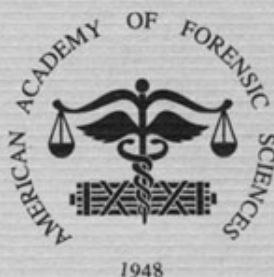


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J. Reid Meloy,¹ Ph.D. and Helen Fisher, Ph.D.²

Some Thoughts on the Neurobiology of Stalking*

ABSTRACT: The authors examine the crime of stalking, including the cognitive traits, emotional reactions, attachment pathology, violence patterns and sex differences of samples of stalking offenders. They focus on two common types of stalkers: 1) those who sustain pursuit of a former sexual intimate who has rejected them; and 2) those who pursue a stranger or acquaintance who has failed to return the stalker's romantic overtures. The authors discuss data from neuroimaging (fMRI) studies of romantic love which suggest that these forms of stalking may be associated with heightened activity of subcortical dopaminergic pathways of the "Reward System" of the brain, perhaps in combination with low activity of central serotonin. The authors propose that this set of neural correlates may contribute to the stalker's focused attention, increased energy, following behaviors, obsessive thinking about and impulsivity directed toward the victim. To further explore the neural systems associated with stalking behavior, they also discuss several biopsychological phenomena associated with romantic rejection, including the "protest response," "frustration attraction," "abandonment rage" and "mate guarding." They illustrate the parallels between stalking and addiction. They conclude that stalking may be associated with a specific set of biological components and they offer suggestions for further research into this pathological emotional/motivational state.

KEYWORDS: forensic science, stalking, dopamine, romantic love, obsession, addiction, attachment pathology

Without brain there is no mind, and without biology there are no human psychological phenomena. Despite these truisms, the biological correlates of those who stalk, a behavior typically defined as a pattern of unwanted pursuit that threatens the safety of the victim (1), have not been investigated.

Stalking is recognized as a crime in North America, some European countries, Australia, and New Zealand. Yet studies of this psychobiological phenomenon have been limited to delineating various psychological and social behaviors of numerous samples of offenders and their victims' reactions (1-4). Spitzberg (5) recently conducted the first meta-analysis of stalking, analyzing the results of 103 studies which represented more than 70,000 subjects, both victims and perpetrators. His aggregate findings lend important insights on stalking. Nevertheless, none of these studies have proposed a theory of the biological substrates that contribute to stalking.

Investigation of the biological correlates of stalking behavior is difficult. Until the recent advent of neuroimaging, investigators have had major practical obstacles to measuring the physiological correlates of any social behavior. Moreover, researchers risk reductionism: attributing the cause of all behavior to biology, thereby missing contributing psychological and social motivators. One also risks making empirical measurements without the guidance of theory to both formulate hypotheses and explain findings.

With these cautions in mind, we would like to explore the neurobiology of two related and predominant types of stalking: 1) sustained pursuit of an individual by someone who has been rejected by his sexual intimate; and 2) sustained pursuit of an individual by someone who is infatuated with a stranger or acquaintance who fails

to return the stalker's romantic overtures. These two related types of stalking cases represent the majority of individuals who stalk (5). Our supposition is that these stalkers express a deviant pattern of heterosexual pair formation associated with several biological and cultural variables, including a specific brain system for romantic attraction (7) and specific patterns of abnormal attachment.

Stalking and Obsessional Following

Meloy and Gothard (6) used the term "obsessional following" to describe, for research purposes, the more colloquial and sensational term "stalking." They defined obsessional following as an abnormal or long-term pattern of threat or harassment directed toward a specific individual that is perceived by that individual as harassing.

Despite controversy over the definition of stalking for both legal and research purposes (2), the crime of stalking usually contains three elements: a pattern of unwanted following or harassment; a credible threat; and the induction of fear in the victim. A pattern of stalking must typically also involve at least two discrete behavioral events. Moreover, without victim awareness, no crime of stalking is committed. This eliminates the inappropriate application of the word "stalking" to describe violent crimes in which some form of surveillance of the victim precedes the attack, such as rape or robbery. Unwanted pursuit and sustained fear in the victim are the *sine qua non* of stalking.

Behaviors

Unwanted following is the most common legally-prohibited act in stalking laws throughout the United States (8). Despite the absence of knowledge concerning whether or not stalking is on the increase, it is a major criminal and social problem. Eight to fifteen percent of women and 2-4% of men will be stalked sometime during their lifetime in the United States, Great Britain, and Australia—countries where epidemiological research has been conducted (2). The vast majority of stalkers are men and the vast majority of stalking victims are women (1). Meta-analysis indicates that 77% of

¹ Department of Psychiatry, Univ. of California, San Diego, PO Box 90699, San Diego, CA 92169.

² Department of Anthropology, Rutgers University, 4 East 70th Street, New York, NY 10021.

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stalking cases involve prior acquaintances and 49% began with a romantic relationship (5).

Stalking behavior regularly includes several tactics (5): 1) Hyperintimacy—excessive interest or acceleration in developing closeness or intimacy that induces fear or anxiety in the victim; 2) proximity/surveillance—watching or following the victim; 3) invasion—violations of legitimate privacy of the victim; 4) proxy pursuit—using third parties to pursue the victim; 5) intimidation and harassment—threatening or psychologically manipulating the victim; 6) coercion and constraint—forceful efforts to restrict the behavior of the victim, including kidnapping; and 7) aggression—violence toward self, the victim, third parties, or property.

Attachments

We believe that stalking is, in part, associated with pathology in the human biobehavioral attachment system. Attachment is a biologically-rooted, species-specific behavioral system which, when activated, serves to maintain close proximity between a child and its caretaker. First identified by the psychoanalyst John Bowlby during World War II (9), attachment has received an enormous amount of research attention (10). Adult analogs of both normal and abnormal attachment have been proposed and researched (11).

Studies suggest that stalking may stem from a pathological or insecure form of attachment during childhood. This was first proposed by Meloy (12,13) and has received empirical support (14–22). The nature of the attachment pathology suggests a pattern of preoccupation in which the stalker harbors a negative perception of self and a positive perception of others. Attachment behaviors and internal regulation of arousal may have been conditioned by inconsistent parenting in childhood, or the loss of a primary parental object (14). The adult stalker blames himself for a lack of love and is very dependent in his/her attempts to gain others' approval and acceptance.

Dutton (23) has shown empirically that this attachment pathology, when combined with shaming and violent victimization as a child, contributes to the formation of a borderline personality in the adult male. Such personality organization can stimulate "intimacy anger" during a relationship, a proneness to experience "rejection anxiety," and "abandonment rage" when loss of a partner is imminent. In fact, domestic violence and psychological dominance and isolation of the mate have been shown to be closely allied with, and in some cases predictive of stalking (15,24).

Violence

The frequency of violence committed by stalkers toward their victims is disturbingly high, typically ranging between 25% and 40% (25). Meta-analysis indicates that the average incidence of physical violence to the victim is 33% (5). To put this figure in context, stalking violence slightly exceeds the 31% general violence base rate over the course of one year in a large sample of discharged psychiatric patients with substance abuse problems (26).

The frequency of violence among stalkers, moreover, dramatically increases if the stalkers of prior sexual intimates are examined separately from the aggregate samples of all stalkers. Five independent research groups on three continents have recently documented violence during stalking by prior sexual intimates in 55–89% of the cases (27–31). The importance of this significant increase in stalking violence among prior sexual intimates should not be underestimated: it suggests that sexual intimacy intensifies attraction, attachment and emotional reactivity when this bond is threatened. Consequently, violence is to be expected among stalkers who have had a prior history of sexual intimacy with their victims.

The nature of the violence in such cases—what Meloy (1) labels "affective" violence—is characterized by heightened arousal, anger and/or fear, and the presence of an imminent threat of rejection; it is also unplanned (32). The assaults are usually done without a weapon and do not result in serious physical injury. The victim is choked, grabbed, shook, hit, slapped, kicked, or punched (13, 33,34). Risk of homicide in stalking cases is estimated to be 0.25% (25), although recent data also suggest that stalking is an important predictor of spousal homicide (35).

Conscious and Unconscious Thought

Stalkers are preoccupied with thoughts of their object of pursuit. If an obsession is functionally defined as "the frequency of preoccupation with an object (1, p. 14)," substantial data indicate that obsessional thinking is the most common cognitive trait of the stalker (36–37). However, one could take issue with the use of obsession in this manner (38), since such persistent thoughts are traditionally defined as unwanted and nonvolitional in American psychiatry (39). Our broader, functional use of the term, however, does not eliminate the possibility that various obsessive-compulsive diagnoses may be present in certain stalking cases. What is most anecdotally apparent is that many stalkers are prolific in their written narratives concerning the victim, inferring an inordinate amount of time consciously thinking about her.

The content of the stalker's conscious thoughts varies from case to case, but thinking is generally characterized by paradox and contradiction. Examples include the juxtaposition of statements that both idealize and devalue the victim; the wish for complete freedom for the victim alongside demands for complete control; or statements of rage intermingled with yearnings for love and affection.

The preoccupations and contradictions which characterize the stalker's thinking may be unconsciously rooted in the narcissistic fantasies which he conjured during his initial contact with the victim. These fantasies of a special and unique relationship with this specific idealized individual (1) are normal in the initial stages of romance or infatuation (40). Yet in the case of the stalker, they are met with rejection when acted upon—and they usher in feelings of intense humiliation that the stalker expresses with rage toward the victim.

In normal men and women, such romantic rejection regularly triggers feelings of grief, anger, and sadness, and usually results in the search for a new love object. But in those individuals where pathological narcissism is an issue, as it is in stalkers, the intensity of the fury is a measure of the degree of ego-deflation—and the pursuit begins.

Emotions and Defenses

Accumulated forensic, clinical and social research strongly suggests that the two most prominent emotions of most stalkers are anger and jealousy (22,28,37,41–2). Such feelings are often consciously felt and acknowledged by the stalker. Nevertheless, these feelings often serve to defend the stalker against more vulnerable feelings that are outside of the stalker's awareness. Anger can mask feelings of shame and humiliation, the result of rejection by the once idealized object, and/or feelings of loneliness, isolation, and social incompetency.

Anger may also fuel the pursuit, motivated by envy to damage or destroy that which cannot be possessed (43), or triggered by a desire to inflict pain on the one who has inflicted pain, the primitive impulse of *lex talionis*, an eye for an eye. For example, one 22-year-old stalker telephoned his victim, "I mean some guys like fucking

anorexic whores that look like they're fucking starving in Ethiopia. But fuck you, I am going to kill you and make you look fucking ugly as hell, and no one will ever want to touch your disgusting ass" (JRM case files).

Angry pursuit can also repair narcissistic wounds through a fantasized sense of omnipotence and control of the victim. Victim surveys, in fact, have noted that the most common victim perception of the stalker's motivations is to achieve control of her (24).

Jealousy is a complex emotion, and is defined interpersonally by competition for the affection of the love object. It intrapsychically suggests developmental Oedipal issues. There must be three people in a jealous triangle, whether fantasized or actual. From an evolutionary perspective, jealousy may be an adaptive emotion system designed to protect against threats to reproductive success (44). However, pathological or morbid jealousy may be the norm among those who stalk; in fact, it may reach delusional proportions wherein the competitive threat is a fixed and false belief (41). Jealousy may even motivate behavior to dominate and isolate the victim prior to the onset of stalking. Pathological jealousy independently predicted stalking behavior in one study (15).

The psychological defenses that are used to manage such unpleasant feelings include minimization ("I just wanted a date"); denial ("I'm not stalking her"); projection of blame ("She deserves it"); and projective identification ("She's stalking me.") (37). Defenses serve to protect the stalker's inflated narcissism, but at a price. He remains vulnerable to sudden deflation when confronted by his behavior, which paradoxically can escalate rage. And he inhabits a world populated by his own persecutory objects, which he sees outside of himself. His feelings of persecution may be confirmed by third parties (such as a husband, attorney, or the police) whom he perceives as interfering with his approaches as well as an imminent threat (45).

In one celebrity stalking case, the delusional stalker was furious at the two sequential celebrity boyfriends who had, in turn, rejected his love object. He also fervently believed that the members of her private security staff were threats to her and that he needed to travel to Los Angeles to protect her (JRM case files). This man was subsequently prosecuted for stalking and found not guilty by reason of insanity.

Gender Differences

Although most stalkers are male, 15–20% are females (46). Purcell, Pathé and Mullen (47) found in a comparative study of male and female stalkers in Australia that there were more similarities than differences between the sexes. There were some significant differences, however.

The female stalkers were less likely to have a history of violent criminality (12.5% vs. 31.3%) or substance abuse (7.5% vs. 28%). They were less likely to stalk a stranger, but more likely to pursue a professional contact, motivated by "a desire to establish a close and loving intimacy with the victim" (p. 2058). Women were also more likely to pursue a victim of the same gender. Female stalkers were significantly less likely to follow their victims, however; instead they chose to telephone. Threat and assault rates showed no significant differences between men and women, but women were less likely to threaten and then assault. One out of five female stalkers attacked their object of pursuit.

Meloy and Boyd (46) conducted a large study of female stalkers from the United States, Canada and Australia with the help of numerous research collaborators. Although they did not directly compare their sample of 82 female stalkers to male stalkers, their archival study confirmed many of the findings of Purcell

et al. (47). The women were generally in their thirties, single, educated, and intelligent. A minority (27%) were prior sexual intimates of their victims. The most common, clinically documented emotion they exhibited was anger, specifically abandonment rage. Such intensity of feeling toward the male victim was most likely based upon transference emotion and perception (perhaps to a psychotic degree), because at least half of these female stalkers expressing abandonment rage had experienced no prior intimate relationship with their victim. Two thirds of the sample also expressed obsessional thinking. Moreover, feelings of jealousy and betrayal were apparent in one third of the female stalkers. A history of failed sexual pair bonding marked both the male and female stalkers.

In this study, Meloy and Boyd found a significant, although moderate relationship between prior sexual intimacy and violence. The more intimate the relationship had been, the greater the risk of physical violence. One out of four female stalkers physically attacked their object of pursuit, a finding similar to that of Purcell et al. (22.5%)(47).

The most common personality disorder found among these female stalkers was borderline, which is consistent with both abandonment fears and a "preoccupied" attachment pathology found in the domestic violence and stalking research on men (48). Thirty-eight percent of the women had a significant personal loss during the year before the onset of stalking, an event which could exacerbate their suggestive underlying insecure attachment style.

The most striking finding, consistent with Purcell et al. (47), was that most women were not pursuing a prior sexual intimate. This is a significant departure from the data on male stalkers, and suggests that female stalkers are motivated to *establish* intimacy with their victims, whereas male stalkers are attempting to *maintain* intimacy with their victims. Pathological narcissism appears to be less frequent in female stalkers, who may be more intent on forming a relationship to assuage feelings of loneliness, dependency, and anger, than on restoring a special, idealized relationship.

The victims of female stalkers are often married men who are acquaintances. Female stalkers generally choose victims who are, on average, older than themselves, while male stalkers generally prey on women who are somewhat younger than themselves. There is symmetry to these gender data: in most cultures, men pursue younger women for sexual/romantic pair formation, while most women prefer to form a sexual/romantic bond with somewhat older men (49).

Lust, Attraction, and Attachment

Stalking behavior may be associated with any one or any combination of three primary brain systems that evolved for mating and reproduction: the sex drive, attraction, and male/female attachment (7,50).

The *sex drive* (the libido, or lust) is the motivation to achieve sexual gratification; in both sexes it is associated primarily with testosterone and specific brain systems (51–53). *Attraction* (known in its developed form in humans as romantic love, obsessive love, or being in love) is the preference for and motivation to pursue a *specific* mating partner; romantic attraction is associated primarily with subcortical dopaminergic pathways in the reward system of the brain (7,54,55). *Male/female attachment* (known in humans as companionate love) refers to the formation of a pair bond, the maintenance of proximity, co-parenting duties, and in humans feelings of calm, security and union with a long-term partner. Attachment behaviors have been associated with elevated activities of vasopressin and oxytocin in several mammalian species (56–59).

Fisher (7,50) has proposed that each of these three primary and distinct brain systems—the sex drive, attraction and attachment—evolved in birds and mammals to solve a different aspect of courtship, mating, reproduction and parenting. The sex drive evolved to motivate individuals to copulate with a *range* of appropriate partners; attraction evolved to motivate individuals to focus their courtship energy on *specific* individuals, thereby conserving mating time and energy; and male/female attachment evolved to motivate individuals to cooperate at least long enough to complete species-specific parenting duties. Moreover, the mammalian brain system for attraction or mate preference has further developed in *Homo sapiens* to produce our contemporary human experience of romantic love (60).

Stalkers may suffer from pathological responses associated with any combination of these three primary brain systems, depending on the stalker's idiosyncratic biological make up, his/her childhood experiences, and the circumstances that lead to the stalking behavior; many other brain systems are undoubtedly also involved. Nevertheless, recent data on the brain system associated with attraction (i.e. romantic love) suggests that this particular brain system may be involved in most stalking cases.

Neurobiology of the Stalker

Two functional Magnetic Resonance Imaging (fMRI) studies have measured brain activity among normal, happily "in love" women and men; both suggest some of the biological substrate of the spurned or unrequited stalker.

The protocol of these studies varied. In Study A (54), ten women and seven men alternately viewed a photograph of their beloved and a photograph of a familiar, emotionally-neutral individual, interspersed with a distraction task. In Study B (61), eleven women and six men alternately viewed a photo of their beloved and photographs of three friends of similar age, sex and duration of friendship as their partners.

These variations in experimental design did not appear to produce significant variations in the results. But another variation in these two experiments did affect the results: In Study A, participants were "in love" for a range of 1–17 months, with a mean duration of 7 months, while participants in Study B were "in love" a range of 10–46 months, with a mean duration of 28.8 months or 2.3 years. Both studies asked participants to fill out several questionnaires prior to entering the fMRI machine, including the Passionate Love Scale (62). When these questionnaire responses were compared, it was evident that those in Study A showed a higher degree of romantic passion than did those in Study B. These data suggested that Study A was quantifying *early-stage intense* romantic love while Study B was quantifying *later-stage* romantic love.

The results of Study A showed group activation specific to the beloved in the right ventral tegmental area (VTA), highly localized in the A10 dopamine cell region, and in the right postero-dorsal body and dorsal tail of the caudate nucleus (54,55). Study B also showed activity in parts of the VTA and caudate nucleus (61).

The VTA produces and distributes dopamine to several brain areas; the caudate nucleus houses 80% of the brain's dopamine receptor sites; and both brain regions play major roles in the dopaminergic "reward system" of the mammalian brain (63–67). Elevated activity of dopamine in this reward/motivation system produces focused attention and unwavering motivation and goal-directed behaviors. Elevated activities of central dopamine are also associated with many of the other feelings that lovers report, including exhilaration, increased energy, hyperactivity, sleeplessness, and sometimes

mania, anxiety and/or fear (63). And in animal studies, elevated activity of dopamine in this reward system has been associated with a *preference* for a particular mating partner (68,69), as it is in humans.

These data suggest that subcortical dopamine pathways in the brain's reward system are associated with early-stage intense romantic love. Hence it is parsimonious to conclude that this dopaminergic circuit is also part of the neural underpinnings of the spurned or unrequited stalker.

The dopaminergic reward system becomes active in association with a range of other arousing phenomena, however, including the motivation to win a monetary reward (67,70,71) and the craving for cocaine (67). In fact, it has been hypothesized that every human motivation is comprised of two simultaneously activated brain systems: a *generalized* arousal system that produces the energy and motivation to acquire the biological need; and a *specific* constellation of brain systems that produce the feelings, thoughts and behaviors associated with each particular biological need (72).

Activation of subcortical dopaminergic pathways of the VTA and caudate nucleus may comprise only the general arousal component of early-stage intense romantic love, experienced by both normal individuals and stalkers. Nevertheless, activation of these subcortical dopaminergic pathways most likely contributes to several traits of the spurned or unrequited stalker, including his/her heightened energy, focused attention and intense motivation to pursue his victim.

All individuals in study A also showed activation in regions of the cortex, although individuals varied. And several of these regions are also part of the brain's reward system, including the orbitofrontal and medial prefrontal cortex (64,66). It may become established that some of these cortical pathways (as well as specific regions of the caudate nucleus) are part of the constellation of neural systems *specific* to romantic love.

Specific deactivation patterns may also be among the constellation of brain responses associated with early stage intense romantic love and stalking. Study A showed several deactivations specific to viewing the photograph of the beloved. Among these were deactivation of the right amygdala, a brain region involved in fear (73) and other strong negative emotions. Study B (61) reported deactivation in the amygdala as well. These researchers suggest that romantic love decreases fear responses (74). This neural deactivation response associated with feelings of romantic love may contribute to the stalker's inability to heed the dangers involved in his pursuit.

Men and women who fall in love also display another psychophysiological trait that they most likely share with stalkers. Lovers think obsessively about the beloved; they cannot get these intrusive thoughts out of their minds (7,50,62,75). This obsessional thinking is most likely due to the *suppressed* activity of central serotonin (7,50), because *low* activity of serotonin in the brain is regularly associated with Obsessive-Compulsive Disorder (76,77).

A recent study supports this supposition. In this experiment 20 men and women who had fallen in love in the previous six months, 20 who suffered from unmedicated obsessive-compulsive disorder (OCD), and 20 normal (control) individuals who were not in love were tested for plasma levels of serotonin (78). Both the in-love participants and those suffering from OCD had significantly lower levels of serotonin than did the controls. Low activity of central serotonin is also associated with impulsivity, another characteristic of both lovers and stalkers.

These data suggest that the stalker's intrusive thinking about and obsessional following of the victim may be associated with an array of neural mechanisms, including elevated activities of central

dopamine in the reward system of the brain, and low activity of central serotonin in corresponding neural pathways.

In fact, it is probable that the spurned or unrequited stalker suffers from a negative feedback loop between the brain's dopamine and serotonin systems. Suppressed activity of central serotonin often acts to elevate the activity of central dopamine, and elevated activity of central dopamine often acts to suppress the activity of central serotonin (79,80). So as the stalker progressively feels more energy, more focused attention and more motivation to pursue the victim, rising levels of central dopamine may be suppressing the activities of serotonin and producing more obsessive thinking and dysphoria. As the stalker's obsessive thinking intensifies, declining activity of central serotonin may be elevating the activity of central dopamine, producing even greater energy, focused attention and motivation to pursue the victim.

The above theory has caveats. Different activities, quantities and ratios of dopamine and serotonin at the synapse can produce different effects. These substances do different things in different brain regions. Each monoamine interacts with many other chemical systems in different ways under different biological and cultural circumstances, setting up complex feedback loops and chain reactions. Moreover, the urge to stalk a rejecting partner undoubtedly takes a variety of graded forms. Many other brain systems are most likely involved in stalking, including those associated with guilt, fear, anger, impulse control and other complex emotions and motivations.

Nevertheless, data indicate that romantic love engages a constellation of dynamic brain systems associated with reward, motivation, emotion and cognition, including those associated with elevated activity of central dopamine and lowered activity of central serotonin. We suggest that these neurotransmitters are also part of the neurobiology that underlies stalking behavior, contributing to the stalker's energy, impulsivity, dysphoria, fearlessness and obsession. Data on the stages of rejection response also support our hypothesis that dopaminergic pathways in the brain are involved in stalking.

The Stages of Rejection: Stage One—Protest

In normal men and women, rejection by a beloved sets in motion a two-phase rejection response (50,81–2). During the Protest Phase, the deserted lover obsessively tries to win back the beloved. As resignation/despair sets in, the lover gives up entirely and slips into despair. It is the first phase of this rejection response that most likely contributes to the obsessive thinking, energy, focused attention, and motivation of the spurned or unrequited stalker—because the protest phase has been associated with elevated activity of central dopamine in the reward system of the brain (82).

Lewis, Amini and Lannon (82) assert that the Protest Phase is a basic mammalian mechanism that becomes active when *any* kind of social attachment is ruptured. For example, when a puppy is removed from its mother and put into the kitchen by itself, it begins to pace, frantically leaping at the walls, barking and whining in protest. Isolated baby rats emit ceaseless ultrasonic cries; they hardly sleep because their brain arousal is so intense (81). These researchers propose that this Protest Phase is associated with elevated activities of dopamine, as well as with the closely related neurotransmitter, norepinephrine. They also hypothesize that the elevation of these catecholamines is an adaptive mechanism that elevates alertness and stimulate abandoned baby mammals to search, call for help, and be rescued.

But Lewis and his colleagues do not propose how these catecholamines become activated. Fisher (50) has hypothesized that the escalation of activity in these subcortical dopamine pathways

is most likely associated with stress. When mammals first experience severe stress, among the bodily reactions is an increase in the activities of central dopamine and norepinephrine and a suppression of central serotonin (83). Hence it is likely that the stress of romantic rejection elevates the activity of central dopamine and norepinephrine in the rejected lover, thereby intensifying the Protest Phase.

In the case of stalkers, rejection most likely also increases stress and elevates the activities of dopamine and norepinephrine. But in these individuals, these internal reactions escalate their drive to pursue.

Frustration Attraction

Continual rejection by the victim can potentially increase the motivation to pursue the victim even more—by triggering another brain system associated with rejection, "Frustration-Attraction" (50).

When normal, well-adjusted lovers encounter barriers to their romantic feelings, they tend to love even more intensely; adversity heightens romantic passion (50). This frustration-attraction has a biological basis. When a reward is delayed in coming, neurons of the brain's reward system sustain their activation (64)—potentially increasing the activity of central dopamine. Frustration-attraction may sustain, even increase, the stalker's motivation to stalk.

Abandonment Rage

During the Protest Phase of rejection, both men and women can also exhibit abandonment rage (1). Even when a rejecting individual departs with compassion and honors her responsibilities as a friend or co-parent, or when someone who is loved from afar declines the lover's amorous advances graciously, many rejected people oscillate between feelings of heartbreak and utter fury. The neural system associated with this abandonment rage (50) most likely also plays a role in the behavior of stalkers.

Although the primary circuits for rage run through regions of the amygdala to the hypothalamus, and on to areas of the periaqueductal gray and several other brain regions, the brain system for rage is well integrated with centers in the prefrontal cortex that process reward assessment and expectations (81). And when a human or other mammal begins to realize that an expected reward is in jeopardy, even unattainable, these regions of the prefrontal cortex often stimulate the amygdala and trigger rage (81). Known as "frustration-aggression," this rage response to unfulfilled expectations is well known in mammals. When a cat's brain circuits for reward are artificially stimulated, for example, it feels pleasure. When this pleasurable stimulation is withdrawn, however, it bites.

Romantic love and rage have much in common. Both are associated with bodily and mental arousal; both produce obsessive thinking, focused attention, motivation and goal-directed behaviors; and both cause intense yearning—either for union with or revenge against a beloved (50). Over time, moreover, rage may take on a more complex, enduring, and object-related dimension, transformed into the emotion of hate. Gabbard (103:48) wrote, "to hate is to hold on to an internal object in an unforgiving way," implying a necessary object relationship to which one is bound.

Love and hatred can act in tandem. In a study of 124 dating couples, Ellis and Malamuth (84) reported that romantic love and "anger/upset" react to different kinds of information. The lover's level of anger/upset oscillates in response to events that *undermine* the lover's goals, such as a mate's infidelity or lack of emotional commitment. The lover's feelings of romantic love fluctuate, instead, in response to events that *advance* the lover's goals, such

as a partner's visible social support during communal engagements with relatives and friends. So romantic love and anger/upset, though linked, can operate concurrently.

This brain architecture most likely enables the stalker to threaten and attack someone whom they deeply love. Anecdotal evidence supports this psychobiological model since stalkers will be most dangerous—and sometimes commit homicide—in a setting where they have approached the victim driven by affectional yearning, and are rejected by her (13). The emotional-behavioral sequence is usually love, then humiliation, then rage, then violence.

Stage Two—Resignation and Despair

Eventually, however, the well-adjusted but disappointed lover ceases his pursuit. This second phase of romantic rejection is known as Resignation/Despair. During this phase of rejection, the abandoned or unrequited lover often slips into a deep melancholy known as the "despair response" (50,81,82) often indistinguishable from depression. In a study of 114 men and women who had been rejected by a partner within the past eight weeks, over 40% experienced "clinically measurable depression" (85). People can also die of a broken heart, either from myocardial infarctions or cerebral vascular accidents caused by their depression (86,87).

This feeling of despair has been associated with several different brain networks, including the dopaminergic reward system. As a depressed mammal comes to believe a reward will never come, the dopamine-making cells in the midbrain *decrease* their activity (64). Diminishing activity of central dopamine produces lethargy, despondency and depression (81).

Stress contributes to this despair response. Short-term stress activates the production of dopamine and norepinephrine. But as stress continues, it suppresses the activity of these catecholamines and associated brain systems down below normal—producing clinical depression (81,83).

Men and women in this second phase of rejection are less likely to stalk a rejecting or deserting mate; they do not have the energy, focus or motivation; they are too engulfed by grief and/or depression. One manipulative adaptation of this state of mind, however, is to threaten suicide if the victim will not reconcile or reciprocate.

The Adaptive Underpinnings of Stalking

It is curious that the stalker is willing to expend the time and metabolic energy to relentlessly pursue an uninterested, even hostile victim. Yet even normal people who have been rejected expend what appears to be an unreasonable amount of time and energy responding to their loss, most likely for logical Darwinian reasons.

Rejected men and women have often wasted precious courtship time and energy, even money. Their reproductive future has been jeopardized, along with their social alliances, personal happiness, self-esteem and reputation. And lovers who are unable to win a partner whom they have adored from afar have been denied possible social and reproductive opportunities. Romantic rejection has social, psychological and genetic consequences.

As a result, *Homo sapiens* has evolved a constellation of powerful neural systems designed to enable men and women to doggedly pursue specific mating partners and protest desertion (50). For example, the "Protest Phase" and "frustration-attraction" most likely evolved to motivate the lover to entice a rejecting object to begin or resume a relationship. Abandonment rage may have evolved to escalate estrangement so the disappointed lover could begin the process of looking for a more willing mating partner; or to frighten the rejecting object into courtship submission. And the "Resignation/

Despair Phase" may have evolved to enable the rejected lover to send clear, honest signals to relatives and friends that he/she needs social support in a time of intense psychological pain (50); or to rest, withdraw, and "lick his wounds," a common English metaphor that can be directly observed in other mammals.

These brain mechanisms still enable rejected men and women to either win a beloved back or depart from a time-consuming, reproductively unsuccessful match. But the spurned or unrequited stalker, for reasons likely stemming from his idiosyncratic development and biology, is unable to handle these brain responses appropriately. Instead he persists in pursuing an unwilling partner, and may become violent as well.

Jealousy, or Mate Guarding

Stalking and violence toward a stalked victim are regularly associated with jealousy (22,28,37,41–2). The biological underpinnings of jealousy are unknown. But romantic jealousy is common in societies around the world (44). Moreover, possessiveness of a mating partner is so common in other mammalian and avian species that scientists call it "mate guarding." So there are likely to be a constellation of neural mechanisms associated with this phenomenon.

Data from animals and humans suggest some of the systems that may be involved in jealousy. Among male prairie voles, mate guarding is associated with the elevated activity of central vasopressin (88) that may play a role. A recent neuroimaging study examining the neural correlates of social exclusion indicates that the right ventral prefrontal cortex and the anterior cingulate cortex are associated with social rejection (89). Perhaps these regions are involved. We suspect that many brain systems contribute to human jealousy and play a role in the neurobiology of stalking.

Stalkers as Addicts

An addiction model may also shed light on the neurobiology of stalking. This is hypothesized because normal men and women who are in love show all of the basic symptoms of addiction, including tolerance, dependency/craving, withdrawal and relapse (50).

As the tolerance builds, the lover (and the stalker) must interact with the beloved (or the victim) more and more frequently. They crave contact with the beloved. If the beloved breaks off the relationship, the lover (and the stalker) shows the common signs of drug withdrawal, including depression, crying spells, lethargy, anxiety, insomnia or hypersomnia, loss of appetite or binge eating, irritability and chronic loneliness. Like most addicts, rejected lovers may also go to degrading, even physically dangerous extremes to procure the beloved. Lovers (and stalkers) also relapse the way drug addicts do. Long after the romantic relationship is over, events, people, places, even songs associated with the beloved can trigger the lover's (and stalker's) craving and initiate obsessive thinking and/or compulsive calling or writing to achieve contact with the beloved.

Because romantic love is regularly associated with intensely focused attention, euphoria, craving, obsession, compulsion, distortion of reality, emotional and physical dependence, personality changes and loss of self-control, psychologists regularly regard romantic love as an addiction (50,75,90–98). The spurned or unrequited stalker simply goes to far greater lengths to procure his/her drug, the victim.

This emotional and physical dependence is most likely associated with the elevated activity of subcortical dopaminergic pathways in the brain's reward system—because all drugs of abuse are associated with emotional and physical dependence and all

drugs of abuse elevate the activity of dopamine in the reward system, either directly or indirectly (99,100). In fact, in Study B, Bartels and Zeki (61) compared the brain scans of their love-stricken subjects with those of men and women who had injected cocaine or opioids (Study B); many of the same brain regions became active, including the caudate nucleus.

Summary Findings and Hypotheses

The drive to love is unquestionably associated with a mixture of brain systems acting in parallel, combinatorial and synergistic ways. The above data suggest that a general arousal mechanism is part of the constellation of brain systems associated with *early stage, intense* romantic love. Specific to this general arousal mechanism are elevated activities of central dopamine. It is parsimonious to suggest that this general arousal mechanism is also active in the stalker and that the subcortical dopaminergic reward system contributes to the stalker's tendency to express heightened energy, focused attention, intense motivation to pursue the victim, frustration-attraction, protest, and rage. All are characteristics found in the clinical stalking research (1-2).

Because elevated activity of dopaminergic systems tends to suppress activity of serotonergic systems, and low activity of central serotonin is associated with obsessive thinking, compulsive behaviors, and dysphoria, it is likely that the stalker exhibits low levels of central serotonin in conjunction with elevated activity of central dopamine. Normal men and women express these neurobiological responses in prosocial ways, while the stalker is unable or unwilling to respond appropriately while in this psychophysiological state.

In summary, we would like to advance five hypotheses concerning the neurobiology of the stalker:

First, stalkers may have a different magnitude or ratio between activities of central dopamine and serotonin than normals, producing in the stalker more energy, dysphoria, vigilance and tenacity in his pursuit of his love object than normals.

Second, research on the attachment patterns among stalkers suggests that their bonding is insecure (12-22), inferring that their attachment biochemistry varies from that of normal individuals with secure attachments. Supporting this hypothesis, attachment pathology often provokes both abandonment rage and violence (16), both of which are commonly seen in stalkers—especially those who have been spurned by a spouse or lover. Research investigating circulating levels of oxytocin and vasopressin in female and male stalkers respectively (compared with normals) could establish this possible link.

Third, the affective nature of stalking violence—characterized by an immediate emotional reaction, high levels of autonomic arousal, perceived rejection, and pushing, kicking, biting, hitting, hair pulling, slapping, and shoving of the victim—suggests that the stalker has at times a gross lack of impulse control. Impulsivity has been strongly associated with depleted levels of circulating serotonin; moreover affective violence has been treated with selective serotonin reuptake inhibitors (101). Spurned stalkers and unrequited stalkers may both have a positive psychopharmacological response to SSRIs or other serotonin-enhancing medications, enabling appropriate affectivity, suppressing their impulsivity, and reducing their violence. Comparative research using groups of stalkers and controls in which impulsivity and circulating levels of serotonin are measured has yet to be done.

Fourth, although the biochemical research concerning obsessive-compulsive disorders is burgeoning (102), little attention has been paid to the pharmacological link between obsessive-compulsion and stalking behavior, despite forensic and clinical research which suggests a strong relationship between these phenomena (1). Stalking, under some circumstances, may be a manifestation of a compulsion.

Fifth, although stalking is typically not highly sexualized (1-2), it is certainly aggressive, suggesting that testosterone may play a role in stalking behavior. The relationship between testosterone and aggression is complex. For example, base levels of testosterone are inherited; but a change in one's position in a social dominance hierarchy alters a man's testosterone levels. Despite the complexity of this system, stalkers have a high frequency of violence. Moreover, dominating behavior during a relationship is a predictor of stalking after the relationship (15). These correlations suggest that research into the role of testosterone in stalking behavior would be appropriate.

Meloy (1,36-37) has suggested that most stalking behavior results from a confluence of five psychosocial factors: social incompetency, isolation and loneliness, obsessional cognitions, pathological narcissism, and aggression. At a psychosocial level of analysis, the neurobiology of the stalker seems far removed. Nevertheless, we have attempted to link certain aspects of stalking behavior to various structures and functions of the central nervous system. Social incompetency suggests continuous failure to *attract* members of the opposite sex as potential mates; isolation and loneliness suggests a failure to form an attachment, or stable pair bond; obsessional cognitions suggest a psychobiological preoccupation that enables the stalker to ignore social and legal constraints; pathological narcissism suggests a sense of grandiosity and entitlement that diminishes any empathy for the victim; and the stalker's focused attention, motivation and aggression suggest that some biochemical drivers contribute to the stalker's need to pursue the victim despite constant sanction from others.

Neurobehavioral mechanisms likely underlie each of these social and psychological factors, but research is necessary to demonstrate the empirical links between the neurobiological elements of stalking and stalking psychology.

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Additional information and reprint requests:
 J. Reid Meloy, Ph.D.
 PO Box 90699
 San Diego, CA 92169
 E-mail: jrmeloy@san.rr.com