P., Harvey, J., & Hatfield, E. (2007). The businessoflove.com: Relationship initiation at Internet matchmaking services. In S. Sprecher, A. Wenzel, & J. Harvey (Eds.), *The Handbook of Relationship Initiation*. New York: Erlbaum.

Thompson, M., Zimbardo, P., & Hutchinson, G. (April 29, 2005). *Consumers are having second thoughts about online dating*. Unpublished report from weAttract.com, Inc.

Trawick, M. (1990). *Notes on love in a Tamil family*. Berkeley, CA: University of California Press.

Tucker, N. (February 13, 2007). An affair of the head. *The Washington Post*. (p. C1.)

Wargo, E. (2005). With the brain, is seeing believing? *American Psychological Society, 18*, p. 33.

White, G. L., Fishbein, S., & Rutstein, J. (1981). Passionate love and the misattribution of arousal. *Journal of Personality and Social Psychology*, *41*, 56-62.

Zillman, D. (1984). *Connections between sex and aggression.* Hillsdale, NJ: Lawrence Erlbaum Associates.