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Romantic Breakup Distress, Betrayal and Heartbreak: A Review

Review Article

Field T*

University of Miami School of Medicine, Florida, USA.

Abstract

A review of the romantic breakup literature suggests that it can lead to breakup distress, betrayal and heartbreak. The breakup distress that occurs can be explained in part by depression and feelings of rejection and betrayal. These may lead to physical problems including heartbreak or the broken heart syndrome and immune dysfunction. The broken heart syndrome has notably mimicked heart attacks, but it has been differentiated from a real heart attack by angiograms revealing unclogged arteries and no permanent heart damage. Reduced vagal activity and increased cortisol and catecholamine levels (dopamine and norepinephrine) accompanying heartbreak are thought to be potential underlying mechanisms for the broken heart syndrome and for immune dysfunction including increased inflammatory cytokines and reduced natural killer cells. fMRIs following breakups have revealed increased activity in the cingulate cortex and the right ventricular prefrontal cortex. These data highlight the complexity of breakup distress, betrayal and heartbreak and the need for multi-variable research.

This narrative review involved a literature search on the terms romantic breakup distress, betrayal and heartbreak on PubMed and PsycInfo. For the selection process, the inclusion criteria were: published empirical studies, systematic reviews and meta-analyses. Exclusion criteria included: non-English papers, case studies, under-powered samples, and non-juried papers. Following these screening criteria, the publications selected are briefly reviewed here.

Romantic Breakup Distress

Although romantic breakups, breakup distress and heartbreak are common among adults, they have occurred as early as the seventh grade [90], and most of the studies on these topics have been conducted with university students, as reflected by the literature reviewed in this paper. Romantic breakups occur in as many as two-thirds of university samples [43, 104]. The breakups frequently lead to breakup distress which is often associated with depression, feelings of rejection and betrayal, heartbreak symptoms including chest pain and compromised immune function. This review summarizes some of that literature.

In one of the early studies on romantic breakups in university students, the Breakup Distress Scale (adapted from the Inventory of Complicated Grief) and several other measures were used to assess the distress that followed romantic breakups [43]. In that, 192 university students (primarily Hispanic women)were surveyed about their recent romantic breakup. The students were divided into high versus low scoring groups based on the Breakup Distress Scale. The group with high Breakup Distress Scale scores reported that they had less time since the breakup occurred, that they were not the initiators of the breakup, that the breakup was sudden and unexpected, and that they felt rejected and betrayed. In a regression analysis on the same database, the depression scores (CES-D) and feeling rejected and betrayed by the breakup were significant predictors of the Breakup Distress scores. These variables explained 37% of the variance, highlighting their relationships to breakup distress. These results were not surprising given that depression has been related to other kinds of grief, and feelings of rejection and betrayal have been notably similar to physical pain and have led to immune dysfunction [29, 47]. Thus, literature that related romantic breakups to depression, rejection and betrayal, pain and immune dysfunction are reviewed here. In addition, fMRI and biochemical data are reviewed as potential underlying mechanisms, and social and biochemical interventions are briefly explored.

***Corresponding Author**:
Tiffany Field, PhD,
University of Miami School of Medicine, Florida, USA.
Tel: +305-975-5029
E-mail: tfield@med.miami.edu

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Depression

Breakup distress has frequently been associated with depression shortly before or during college [78]. Depression in university students is an increasing concern worldwide [12], ranging from an incidence of 6% in a Chinese survey [63] to 17% of students at a New Zealand university having depressive symptoms [116] and to 48% of those students at a U.S. university reporting clinically significant depressive symptomatology [21]. The most frequent symptoms expressed among the students were sleep problems, intrusive thoughts and difficulty concentrating. Another U.S. University Counseling Center reported an increase of 131% in yearly visits as well as a 173% increase in total yearly clients [13]. Thus, depressive symptoms are prevalent in university students, and they are associated with significant academic impairment [66, 71].

In a phone survey, romantic breakups were one of the most commonly reported "worst events" and they were a significant risk factor for depression [100]. In another study, over 40% of those experiencing romantic breakups became clinically depressed (12% experienced moderate to severe depression) [97].

Other predictors of depression in university students have included insecurity of attachment [74], perfectionism, and rumination [15, 73]. In a sample of 283 university students, those with high depression scores also had high scores on anxiety, intrusive thoughts, and sleep disturbance scales [45]. A stepwise regression suggested that those problems contributed to 51% of the variance on the depression scores. Two subscales of the depression scale that correlated most highly with these variables included the depressed affect and the vegetative symptoms subscales.

Women typically experience more severe depression and hopelessness following breakups, being twice as likely to be depressed as men [97]. However, men are three to four times more likely to commit suicide after romantic breakups. Depression, in turn, has been related to loneliness (an incidence of 35% for female university students and 24% for male students), and, here again, women had higher depression and loneliness scores [80]. Heart attacks and strokes can also follow breakups and depression [113].

Depression occurs more often in those who have been rejected versus those who initiated the rejection [6]. In those who are depressed, positron emission tomography (PET) scans suggest that rejection results in reduced opioid release in brain regions that regulate stress, mood and motivation and, in turn, to slower emotional recovery [70].

Rejection

Feeling rejected was the second predictor variable to contribute to the variance in the Field et al., [43] study on breakup distress. Rejection is often felt following breakups. In a survey at Case Western Reserve University, 95% of the students reported that they had rejected someone who was in love with them, and 93% said that they had been rejected by someone they loved [11]. Rejection following romantic relationships has been reputedly so painful that people report that they are "not only in agony, but incapacitated" [92].

Rejection following romantic breakups has been accompanied by increased blood pressure and elevated stress hormone (i.e. cortisol) [126] and by analgesia or numbing [92]. Paradoxically, the same part of the brain that is activated by rejection is also activated by love [39]. Social rejection has also been simulated using the Cyberball paradigm (a social exclusion or inclusion condition in a virtual ball-tossing game), and increased heart rate has been noted following this "social rejection" condition [72].

Romantically rejected individuals have shown signs of drug withdrawal including anxiety, depression, crying, loss of appetite and irritability, and their fMRIs were similar to individuals withdrawing from cocaine or opioids [10]. Paradoxically, activation of endogenous opioid activity in the amygdala and anterior cingulate cortex (based on PET scans) is associated with the reduction of social rejection pain [70].

To address the question of why some people become depressed following socially painful rejection life events and some do not, a research team assessed recent rejection stress using self-reports and interviews, and the participants were also genotyped for the polymorphism of the opioid receptor gene [120]. The researchers found that carriers of the G allele, who typically exhibit less opioid expression and signaling, were more severely depressed following a recent rejection. These data suggest a potential underlying biological mechanism for sensitivity to rejection and social pain.

Betrayal

Feelings of betrayal often accompany feelings of rejection, and betrayal also entered the regression analysis on breakup distress in the Field et al., (2009) [43] study.

Betrayal has been defined as "…a sense of being harmed by the intentional actions or omissions of a person who was assumed to be a trusted and loyal friend, relative, partner, colleague or companion. Many betrayals are unexpected events that come as a surprising shock; not infrequently, the betrayal is disbelieved at first. The effects of a betrayal tend to be long-lasting, even permanent, and are well-remembered" [109]. Some symptoms of betrayal are distress, intrusive images and rumination [109]. Others have studied betrayal as the loss of "social provisions", most especially the loss of attachment to and guidance from the betrayal partner [30]. In this study 91% of the participants lost social provisions from their partners following romantic betrayal.

In a study on university students, the level of betrayal was assessed by the closeness of the relationship [95]. Those with high betrayal that happened in close relationships had more symptoms of depression and PTSD. In another study [58], betrayal was measured by three scales including: 1) The Brief Betrayal Trauma Scale [57] that defines high levels of betrayal as occurring in a close relationship and low levels in a non-close relationship; 2) The Impact of Event Scale [69] that assesses symptoms of intrusion, avoidance and hyperarousal; and 3) the Trauma Symptom Checklist [41] that assesses symptoms related to depression, anxiety, sleep disturbance, dissociation and sexual problems [58]. In this study, the final path model from a structural equations analysis suggested that high levels of betrayal (that experienced in a close relationship) were predictive of all of the assessed factors including depression, anxiety, intrusions and avoidance [58]. In contrast, low

levels of betrayal (experienced with someone who was not close) were only minimally related to anxiety. The most common high level betrayal was being emotionally or psychologically mistreated for a significant length of time by someone close. Betrayal trauma indirectly affected symptoms of intrusion, avoidance, depression and anxiety via disturbed emotion regulation.

Similar symptoms were reported by Rachman (2010) [109], who also noted obsessive compulsive disorder (OCD) and posttraumatic stress disorder(PTSD) symptoms in those with high betrayal. These symptoms as well as physical health complaints have been reported by university undergraduate students experiencing betrayal [57]. Still others have suggested that betrayal can lead to borderline personality disorder [14].

Gender differences have been noted in the level of betrayal, suggesting that females were more likely to experience high levels of betrayal [95]. Others have reported that females (again university students) not only experienced higher levels of betrayal but also more PTSD symptoms [8]. These authors also noted that females experienced more betrayal in both childhood and adulthood, consistent with others' findings [57]. And, greater betrayal during childhood has been related to greater betrayal during adulthood [7].

Other factors include age and being a psychology major (Barlow & Cromer, 2006) [8]. These authors suggested that psychology majors experienced more low and high betrayal in childhood and more low betrayal in adulthood, and that current age was correlated with reporting betrayal regardless of whether it occurred in childhood or adulthood.

Other betrayal-related phenomena have been noted including that depressed individuals experiencing interpersonal betrayal become more critical of their personality characteristics and their performance on an experimental task than those who experienced a cooperative interaction [64]. In the same experiment, the depressed subjects in the betrayal condition behaved more aggressively toward their betraying partner. Betrayal aversion is another phenomenon. In an fMRI study the anterior insula became active during trusting decisions that involved the possibility of betrayal [2]. The authors suggested that "betrayal aversion" derives from the desire to avoid negative emotions that result from one's trust being betrayed.

Betrayal blindness has also been reported [76]. These authors suggest that in highly dependent relationships, the betrayed individual may be advantaged by "remaining unaware" of the betrayal rather than risking being alienated by the needed other. Forgetting or misremembering betrayal might also be adaptive [34]. Forgiveness of betrayal has been associated with commitment to the relationship [46]. In this study, commitment to a relationship was more likely to lead to forgiveness than to vengeance or bearing a grudge.

A growing literature on oxytocin and betrayal suggests the modulating effects of oxytocin. For example, in one study, oxytocin made females, but not males, less forgiving following betrayal of trust [139]. Even though oxytocin has been thought to enhance trust behavior, the females in this study exhibited more punitive behavior toward partners who violated their trust and were less sensitive to repair strategies. Females with a more forgiving attitude were more likely to punish betrayal. In a study on high attachment- avoidant males, oxytocin that was administered intranasally decreased their betrayal aversion and enhanced their trust and cooperation compared to a placebo [33].

Oxytocin has increased and maintained trust even towards untrustworthy partners [81]. In this study, participants played a trust game involving the opponent betraying their trust, and oxytocin reduced the link between the anger and blaming the other person that usually follows betrayal. This might be explained by variations in the gene that encodes the oxytocin receptor [127]. In this study, one haplotype was associated with increased anger following betrayal, while another haplotype was associated with less anger.

Heartbreak (Broken Heart Syndrome)

Physical pain in the heart or chest after losing someone has been labeled heartbreak or the broken heart syndrome [136]. This acute pain has also been called stress cardiomyopathy or "takotsubo cardiomyopathy". Takotsubo is a fishing pot with a narrow neck and a wide base that is used to trap octopus in Japan, and the left ventricle of the heart looks like that fishing pot following heartbreak. Heartbreak has led to endocrine and immune dysfunction [56] and serious medical conditions including cancer, hypertension and heart attacks [125]. Although the heartache mimics symptoms of a heart attack, those with broken heart syndrome typically recover faster. Cardiac contractile abnormalities and heart failure have been recorded by several investigators following acute emotional stress [20, 85]. Angiograms, however, revealed no clogged arteries in heartbreak, unlike real heart attacks.

In addition, cardiac enzymes typically released from damaged heart muscle during real heart attacks have not been reported [136]. Although other heart changes associated with stress also occur including weakened contractions in the left middle and upper portions of the heart muscle and inverted T waves. These heart changes have been attributed to exaggerated sympathetic stimulation and elevated catecholamines including norepinephrine and epinephrine [135, 136].

The spasms in the coronary arteries may also relate to the increased catecholamines [136]. The spasm-related loss of blood flow could also lead to the transient stunning of the heart [85]. A failure of the arteries to provide adequate oxygen to the heart is another possibility [77]. Finally, all of these factors may be operating. Despite their heart attack symptoms, none of the broken heart syndrome patients suffered irreversible heart damage based on magnetic resonance imaging scans, and their recovery rates were typically two months faster than after real heart attacks [3]. Paradoxically, takotsubo cardiomyopathy has also followed a positive emotional event in a postmenopausal woman [4].

These data are tenuous at best given the mixed findings (i.e. both negative and positive events leading to the cardiomyopathy) and the small samples in these studies. Although increased heart rate and the release of catecholamines are correlated with the heartbreak symptoms, the relationships are only suggestive. Elevated catecholamines may be an epiphenomenon of the stress cardiomyopathy rather than the cause. The types of pain (acute, chronic, psychological, somatic) needs to be differentiated for the diagnosis to be more clearly made.

Reduced Vagal Activity

A potentially related problem is the decreased vagal tone following emotional stress, suggesting a sympathetically activated (aroused) state [50]. And, curiously, gastric activity is increased following emotional arousal [132]. These effects are difficult to interpret given that the vagus has a branch to the GI tract, and decreased vagal tone is typically expected to lead to decreased not increased gastric activity [35]. The expression "gut feelings" that is often used to describe emotional arousal may relate to the increased gastric activity.

Compromised Immune Function

Romantic breakups have been associated with extreme physical and emotional distress, exaggerated attempts to re-establish the relationship, angry and vengeful behavior, and drug and alcohol use based on a survey of more than 5,000 internet respondents [32]. In addition, increased stress hormones and disrupted sleep and immune function have been noted [119]. Cortisol dysregulation has been associated with sleep disturbances such as increased REM density [111], insomnia [55] and immune changes [1996]. Compromised immune function may result from the increased heart rate, blood pressure, cortisol and norepinephrine levels following heartbreak [130]. These physiological and biochemical reactions may initially be adaptive in increasing proinflammatory cytokines, and they, in turn, increase antibodies to prevent infection [18]. But if this response is prolonged, elevated stress hormones and cytokines can impair immune function [79]. For example, proinflammatory cytokines (IL-1, IL-2, IL-6 and TNF-alpha) accompany depression [86].

In a social rejection study, the social stressors were associated with increases in two markers of inflammatory activity including TNF-alpha and IL-6 [120]. Greater increases in TNF-alpha were also associated with greater activity in the dorsal anterior cingulate cortex and anterior insula, regions that have been reportedly affected by rejection-related distress. In a more recent study, heightened activation of the amygdala was associated with greater increases in inflammation [102]. Individuals who had a stronger coupling between the amygdala and the dorsomedial prefrontal cortex showed a greater inflammatory response to the stressor. Still another example of the inflammatory response is high antibody titres to the Epstein-Barr virus following divorce [108].

Decreases in natural killer cells (noted to kill bacterial, viral, and cancer cells) have also occurred in individuals who experienced loss and had high anxiety and depression scores and elevated cortisol [56]. Some of the participants had reduced natural killer cells for as long as six months. Other researchers have reported a greater incidence of illness [51] and heart disease [75] in individuals who have experienced loss.

Brain Activity Associated With Heartbreak

The anterior cingulate cortex has been noted to light up on fMRIs following rejection [39]. The cingulate cortex, the long ribbon of tissue at the brain's midline, has a region that is involved in negative emotions like rejection. In an fMRI study on bereaved women, for example, photographs of the lost person were used to elicit grief [62], and the posterior cingulate cortex was activated.

In another fMRI study, women who were grieving the loss of a romantic relationship showed similar regional brain activity [103].

In a computer game (Cyberball) study, the fMRIs of players who were excluded from the game showed that social rejection lit up the cingulate cortex very much like physical pain [106]. The anterior cingulate cortex was the critical site for physical pain signals in a study using PET scans [110]. Antidepressants have reduced the activity of the anterior cingulate [96] and they typically reduce pain as well [22]. Opioids such as morphine can regulate both physical and social pain [128].

The right ventral prefrontal cortex (RVPFC) has also been activated in response to rejection [39]. In a more recent study, the right ventral prefrontal cortex was also activated following social rejection [26]. The authors suggested that this activation led to a subsequent self-regulatory imbalance that led to reflexive impulses like daily cravings for alcohol.

Social Pain And Physical Pain Activate Similar Brain Regions

The same region (the right ventral prefrontal cortex) has been active in neuroimaging studies during painful stimulation [87, 106]. Greater RVPFC activation was associated with less pain. Because the RVPC is involved in cognitive activities, its activation during pain suggests the therapeutic use of cognitive tasks to interrupt social pain. Cognitive tasks have been successful at least in reducing the impact of intrusive thoughts following rejection and loss. Thus, the underlying mechanisms common to physical and social pain include the location in the brain (the anterior cingulate cortex and the right ventral prefrontal cortex) and the opioid system [114].

Many of the neuroimaging studies that suggested that social rejection activated the pain matrix were Cyberball studies and small sample studies. A meta- analysis on the Cyberball studies, however, failed to support the claim that social and physical pain activate the same regions [23]. And, in a study in which participants experienced both physical pain (heat) and social pain (photos of ex-partners) on separate trials, the fMRI patterns discriminated the physical and social pain conditions, i.e. those conditions did not activate the same region (the anterior cingulate cortex) [137].

In contrast, in a study on recent unwanted break-ups, when the participants viewed a photograph of their ex-partner, even the sensory areas for physical pain were activated (the secondary somatosensory cortex and the dorsal posterior insula) [83]. Further, these authors compared their data to data from over 500 published studies on physical pain demonstrating that both social pain and physical pain activated these sensory regions. The authors suggested that these effects may have been elicited by more powerful, more recent and unwanted break-up experiences. Thus, the literature is very mixed on physical and social pain sharing neural systems [37].

fMRIs Of Rejected Love Are Similar To Those Of Romantic Love

The same brain areas that light up in long-term love relationships also light up in rejected relationships [48]. In this study, women

who were still in love with their rejecting partner viewed a photograph of their rejecting loved one and a photograph of a familiar individual interspersed with a counting task. Similar brain areas were activated for rejected lovers, although they showed greater activity in the ventral pallidum than the in-love sample. This region has been associated with uncertain reward and delayed reinforcement [25]. These data suggest that the brain systems involved in reward and motivation remain active in those who have been romantically rejected. The data also showed that activity in regions associated with physical pain increased during rejection. These findings are consistent with data showing similar biochemical profiles for romantic love and romantic rejection.

Rejected And Romantic Love Have Similar Biochemical And Physiological Profiles

Neuroscientists have reported that the brain releases similar chemicals for both rejected and romantic love including dopamine, norepinephrine, epinephrine and serotonin, which act like amphetamines in stimulating the brain's pleasure center [48]. As dopamine and norepinephrine levels increase, serotonin levels decrease [91]. Elevated dopamine and norepinephrine and low serotonin levels, as already mentioned, have been associated with both heartbreak and romantic love [48]. Other characteristics of heartbreak and romantic love have also been correlated with elevated dopamine including increased energy, sleeplessness, loss of appetite, a pounding heart, accelerated breathing and anxiety. Elevated norepinephrine has also accompanied excessive energy, sleeplessness and loss of appetite [61]. The dependency and cravings that are associated with both romantic love and rejection are symptoms of addiction, as already mentioned, and both romantic love and addictions are associated with elevated dopamine [1, 49, 118]. Romantic love has been associated with both elevated dopamine and oxytocin, while addictions are more often associated with elevated dopamine [133]. The heartbreak experience may be similar to drug withdrawal, as in withdrawal from dopamine and oxytocin.

Low serotonin levels have also accompanied heartbreak and romantic love [48]. In that comparison between individuals who were in love and those who were not in love, the group in love had lower serotonin levels than the group not in love. Low serotonin may contribute to the ruminations that have been associated with both being in love and being rejected [48].

fMRI Studies Show Activation Of Dopaminergic Pathways

The biochemical findings just reviewed are not surprising given that the parts of the brain that are stimulated by both romantic love and heartbreak also release these chemicals. In an fMRI study, those who were in love were given fMRIs while viewing the photo of their loved one versus a photo of an acquaintance [5]. The photo of the loved one activated the caudate nucleus which was not surprising since the caudate nucleus is also involved in the reward system and the release of dopamine [107]. The caudate nucleus near the center of the brain is generally considered one of the brain's reward systems involved in pleasure, general arousal and motivation for rewards [118]. Other areas of the reward system including the septum are activated by love as well as by chocolate, both of which are thought to be addictive [121].

Other fMRI studies using the same paradigm (viewing a romantic lover) have revealed different findings. For example in an fMRI study, functional connectivity in the reward and emotion regulation network (the dorsal anterior cingulate cortex) was positively associated with length of time in love in the "in-love" group and negatively correlated with the duration since breakup in the "ended-love" group [122]. These inconsistencies highlight the need for additional fMRI studies that use similar experimental paradigms and imaging measures.

Protective Factors

Several protective factors have been discussed in the literature on break-up distress including personality characteristics such as self-esteem [82, 132], attachment style (secure versus anxious attachment) [16, 32], coping style [105], and rejection sensitivity [36, 84]. Other factors such as forgiveness [138], finding a new partner/rebound [123], social support [98], healthy diet [40], heartbreak songs [129], and ball sports and dancing [54] can mediate breakup distress. Finally, interventions, including cognitive behavioral therapy [19], intranasal oxytocin [89] and MDMA (3-4-Methylenedioxymethamphetamine) [52] have been effective. A few examples of these are elaborated here.

Individuals with higher trait self-esteem have shown less distress after imagining a romantic rejection than after ending or imagining themselves ending their relationships [134]. In this study, university students were assessed following the end of their real-life romantic relationships as well as in a laboratory condition in which they were asked to imagine breaking up with their partners. Self-esteem was a mediating factor in another study along with attachment anxiety and covert narcissism [16]. In the first of two studies, emotional responses to a vignette on romantic rejection were assessed including self-reported mood states, anger, somatic symptoms, self-esteem and attachment style. Those with higher scores on attachment anxiety had stronger responses to the romantic rejection scenarios. In their second study (same publication) the same authors reported that higher scores on covert narcissism were also associated with stronger responses to the romantic rejection.

Attachment anxiety has been related to greater preoccupation and perseveration about romantic breakups, greater emotional and physical distress, extreme attempts to reinstate the relationship, and angry and vengeful behavior [32]. In this survey on more than 5,000 internet respondents, attachment anxiety was also related to drug and alcohol use, while those who were securely attached used more social coping strategies such as "using friends and family as 'safe havens' ".

Paradoxically, greater breakup distress in individuals with an anxious attachment style has led to more personal growth [94]. In a structural equations analysis, the greater personal growth appeared to be mediated by "enhanced reflection and brooding…. and a proclivity to rebound". Posttraumatic growth has been frequently reported [24, 88].

In a series of studies, finding a new partner was a key factor in overcoming attachment to an ex-romantic partner by individuals with an anxious attachment style [123]. First, a correlational

study suggested that finding a new romantic partner disrupted the attachment to the ex-partner. Then, experimental manipulations inducing belief in finding a new partner effectively facilitated breakup recovery.

Cognitive behavior therapy has been notably effective in treating romantic breakups [19]. In addition, two drug treatments have been reputedly effective including intranasal oxytocin [89] and MDMA [52]. In the double-blind intranasal oxytocin study. The Yale Interpersonal Stressor, a live social rejection paradigm, was used with undergraduate students [89]. The students who received intranasal oxytocin versus those who received placebo showed a decrease in cortisol levels. In the MDMA study, MDMA versus placebo decreased the effects of simulated social rejection (Cyberball condition) on self-reported mood and self-esteem and decreased the perceived intensity of rejection [52]. MDMA also decreased respiratory sinus arrhythmia, as might be expected given its sympathomimetic properties.

Methodological Limitations

This review is based on separate literatures including research on romantic breakups, rejection, betrayal and the heartbreak syndrome. Much of the breakup literature is focused on romantic breakups and divorce. While these may have the commonalities of feelings of rejection and betrayal, divorce has the difference of having or not having to continue the relationship for family reasons. The heartbreak syndrome literature is mostly based on loss to death, making it difficult to compare to romantic breakups and divorce given the different durations of the relationships and depth/meaningfulness of the relationships. Even within the same type of loss literatures comparisons are difficult because of the different measures used, the different intervals from the time of loss to the time of the assessments and the different ethnic and age groups assessed.

Other problems are the small sample sizes and the limited number of variables measured. Multi-variable studies are needed especially to assess those paradoxical findings such as romantic breakups and romantic love yielding similar results on fMRIs and on biochemical measures. Optimally, self-report, behavioral, physiological and biochemical measures would be taken on the same samples.

Summary

In summary, the distress that occurs following romantic breakups is largely explained by depression, rejection and betrayal. These may lead to heartbreak or the broken heart syndrome and immune dysfunction. Although the broken heart syndrome mimics a real heart attack, it has been differentiated from heart attacks by angiograms revealing unclogged arteries and no permanent heart damage. Reduced vagal activity has been noted to accompany heartbreak, and increased cortisol and catecholamines are thought to lead to the associated immune dysfunction including increased inflammatory cytokines and decreased natural killer cell number. fMRIs reveal increased activity in the cingulate cortex and the right prefrontal ventricular cortex. These data highlight the complexity of breakup distress, rejection, betrayal and heartbreak and the need for multi-variable research.

Recommendations for Future Research

One of the most perplexing questions that needs to be addressed to inform the breakup/heartbreak literature is what aspects of the relationship are then missing when the breakups occur. Relationships have been viewed as regulators of stimulation so as not to be understimulated or overstimulated [42, 67, 117]. This has been called "psychobiological attunement". Physical and emotional intimacy are also critical to relationships [44]. Most of the breakup distress studies are based on retrospective self-reports. Prospective studies are needed to capture the relationship variables that are lost following breakups. For example, the social interactions of university students could be videotaped during the relationship, and heart rate and cortisol levels could be assessed to provide more data on the features of the relationship that get interrupted by breakups, much like Gottman and Levenson (2002) [60] have done with married couples. These data might provide important information for designing interventions to alleviate the pain associated with the breakups that are so prevalent, especially among university students.

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