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The Relationship Between Heart Rate Reactivity, Emotionally Aggressive Behavior, and General Violence in Batterers

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This study examined the relationships among physiological responses during marital conflict, aggressive behavior, and violence in battering couples. As an index of physiological response, the authors used the male batterer's heart rate reactivity, assessed as the change from an eyes-closed baseline to the first 5 min of their marital conflict interaction. During marital interaction, violent husbands who lowered their heart rates below baseline levels were more verbally aggressive toward their wives. Wives responded to these men with anger, sadness, and defensiveness. The husbands were classified as *Type 1* batterers. When compared to the remaining violent husbands (classified as *Type 2* batterers), Type 1 men were also more violent toward others (friends, strangers, coworkers, and bosses), had more elevated scales reflecting antisocial behavior and sadistic aggression, and were lower on dependency than Type 2 men. The 2-year followup revealed a separation–divorce rate of 0 for marriages involving Type 1 men and a divorce rate of 27.5% for marriages involving Type 2 men.

The domestic assault of women in the United States has become a problem of widespread proportions. For example, each year at least 1.6 million wives in the United States are severely assaulted by their husbands (Straus & Gelles, 1986), and about 13% of all murders are husbands killing their wives (Ohrenstein, 1977). A recent study reported premarital prevalence rates of physical violence among 625 newlywed couples of 36% (McLaughlin, Leonard, & Senchak, 1992).

A number of writers have suggested that scientific progress in understanding the domestic assault of women would be aided by basic research on classifying batterers (e.g., Holtzworth-Munroe & Stuart, 1994). There have been a number of attempts at creating typologies of men who batter their wives (Ceasar, 1988; Elbow, 1977; Gondolf, 1988; Hamberger & Hastings, 1986; Saunders, 1987; Shields & Hanneke, 1983; Snyder & Fruchtman, 1981). These typologies have been based on interviews, personality variables and other self-reports, and police records. Recently, Holtzworth-Munroe and Stuart (1994) reviewed these studies and suggested that there are three types of batterers: family only, dysphoric–borderline, and generally violent–antisocial batterers. Most agree that there is a subgroup of batterers who are also violent outside the marriage (Dutton, 1988; Gondolf, 1988; LaTaillade, Waltz, Jacobson & Gottman, 1992;

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Widom, 1989). There is also consensus that there is another group of wife abusers who are not generally violent outside the marriage. In this article, we examine one potential physiological basis for distinguishing these two subtypes: heart rate reactivity.

The *Diagnostic and Statistical Manual of the Mental Disorders (DSM–III–R*; American Psychiatric Association, 1987) lists a variety of disorders that share symptoms with descriptions of wife assaulters. Among the possible symptoms that have been suggested as characteristic of wife assaulters is an intense acceleration of autonomic activity (under the diagnosis of intermittent explosive disorder; see Dutton, 1988, p. 12). Unfortunately, there is no empirical evidence to support this symptom of accelerated autonomic activity among abusive men (Browning, 1983; Dutton, 1988). Previous studies of violent marriages have not examined the physiology of batterers. Margolin, John, and Gleberman (1988) found that physically aggressive husbands report more internal arousal during arguments with their wives than do other men. However, self-reports of physiological activity may not correspond to actual arousal (e.g., Katkin, 1985; Katkin, Blascovich, & Goldband, 1981).

There is good reason to examine physiological variables in the study of battering. There is a venerable literature suggesting that there is a physiological basis to criminality; specifically, the literature suggests that criminality is associated with low levels of physiological reactivity. The hypothesis offered in this literature is that hypophysiologic reactivity is related to sensation seeking (e.g., Schalling, Edman, and Asberg, 1983). According to the hypothesis, the state of low reactivity is aversive; therefore, increased stimulation is sought and this may lead to risk seeking and criminality. For example, Raine, Venables, and Williams (1990) conducted a prospective study using cortical and autonomic measures of persons at age 15 to predict criminality at age 24. They reported that criminals had lower resting heart rate, lower skin conductance activity, and more slower frequency electroencephalographic (EEG) activity than noncriminals. Furthermore, these differences were not mediated by social, demographic, or academic factors. This important prospective study was the first to combine EEG and autonomic measures. However, Raine et al.'s study is simply one example of a substantial literature with well-replicated findings (e.g., see Magnusson, 1985; Moffit & Mednick, 1988).

There is another venerable and sizable literature linking high heart rate reactivity to Type-A personality, to risk for coronary heart disease, and, more recently, to hostility both as a trait and in the observation of actual marital behavior (Brown and Smith, 1992; Smith and Brown, 1991). This literature on hostility may be relevant because domestically violent men have been described in the clinical literature as more hostile, more abusive psychologically, and more provocative and aggressive toward their wives than other men (e.g., see Dutton, 1988). The study of this linkage between high heart rate reactivity and hostility is still the subject of considerable study and some controversy (for a recent review, see Siegman & Smith, 1994).

Because previous research has relied on couples where violence was relatively low level and bilateral (e.g., Margolin et al., 1988), we wondered what one would find with a more severe, clinical population. Hence, we recruited a severely violent sample that was closer to the classic situation of a male batterer and a battered woman. Until now, the only information we have had about emotional experiences of violent partners during arguments is based on self-reports. As an attempt to study these affective processes more objectively, we collected psychophysiological measures of autonomic nervous system arousal during direct observations of marital conflict discussions.

It is known that domestically violent men are more affectively negative in interactions with their partners than are other men (Margolin, Burman, & John, 1989; Margolin et al., 1988). Anger management, designed to control negative affect before it results in violence, is a widely used treatment strategy for batterers (e.g., see Margolin, 1979; Taylor, 1984). Anger control is actually a generic term that includes training in impulse control as well as attention to subjective states of anger. However, because there is controversy in the marital literature about whether anger actually functions as a negative emotion in marriage (Gottman, 1994; Gottman & Krokoff, 1989), we recently questioned whether anger in marital interaction is actually the defining characteristic of violent men as compared to nonviolent men. To test this idea, we explored the expression of negativity in more detail, using an observational coding system—the Specific Affect Coding System (SPAFF; Gottman, in press)—that breaks down negative affect into more specific codes such as anger, contempt, belligerence, sadness, and fear. In this system anger is carefully discriminated from codes that might refer to a "hostility" dimension. Using this observational coding system, Jacobson, Gottman, Waltz, Rushe, & Babcock (1994) reported that violent couples could be discriminated from distressed but nonviolent couples by the higher levels of both husband and wife contempt and belligerence in violent couples. There were no significant differences between groups in husband or wife anger. Contempt, particularly in its more intense forms, can be considered a form of psychological abuse, and belligerence is a highly provocative form of anger expression. We called the sum of these two codes *emotional aggression*.

Within the violent group of couples in our study, we decided to search for a subgroup of male batterers who calm down physiologically while remaining emotionally aggressive toward their wives in a marital conflict resolution discussion in our laboratory. This search was inspired by research literature suggesting that there is a physiological basis to criminality in low levels of physiological reactivity. In our search we used one variable, heart rate reactivity, because literature links heart rate reactivity to Type-A personality, to risk for coronary heart disease, and, more recently, to hostility both as a trait and in the observation of actual marital behavior.

In our exploration we divided our male batterers into two groups, those who lowered their heart rate (classified as *Type 1* batterers) during the marital interaction (compared to a baseline) and those who increased their heart rates (classified as *Type 2* batterers). In addition to examining whether there were any differences between these two types of men in their marital interaction, we concluded, as did Holtworth-Munroe and Stuart (1994), that it would be useful to examine the following: levels of general violence outside the marriage, abuse in the families of origin, and the degree of psychopathology.

Abusive relationships have often been characterized as remarkably stable, without much empirical evidence. In fact, the question of why abused women remain in these relationships has often been asked. Clinical hypotheses such as a cycle of abuse and courtship have been offered as an explanation for the durability of abusive relationships (Walker, 1984). Because of our interest in empirically studying the longitudinal course of abusive marriages, we also examined the status of the marriages 2 years later.

Method

Overview

A detailed description of the methods of this study is provided in Jacobson et al. (1994), so this section will be abbreviated.

Participants

We recruited 61 married couples who engaged in husband–to–wife domestic violence (DV). All couples were recruited through a combination of public service announcements, media advertising, and random digit telephone dialing. Participants responded to radio, newspaper, or posted ads stating, "Married couples, earn up to $200 in research study. Seeking couples experiencing conflict in their marriage." People who called were briefed on the procedures of the study over the phone. They were told that the purpose of the study was "to better understand marriage relationships. Ultimately this knowledge helps us to improve our relationship therapy programs. All participants must be able to speak and write English easily, be 18 years of age or older, be legally married, and both spouses must be willing to participate." If individuals met these criteria, wives were administered our telephone version of the Locke and Wallace (1959) Marital Adjustment Test and the Conflict Tactics Scale (CTS; Straus, 1979). They were not told explicitly that we were studying domestic violence. However, many questions about the frequency of marital violence were asked. The CTS was used to determine whether couples engaged in husband–to–wife violence. The CTS is the most widely used measure of marital violence; it assesses partner and self-aggression during the past year. The scale has shown high reliability and consistent internal factor structure (Caulfield & Riggs, 1992) as well as reasonable relationships with other related psychological constructs such as jealousy problems in the relationship (Riggs, 1993) and the amount of physical injury sustained (Cantos, Neidig, & O'Leary, 1994; Dutton & Starzomski, 1993). The CTS was found to be as useful as an interview in revealing the presence of physical aggression toward wives, particularly when compared to a written self-report (O'Leary, Vivian & Malone, in press). Significant interpartner agreement on reports of physical aggression have also been demonstrated using the CTS (Jouriles &

O'Leary, 1985). There is widespread agreement in the field about what constitutes less and more severe aggression on the CTS (e.g., see McLaughlin, Leonard, & Senchak, 1992). On the basis of the wife's CTS report, we classified husbands as violent if they exhibited any of the following behaviors within the past year: (a) pushed, grabbed, shoved, slapped, hit, or tried to hit his wife six or more times; (b) kicked, bit, or hit her with a fist at least twice; or (c) beaten her up, threatened her with a knife or gun, or used a knife or gun on her at least once.[1]

The observed grand mean and standard deviation on the Dyadic Adjustment Scale (Locke & Wallace, 1959; Spanier, 1976) was 92.3 (17.1) for husbands and 83.6 (21.0) for wives; these means were significantly different, $t(58) = 3.12$, $p < .001$. The CTS scores indicate a moderate to severe level of violence in the DV group. According to DV wives, during the past year 34% had been beaten up; 66% had been kicked, bitten, or hit; 24% of the husbands had been arrested on a domestic violence charge; and 83% of the wives had been injured by their husbands' actions, with 21% injured seriously enough to seek medical attention.

Overview of Procedures

Couples made two visits to the laboratory. During their first visit, they completed a series of questionnaires and a structured interview. The structured interview was designed to assess a variety of factors related to violence (e.g., general violence and parental violence during childhood), and it also generated husband and wife descriptions of violent and nonviolent arguments. During the individual interview participants were asked, "Have you sustained any injuries due to your spouse's aggression? What injuries? Has your spouse? What injuries? Has your spouse ever been arrested on a domestic violence charge? Have you?" Later, they were called by telephone twice over the next 2 weeks to obtain reports of the worst argument that had occurred during the previous week. Couples returned to the laboratory again for a communication assessment where they were videotaped while discussing areas of conflict in their relationship. After the participants had filled out a problem inventory in which they each rated the perceived severity of each area of continuing disagreement in their marriage (e.g., in-laws, sex, money, communication), the interviewer identified the two areas rated most highly problematic by both spouses. The couple was then interviewed to help them make the problem areas more specific (e.g., the area of "communication" might become "disagreeing about how to behave at a party"). Couples then talked for 15 min in the laboratory about these two problem areas of continuing disagreement in their marriages (e.g., money, in-laws, and sex). The interactions were videotaped and several psychophysiological measures were taken during baselines and during the marital interaction.

Ethical Obligations

Our debriefing procedures were developed with the help of Ann Ganley and Peter Fehrenbach, respected clinicians specializing in domestic violence. Participants were told that they did not have to answer any question they felt uncomfortable answering. They were given the opportunity to delete any portions of the videotape they did not want recorded. All DV women were given referrals for shelters as well as individual and legal counseling after each session. After the communication exercise, the participants were interviewed to assess dangerousness and, if necessary, to develop a safety plan. All interviewers were trained on our safety protocol that includes assessing the lethality of men who batter. Following the marital interaction, participants were given an adjective checklist to assess their emotional states. If DV husbands endorsed any negative emotion other than "feeling somewhat negative," they were interviewed on their likelihood of becoming violent. The campus police were informed as to the nature of our study and guaranteed their assistance within 2 min should it become necessary. All participants were given a written debriefing statement stating that verbal and physical aggression is destructive to intimate relationships and that we do not condone domestic violence in any way. We called the wives in our study 2 weeks after their participation and asked if any violence may have been precipitated by involvement in our study. In no cases did the police need to intervene. Many DV women showed interest in the referrals offered. One woman indicated that a violent argument may have been related to involvement in the study.

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[1] We used wife reports to classify husbands as DV for the following reasons: first, we were primarily interested in husband–to–wife violence; second, we expected many of the husbands to deny that they were violent, given previous findings; third, we reasoned that if we only chose couples where husbands acknowledged that they were violent, we would end up with a very unrepresentative sample. As it turned out, husbands' CTS scores of their own behavior were within the moderate to severe range on domestic violence, and 54 of 57 husbands in the DV condition admitted to at least some violence toward their wives. Moreover, when we divided the DV sample in half and compared husbands in the upper 50% of self-endorsement for violence with those in the lower 50%, the groups were virtually identical in their relationship to criterion variables.

Physiological Measures

Careful consideration was given to the measurement of physiological variables. The problem was to arrive at a compromise between two opposing considerations: the desire to constrain and encumber participants as little as possible and the desire to obtain as comprehensive a physiological assessment as possible. The merits of the first consideration are obvious. There is widespread agreement among psychophysiologists that no single autonomic or central nervous system measure adequately summarizes the physiological state of the organism. In fact, the thrust of much recent research in psychophysiology has been toward establishing the specificity of response capabilities within the autonomic nervous system in general and the patterning related to different emotions in particular. To be sensitive to these kinds of patterns, it is necessary to obtain a representative sampling from the major functional branches of the nervous system. Thus, it would have been imprudent to use a single measure such as heart rate to characterize a broad construct such as "physiological arousal." These considerations led us to select six physiological dependent measures that we obtained from three kinds of recording devices placed on the surface of the participant's skin and from a fourth device attached to the participant's chair.

1. Cardiac interbeat interval (IBI). This measure was determined by measuring the time interval between successive spikes (R-waves) of the electrocardiogram (ECG). It is essentially equivalent to a measure of heart rate (heart rate = 60,000/IBI in ms) but has certain distributional advantages for parametric analysis. The ECG was detected using two Beckman miniature electrodes attached, in most cases, to the sides of the participant's chest. The electrodes were filled with a conductive paste and attached to the skin using small adhesive collars. The IBI was monitored on a beat-by-beat basis by a digital computer at a resolution of 1 ms and averaged over 1-s periods.

2. Pulse transmission time to the finger (PTT-F). This is a measure of the elapsed time between the R-wave of the ECG and the arrival of the pulse wave at the finger (upstroke). IBI electrodes were used to detect the R-wave, and a photoplethysmograph (Grass PTTL) attached to the middle finger of the nondominant hand was used to detect the pulse wave. The photoplethysmograph is a small device that shines a cool reddish light through the finger and detects the light reaching the other side with a photosensitive resistor. The volume of light passing through the finger is modulated by the volume of blood in the finger during each heart beat. The computer monitored both the R-wave and the finger pulse wave, and it timed the interval between them on each heart beat at a resolution of 1 ms, averaging PTT over 1-s intervals. PTT is sensitive to more kinds of physiological functions than is IBI. It is affected by changes in the contractile force of the heart and changes in the mean arterial blood pressure. Newlin (1981) found a median correlation of 0.86 within-subject correlations between pulse transit time to the ear and the pre-ejection period (PEP, which is the time from the onset of the Q-wave to the opening of the aortic valve), and he found a correlation of 0.97 on trial means across participants. PEP is the systolic time interval that is highly responsive to beta-adrenergic influences (Newlin and Levenson, 1979). Pulse transit time is related to blood pressure, though it should not be considered a substitute because it also is affected by arterial constriction. The pulse wave velocity has been shown to be related to blood pressure in some studies, although this relationship is not consistently found (e.g., see Gribbin, Steptoe, and Sleight, 1976; Obrist, Light, McCubbin, Hutcheson, & Hoffer, 1979), and, unlike blood pressure, it can be measured continuously. Pulse transmission time is an excellent sympathetic nervous system (SNS) activation measure because the SNS affects both processes that affect PTT, myocardial contractility (mostly the beta branch of the SNS; how hard the heart contracts), and arterial distensibility (alpha and beta branch of the SNS; how open or closed the arteries are).

3. Finger pulse amplitude (FPA). This is an estimate of the relative volume of blood reaching the finger on each heart beat. The computer measured the valley-to-peak amplitude on the FPA signal after each heart beat, averaging FPA over 1-s intervals. FPA was a useful measure for our purposes because it provided some indication of changes in peripheral blood flow. The SNS is capable of changing the distribution of central versus peripheral blood flow by constricting or dilating the peripheral blood vessels. From an evolutionary point of view, this may have been useful during fighting when the blood was needed in the main organs and large muscles and when reduced peripheral blood flow might decrease blood loss from injuries. The inclusion of the FPA measure advanced the goal of the comprehensiveness of physiological measurement, as it is more sensitive to changes in alpha-sympathetic stimulation, whereas PTT is more sensitive to beta-sympathetic influences.

4. Skin conductance level (SCL). This measure was obtained by passing a small voltage between Beckman electrodes attached to the middle phalanges of the first and third fingers of the nondominant hand. The electrodes were filled with a paste made of potassium chloride in Unibase, a compound that is very stable over periods of prolonged recording. The computer monitored the SCL signal and computed its level at a resolution of 1 μmho, averaging the signal over 1-s periods. SCL is one of a number of useful measures of electrodermal activity. It is sensitive to changes in levels of sweat in the eccrine sweat glands located in the palms of the hand. These sweat levels are thought to change in response to emotional

(as opposed to temperature) stimuli. Minute changes in these levels, far below appearance of sweat on the skin surface, can be detected. Measures of sweat gland activity are unique and useful insofar as the sweat glands are one of the few organs that are innervated only by the sympathetic nervous system, not jointly with the parasympathetic nervous system. In addition, they are the only organs served by the sympathetic nervous system that are not strongly affected by circulating adrenaline, as they do not have an adrenaline or noradrenaline-based stimulation chemistry. At a practical level this simply means that measures that are based on sweat gland activity have the potential for relatively independent action.

5. General somatic activity level (ACT). This was our simplest and least obtrusive measure as well as our only measure of muscular activity. The participant's chair was mounted on a platform that was coupled to a rigid base in such a way as to allow an imperceptible amount of "flexing." When the platform flexed, it moved a ring magnet slightly in relationship to a coil attached to the rigid base, thus inducing a small current. This current was amplified and integrated by the polygraph and averaged by the computer over 1-s intervals. We have found this system to be sensitive to movements in all planes and completely unobtrusive. Obrist's research (see Obrist, 1981, for a summary) suggests that it is critical to a valid interpretation of heart rate deceleration and acceleration. These physiological measures were obtained using a 10-channel Coulbourn polygraph for amplification and filtering. The outputs from the polygraph channels were connected to analog input channels of an LSI 11/23 microcomputer that was programmed to monitor and average the dependent measures and to synchronize the video and physiological recordings.

At the end of each session, the data were printed out, and a copy was stored on a diskette for subsequent analysis. After participants had adapted to the laboratory environment and were relaxed (usually after 30 min), electrodes were attached and the peripheral physiological measures were taken during an eyes-closed and relax baseline, for an additional eyes-open baseline of 2 min before the marital discussion, and throughout the couples' complete marital conflict discussion. Immediately following the communication assessment, all participants privately and independently viewed the videotape and provided a continuous rating of their subjective affect using a rating dial. Detailed interviews about positive and negative moments, selected by their rating dial reports, were also conducted. The data discussed in this article include the laboratory observations of marital interaction and physiology, the structured interview on general violence and parental violence during childhood, and the CTS questionnaire.

Nonphysiological

Two remotely controlled, high resolution videocameras were used to obtain frontal views of each spouse's face. These images were combined into a single split-screen image using a video special effects generator and were recorded on a VHS videocassette recorder. Two lavaliere microphones were used to record the spouses' conversations. Synchronized, parallel clocks in the computers were used for collecting physiological data and SPAFF observations; the time was recorded on each frame of the videotape, enabling us to synchronize physiological data with the video.

Baseline and Reactivity Measures

After the electrodes were attached and the quality of the signal was verified, participants were asked to relax with their eyes closed for 2 min so that a baseline set of physiological measures could be obtained. The mean male heart rate during the eyes-closed and relax baseline was 77.05 beats/min (*SD* = 12.83). Because the mean adult male heart rate is 76 beats/min, this baseline generally was not an arousing condition that created high levels of heart rate. On the other hand, the marital conflict was generally arousing for the males: The mean heart rate during the first third of the interaction was 80.76 beats/min (*SD* = 12.60). These mean increases of only a few beats a minute are not uncommon in the literature on the effects of laboratory stresses on heart rate (e.g., see Coles, Donchin, & Porges, 1986); however, heart rate responses ranged from an increase of 23.05 beats/min to a drop of 20.85 beats/min. There is clearly a great deal of variability in changes in heart rate that is not reflected by the means. To obtain an estimate of the men's initial responses to the marital conflict discussions, cardiovascular reactivity was computed as the difference between the mean heart rate of the first third of the marital discussion and the mean heart rate of the eyes-closed baseline. This definition was consistent with other literature on heart rate reactivity (e.g., see Matthews et al., 1986). Although all of the marital interaction behavior were coded, we linked the first third of the marital interaction behavior with physiology during the same period so that we could coordinate behavior with physiology during this period of initial response. All of our results remain unchanged if we take the heart rate mean and marital interaction behavior for the entire marital interaction instead of the first 5 min.

Two-Year Follow-Up

Two years later, couples were contacted, their marital status was determined, and a smaller set of measures was readministered. Data on marital status were obtained for over 90% of the original sample. We were able to recruit about half of the couples who were still married to return to the laboratory for another marital conflict discussion.

Additional Measures

Psychopathology with the Millon Clinical Multiaxial Inventory (MCMI–II; Millon, 1987). Husbands and wives were independently administered the MCMI–II to assess personality styles and clinical syndromes. The MCMI–II is a 175-item, true–false, self-report inventory intended to be used with clinical populations. This widely used instrument has 22 clinical scales that parallel the *DSM–III–R* (American Psychiatric Association, 1987) plus three response set scales. The Axis I (clinical syndrome) scales include anxiety, somatoform, bipolar–manic, dysthymic disorders, and alcohol and drug dependence. The Axis II personality disorder scales include schizoid, avoidant, dependent, histrionic, narcissistic, antisocial, aggressive–sadistic, compulsive, passive-aggressive, self-defeating, schizotypal, borderline, and paranoid personality disorders. We were particularly interested in the following scales in our study: antisocial, aggressive–sadistic, and drug and alcohol dependence. Briefly, the predominant items of the antisocial scale relate to a need to be self-confident and not to depend on others, a resentment of authority and a dislike for being controlled, as well as impulsivity, mistrust, lack of empathy, and a tendency to shy away from emotional involvement and to use people for one's own purposes (Choca, Shanley, & Van Denburg, 1992). The aggressive–sadistic scale may be considered a more pathological variant of antisocial personality, measuring a tendency to be aggressive or hostile in interpersonal interactions and to blame others when something goes wrong. Subclinical scores may indicate suspiciousness, mistrustfulness, low self-esteem, rigidity of thought process, or a desire to hurt oneself or others. For symptoms and characteristics associated with each scale, the reader is referred to the DSM–III–R (American Psychiatric Association, 1987), the MCMI–II manual (Millon, 1987), or the *Interpretative Guide to the Millon Clinical Multiaxial Inventory* (Choca, Stanley, & Van Denburg, 1992, p. 21).

The completed test forms were computer scored by National Computer Systems (NCS) in Minneapolis. Participants' base rate (BR) standard scores for each scale obtained from NCS were entered into the analyses. For the chi-square analyses, a BR score of 75 or more was used as evidence for a diagnosable level of the characteristic or disorder defined by the scale. Test–retest reliability of the Axis II scales range from .77 to .85. In cross-validation studies comparing clinical diagnoses with MCMI–II scales, the MCMI–II scales correctly identified 64% to 80% of those diagnosed with its respective DSM–III–R Axis II disorder (Millon, 1987, p. 173).

Coding of observational data. The SPAFF was used to code affects in the laboratory interactions (Gottman, in press). The SPAFF is a cultural informant coding system in which coders consider an informational gestalt consisting of verbal content, voice tone, content, facial expression, gestures, and body movement. Using a computer-assisted video coding station and a computer program that gives automated timing information (with a vertical interval time code signal), observers coded the onsets of each of a set of listener and speaker affects. Three coders classified the behaviors of speaker and listener as affectively neutral, as one of 6 positive affects (humor, affection, validation, interest–curiosity, joy–enthusiasm, and affection–humor blend), or as one of 11 negative affects (anger, disgust, contempt, domineering, belligerence, anger–defensiveness blend, whining, sadness, tension, defensiveness, and listening with stonewalling).[2] Twenty-five percent of the data were recoded as a reliability check. Coders coded husbands' and wives' affects separately (the records were later merged), coding both listener and speaker behaviors continuously and entering any change in behavior as a new code while the computer noted the time. An *episode* was defined as all the time between one behavior code and another. For all variables, we counted the number of separate episodes, independent of duration. Thus, our data reflect the number of separate episodes of each variable.

Because we needed to reduce the amount of data we analyzed, and because the management of negativity is presumed to be most central in violence, only the negative affect SPAFF codes of anger (belligerence, contempt, sadness, whining, and defensiveness) were considered in this analysis. These codes can be thought of as falling into three axes: (a) an anger axis (anger, belligerence, and contempt); (b) a sadness axis (sadness and whining); and (c) defensiveness, which we have found to be related to fear and perceived attack (examples are denying responsibility for a problem, meeting a partner's complaint with a complaint of one's own, and any self-protective remark or comment that appears to ward off a per-

[2] We have discovered that our fear–tension code has not turned out to be an adequate operationalization of fear of one's partner in the context of high-conflict marital interaction. Happily married couples tend to be consistently higher across studies in this code than unhappily married couples, perhaps reflecting more tension with the experimental configuration rather than fear of the partner. For this reason, our defensiveness code (tapping self-protection as if a person is warding off a perceived attack) seems to be a better operational definition of fear in our particular context.

ceived attack; Gottman, in press). Within the anger axis, the specific codes differed not only in intensity, but also in how provocative they were. Belligerence and contempt are the most provocative codes. A belligerent act deliberately challenges and provokes (e.g., "What are you gonna do about my drinking, huh? Go on, I dare you to do something about it"), whereas a contemptuous act is insulting or demeaning. These categories closely correspond to most conceptions of emotional or psychological abuse.

The SPAFF was used to code affect during both speaking and listening. The two groups did not differ in the amount of speaking versus listening; for husband listening, $F(1, 58) = .003$, *ns* (Type 1 $M = 27.83$, Type 2 $M = 28.02$). In this study, there were few significant differences in heart rate reactivity as a function of listening and speaking. This is not surprising because listening behavior was generally highly affective, and the correlations between listening and speaking with a particular affect were quite high.[3] Thus, for the current study, the SPAFF codes were combined into four dimensions: (a) *anger*, which represents speaking plus listening with anger; (b) *emotional aggression*, which is the sum of speaking and listening with contempt and belligerence, both of which can be considered extremely provocative forms of anger expression (we abbreviate this code as *aggression* in the remainder of this article, although clearly we recognize that it is not the same as physical aggression); (c) *sadness*, which is the sum of speaking and listening with sadness and whining; and (d) *defensiveness*, which represents speaking with defensiveness. In observational research, a stringent method of interobserver reliability analysis has been the computation of the generalizability coefficient (Bakeman & Gottman, 1986). We computed this generalizability coefficient Cronbach's alpha, which measures something like the amount of variation due to participants compared to the amount of variation due to observers, using the intraclass correlation formula recommended by Wiggins (1973, p. 290). The coefficient is 1.0 if the variation due to coders is zero and the variation due to participants is not zero.[4] The average Cronbach's alpha for the four dimensions of husband affect was .56 (range = .43 to .64); the average Cronbach's alpha for the four dimensions of wife affect was .56 (range = .34 to .83). We examined only the couple's initial behavior in the marital interaction by restricting ourselves to behavior that occurred during the first 5 min of the interaction. We expected that anger would not differentiate couples on the basis of heart rate reactivity but that emotional aggression and defensiveness would.

Due to the relatively low reliabilities obtained from this coding, we also completely recoded the observational data with a reduced version of the SPAFF system using a piece of equipment called the Affect Wheel. In this version of the SPAFF, we ignored

[3] We repeated our multivariate analyses of variance (MANOVA), analyzing separately for speaker and listener codes. All these were main effects only, suggesting that some codes were more likely to be coded when the participant was a speaker than a listener, or conversely. Hence, there are no differences between types of men in the amount of listening versus speaking for any code. This point is important because heart rate may be affected, to some extent, by speaking versus listening. However, when we tested this hypothesis, it was not true for the following: neutral affect, $t(35) = .31$, *ns*; anger, $t(35) = .08$, *ns*; contempt, $t(26) = .91$, *ns*; and defensiveness, $t(51) = 1.72$, *ns*. It was true for sadness, though, $t(29) = 2.38$, $p < .05$, with a mean IBI of 748.40 for speaking with sadness and a mean IBI of 763.53 for listening with sadness (faster heart rate when speaking sadly than when listening sadly). It was also true for belligerence, $t(40) = 2.24$, $p < .05$, with a mean IBI of 764.26 for speaking with belligerence and a mean IBI of 774.68 for listening with belligerence (faster heart rate when speaking with belligerence than when listening with belligerence). The following codes were more likely for speakers than listeners: aggression, belligerence, contempt, and defensiveness. For husband aggression, there was a significant main effect of the listener–speaker factor: $F(1, 58) = 4.50$, $p < .05$; listener $M = 4.55$, speaker $M = 5.29$. For wife aggression, there was also a significant main effect of the listener–speaker factor: $F(1, 58) = 13.65$, $p < .001$; listener $M = 4.29$, speaker $M = 6.06$. For husband contempt, there was a significant main effect of the listener–speaker factor: $F(1, 58) = 4.83$, $p < .05$; listener $M = .94$, speaker $M = 1.47$. For wife belligerence, there was a significant main effect of the listener–speaker factor: $F(1, 58) = 20.86$, $p < .001$; listener $M = 2.91$, speaker $M = 4.40$. For husband defensiveness, there was a significant listener–speaker main effect: $F(1, 58) = 8.91$, $p < .01$; listener $M = 5.62$, speaker $M = 8.33$. For wife sadness, there was also a significant listener–speaker main effect: $F(1, 58) = 51.81$, $p < .001$; listener $M = 3.44$, speaker $M = 6.32$. The pattern was reversed for sadness: listeners were more likely to be coded sad than speakers. For husband sadness, there was a significant listener–speaker main effect: $F(1, 58) = 20.12$, $p < .001$; listener $M = 2.02$, speaker $M = .92$. For wife sadness, there was also a significant listener–speaker main effect: $F(1, 58) = 19.18$, $p < .001$; listener $M = 3.68$, speaker $M = 2.26$.

[4] In a repeated measures analysis of variance (ANOVA) design of participants (couples) by coders (with two coders, coder and reliability checker), the Wiggins formula is as follows:

$$\alpha = [MS(\text{couples}) - MS(\text{residual})]/$$

$$[MS(\text{couples}) + MS(\text{residual})].$$

listener affect, and this time we checked 100% of the data with an independent coder. In this observational system we computed the duration of each code in seconds, instead of the number of episodes. This recoding demonstrated much higher levels of reliability, with Cohen's kappas averaging 0.89. Generalizability coefficients for individual codes were over 0.80 and averaged 0.87. We then reanalyzed the recoded SPAFF data, computing the duration of each coding category.

CTS questionnaire (Straus, 1979). Physical violence and psychological abuse subscales were composed from the CTS. The physical violence subscale was Items K through R that range from "threw something at the other one" to "used knife or gun." The psychological abuse subscale was derived from Items D (insulted or swore at the other one) through J (threw, smashed, hit, or kicked something). The CTS–Form N items K through R were weighed by frequency and summed into a violence scale score (Straus, 1979). Analyses focused on husband–wife abuse and were based on wives' report of husbands' behavior on the CTS.[5]

Interview on General and Parental Violence During Childhood

Interview on general violence. This portion of the interview was designed to assess for violence that had occurred outside of the current marital relationship. Descriptions of incidents of general assault were limited to those occurring after age 18. Participants were asked if they had ever been violent with family members, friends, coworkers or bosses, acquaintances, strangers, or police officers.

Interview of parental violence during childhood. Information on family violence history was recorded by an undergraduate assistant from videotaped and written records of participant's responses to individual interview questions. Parental violence, which included both violence from father toward mother and violence from mother toward father, was coded as present or absent.

Experimental Design

Couples were divided by the change in the husband's heart rate from the mean of the eyes-closed baseline to the first third of the marital interaction. Men who reduced their heart rates were classified as the Type 1 group (n = 12), whereas men who increased their heart rates were classified Type 2 (n = 49). One couple was dropped from the analysis due to physiological equipment problems, so the total N = 60. There were no men whose heart rates did not change.

Results

There were no significant differences on any demographic variable between the two types of violent men: husband age, $t(58) = 1.01$; wife age, $t(58) = 0.56$; husband income, $t(58) = 0.52$; wife income, $t(58) = 0.41$; marital adjustment scores, husband, $t(58) = 1.27$, wife, $t(58) = -0.86$; years married, $t(58) = 0.23$; and number of children, $t(58) = 0.79$.

The distribution of heart rate reactivity had a mean of 3.69 beats/min, with a standard deviation of 4.23 beats/min. Using the Kolmogorov–Smirnov test, the distribution was not different

[5] In the larger study on which this report is based, four groups of couples were recruited. There was a DNV sample of nonviolent but distressed couples (matched with the DV sample group in marital satisfaction), a sample of happily married couples, and a sample of couples exhibiting low-level violence (i.e., some violence in their history but not enough to be classified as DV). We included this last group for purposes of longitudinal follow-up to study the development or the reduction in violence over time. To what extent should our sample be thought of as unilateral (i.e., only exhibiting husband to wife violence), and to what extent was the violence bilateral? According to the wives themselves, almost half (28 out of 57) would have qualified for our DV group if wife violence had been the criteria, and almost all (52 out of 57) admitted to at least low-level violence. Thus, despite selecting for husband–to–wife violence, in the vast majority of DV couples, the wife also admitted to engaging in at least some violence herself. We also used wives to classify couples as maritally distressed. This was largely a matter of expediency because wives were interviewed to determine whether the DV classification was warranted. It was relatively easy to classify them in terms of marital distress in the same interview. Moreover, we set the cutoff for marital distress low enough (90 or less) on the Marital Adjustment Test (MAT; Locke & Wallace, 1959) MAT to ensure that most husbands would score in the distressed range. As it turned out, although the husband Dyadic Adjustment Scale (DAS; Spanier, 1976) means were somewhat higher than their wives, they still fell well within the distressed range. Thus, even though we relied on the wives for classification purposes, we ended up with a valid sample of maritally distressed but nonviolent participants. This is not surprising, given the high correlations between husband and wife DAS scores typically reported in the literature on marital relationships.

from a normal distribution, with $D = 0.04$ (critical D at $\alpha = .05$ was .18). For Type 1 men, the mean heart rate change was -1.94 ($SD = 1.41$), and for Type 2 men the mean heart rate change was 5.09 ($SD = 3.44$).

Our initial analyses focused on whether the heart rate reactivity variable was related to (a) dimensions of affect in the conflictual marital interaction, particularly anger, emotional aggression, sadness, and defensiveness; (b) divorce–separation data on 2-year follow-up; (c) dimensions of violence (particularly marital violence), general violence toward others outside of the marriage, and reported parental violence during the childhoods of the husbands; and (d) dimensions of psychopathology. Finally, we examined whether the husbands' heart reactivity variables were related to other husband measures. In this latter analysis we explored the hypothesis that the physiological basis for the Type 1 men's heart rate reactivity was a heightened baseline vagal tone and an inability to downregulate vagal tone (S. W. Porges, personal communication, October 15, 1994).

Dimensions of Marital Affect

A multivariate repeated measures analysis of variance (MANOVA) was conducted for the two heart rate reactivity groups: Type 1 or Type 2 group, times four affects (anger, emotional aggression, sadness, and defensiveness),[6] times two spouses (husband and wife). The repeated-measure was on affect and spouse. The multivariate main effect for affect was significant, $F(3, 174) = 17.06$, $p = .000$, and the multivariate Group $\times$ Affect interaction was significant, $F(3, 174) = 2.76$, $p = .044$. The Affect $\times$ Spouse interaction was marginally significant, $F(3, 174) = 2.14$ $p = .097$, and the Group $\times$ Spouse $\times$ Affect interaction was significant, $F(3, 174) = 4.21$, $p = .007$. Because the triple interaction was significant, and this qualifies all the double interactions, the significant triple interaction was then followed up by univariate analyses of variance (ANOVAs) for each affect and for each spouse separately. Means for affect as a function of heart rate reactivity group can be found in Table 1.

Marital emotional aggression. There was a significant main effect for husband emotional aggression by heart rate reactivity group, $F(1, 55) = 9.73$, $p = .003$. As depicted in Table 1, the husbands' emotional aggression differentiated couples by the husbands' heart rate reactivity group. Type 1 husbands, when compared to Type 2 husbands, showed significantly more emotional aggression. No significant effects for heart rate reactivity group were found for wife emotional aggression.

Marital anger. As we stressed in the introduction, there are many levels of anger, some of which include provocativeness (i.e., belligerence) and emotional abuse (i.e., contempt), and others of which do not (i.e., direct expressions of anger). So far, we have explored whether our physiological marker differentiated men in terms of the provocative and abusive anger codes, which we called *emotional aggression*, but not necessarily in direct expressions of anger, which could be functional in a marital discussion (e.g., see Gottman & Krokoff, 1989). Husband anger did not differentiate couples on the basis of heart rate reactivity, but wife anger did differentiate the groups, $F(1, 58) = 4.34$, $p = .040$). Wives interacting with Type 1 husbands (who decreased their heart rates) showed significantly less anger than wives of Type 2 husbands (who increased their heart rates).

Marital defensiveness. As shown in Table 1, wives' defensiveness marginally differentiated couples by husbands' heart rate reactivity group. There was a marginally significant main effect for physiological group, $F(1, 55) = 3.12$, $p = .083$. Wives interacting with Type 1 husbands (who decreased their heart rates) were marginally more defensive toward him during the marital interaction than wives interacting with Type 2 husbands (who increased their heart rates). No significant effects for heart rate reactivity group were found for husband defensiveness.

Marital sadness. For wife sadness, there was a significant main effect for physiological group, $F(1, 55) = 4.28$, $p = .043$. As Table 1 illustrates, wives' sadness was found to differentiate couples by husbands' heart rate reactivity group. Similar to displays of defensiveness,

[6] The domineering code might also be considered a candidate for the anger axis, but its subcodes, such as condescending lecturing, suggest that it is unrelated to anger expression and more related to psychological control intended to make anger expression less likely in the spouse. For this reason, we excluded this code from our anger axis.

Table 1
Dimensions of Affect and Violence as a Function of DV Husbands' Physiological Reactivity Group

	Physiological reactivity group					
	Calms down (N = 12)			Gets excited (N = 48)		
Variable	*M*	*SD*	%	*M*	*SD*	%
	Affect (in frequency counts)					
Aggression						
Husband	17.0	13.73		7.6	9.79	
Wife	9.8	11.71		11.3	13.27	
Anger						
Husband	2.0	2.59		2.8	4.58	
Wife	1.3	2.70		5.6	7.03	
Defensiveness						
Husband	8.9	7.79		9.7	8.44	
Wife	9.9	7.44		5.5	4.33	
Sadness						
Husband	4.0	7.31		2.5	3.85	
Wife	10.0	13.84		4.3	7.60	
	Violence					
Marital violence						
Physical violence	25.5	16.99		28.1	26.83	
Psychological abuse	91.0	28.46		78.4	35.44	
General violence[a]		.37	44		.17	3
Familiar		.37	44		.21	5
Unfamiliar		.38	33		.00	0
Parenteral violence		.33	56		.31	13

Note. Percentages refer to the *N*s given, corrected for missing data that varied for each variable. DV = domestic violence.
[a] Standard deviations for percentages are computed using the binomial formula $\surd[p(1-p)]$, where p = proportion.

wives interacting with husbands who were Type 1 showed higher levels of sadness during the marital interaction than the wives in the Type 2 group. No significant or marginally significant effects for heart rate reactivity group were found for husbands' sadness.

Effects over the entire interaction. Because reactivity refers to an immediate effect in heart rate change, to examine reactivity we analyzed only the first third of the marital conflict discussion. However, repeated measures analyses of variance showed the following:

1. For emotional aggression, husbands showed a significant interaction between emotional aggression of heart rate group and time, $F(2, 110) = 7.93$, $p = .001$. Type 1 men got increasingly less aggressive over time, whereas Type 2 men got increasingly more aggressive over time but never got to the level of Type 1 men at the start of the interaction (over thirds, the mean number of episodes was as follows: Type 1 = 17.00, 14.00, 7.33; Type 2 = 7.60, 9.04, 10.67);

2. For anger, there were no significant main effects over time for husband anger, but there was a significant main effect over time for wife anger, $F(2, 110) = 5.16$, $p = .007$. Wives became increasingly angry over thirds of the interaction (M = 4.98, 7.04, and 8.34 episodes);

3. There were no main or interaction effects with time for defensiveness; and,

4. For sadness, there was a significant time main effect with increases over time in the last third for husband sadness, $F(2, 110) = 4.81$, $p = .010$; M = 2.76, 2.73, 3.78 episodes. There was a marginally significant Group × Time interaction $F(2, 110) = 2.39$, $p = 0.97$. Type 1 men increased faster than Type 2 men (mean number of episodes was as follows: Type 1 = 4.00, 4.58, 6.67; Type 2 = 2.54, 2.27, 3.06). For women, there were no significant main effects or significant interaction of group with time.

Recoding of the Observations With Affect Wheel SPAFF

Because the reliability of the SPAFF coding was relatively low, we recorded all the data with a simplified version of the SPAFF, the Affect Wheel, which codes only the speaker's data. To further increase reliability, we required reliability checking on all the coding instead of a portion of it. There was a significant multivariate interaction effect for group by affect, $F(3, 174) = 2.95$, $p = .034$, and there was a significant multivariate main effect for affect, $F(3, 174) = 64.33$, $p < .001$; no other multivariate effects were significant. Subsequent ANOVAs showed that there was a significant group effect for husband aggression in the first third of the interaction, $F(1, 59) = 5.52$, $p = .022$, with the Type 1 husbands' $M = 16.75$ s and the Type 2 husbands' $M = 6.02$ s. When aggression was analyzed across all thirds of the interaction, there was a significant group main effect, $F(1, 58) = 4.43$, $p = .040$, with no significant interation of group by time: first third, Type 1 $M = 16.75$ s, Type 2 $M = 6.02$ s; second third, Type 1 $M = 18.83$ s, Type 2 $M = 9.46$ s; last third, Type 1 $M = 21.50$ s, Type 2 $M = 9.44$ s. Wives of Type 1 men were sadder than wives of Type 2 men, $F(1, 59) = 6.39$, $p = .014$ (Type 1 wives' $M = 10.67$ s, Type 2 wives' $M = 1.29$ s). There was also a significant group effect for husband anger for the first third of the interaction, $F(1, 59) = 5.31$, $p = .025$ (Type 1 $M = 3.75$ s, Type 2 $M = 0.02$ s). There were no significant effects for defensiveness for the group, $F(1, 58) = 2.31$, *ns*. No other effects were significant. To summarize, the recoding of the data with the Affect Wheel SPAFF system replicated the differences between groups in wife sadness and husband aggression, but there was no Group × Time interaction (i.e., no crossover effect). The results also differed in that there was a significant difference on husband anger, with Type 1 men being higher than Type 2 men on anger.

Two-Year Follow-Up: Marital Stability Results

The percentage of couples in each group who separated or divorced was 27% for the Type 2 group and 0% for the Type 1 group; likelihood ratio, χ^2 $(1, N = 61) = 6.51$, $p = .01$.

Dimensions of Violence

ANOVAs were conducted for husband physical violence and husband psychological abuse. Husbands' physical violence and psychological abuse as reported by their wives did not differentiate couples on the basis of heart rate reactivity. No significant main effects for heart rate reactivity were found for physical violence and psychological abuse; husbands in the Type 1 group were not reported as more physically violent or more psychologically abusive toward their spouses than the Type 2 group.

General violence. For the dichotomous data of husband general violence and parental violence in the husbands' families of origin, chi-square analyses by heart rate reactivity group were conducted. Combining data on whether or not husbands had been physically violent with friends, strangers, and coworkers or bosses, a chi-square analysis by heart rate reactivity group resulted in a significant relationship, $\chi^2(1, N = 49) = 14.11$, $p = .0002$. Forty-four percent of the violent husbands in the Type 1 group had been violent toward others compared to only 3% of the husbands in the Type 2 group. When the analysis was repeated with general violence toward people they knew well, that is, family (excluding spouse), friends, and coworkers or bosses, the results were similar with a significant χ^2 $(1, N = 49) = 10.64$, $p = .001$. With people they are not as familiar with such as acquaintances, strangers, and police officers, 33% of the DV husbands in the Type 1 group had been violent, whereas none of the Type 2 husbands had been violent, $\chi^2(1, N = 48) = 13.64$, $p = .001$. These results indicate that violent husbands who decreased their heart rate were more violent to familiar as well as unfamiliar people when compared to husbands who increased their heart rate.

Reports of parental violence. A chi-square analysis of heart rate reactivity group by those who reported a history of parental violence (presence of reported parental violence vs. absence of reported parental violence) was conducted for the violent husbands. A significant relationship, χ^2 $(1, N = 48) = 8.10$, $p = .004$, between heart rate reactivity group and history of parental violence was found. Fifty-six percent of the violent husbands in the Type 1 group reported observing both their parents acting violent toward each other (violence from father toward mother and violence from mother toward father), compared to 11% in the Type 2 group.

Dimensions of Psychopathology

The MCMI–II scale scores were entered into MANOVAs to compare psychopathology between the Type 1 and Type 2 groups. The omnibus test for the 9 Axis I (clinical syndrome) disorders was not significant. For the 13 Axis II (personality) disorders, the omnibus tests showed a trend, $F(13, 47) = 1.90$, $p = .055$. The univariate tests revealed that Type 1 men were significantly higher on antisocial personality disorder than the Type 2 batterers, $F(1, 59) = 14.35$, $p = .000$. The Type 1 men were also significantly lower on dependent personality disorder than the Type 2 husbands, $F(1, 59) = 4.35$, $p = .040$. We tested whether these differences were clinically significant, that is, if the scores of the Type 1 men were more likely to be in the clinical range than the Type 2 batterers. Separate chi-square analyses were performed on each of the MCMI–II scales. Type 1 men had significantly higher rates of antisocial personality disorder, $\chi^2(1, N = 61) = 10.14$, $p = .001$, than did Type 2 men. The Type 1 men also had significantly higher rates of aggressive–sadistic personality disorder, $\chi^2(1, N = 61) = 4.75$, $p = .030$, than did Type 2 batterers. Type 1 men also had higher rates of drug dependence than Type 2 men, $\chi^2(1, N = 61) = 4.64$, $p = .030$.

Other Physiological Variables

Heart rate reactivity and other husband physiological variables. Over time, husbands' gross motor movements increased, $F(2, 116) = 4.08$, $p = .019$. For husbands' finger pulse amplitudes, there was a group main effect, $F(1, 57) = 4.15$, $p = .046$. Type 2 husbands had lower finger pulse amplitude than Type 1 husbands (Type 1 $M = .019$, Type 2 $M = .014$); there were no significant group effects for husband baseline finger pulse amplitude. Lower finger pulse amplitude could be reflective of the general alarm response due to greater alpha-sympathetic activation on the part of Type 2 men that causes arterial vasoconstriction and draws blood in from the periphery.

Consistency of the physiological variables across different salient SPAFF moments. Table 2 is a summary of the correlations of our physiological variables (change from baseline means). It compares physiology during speaking only for the following SPAFF moments: belligerent and contemptuous, belligerent and neutral affect, and belligerent and a frequently occurring positive affect moment (we picked validation). The mean physiology was computed for as long as a moment lasted, as determined by the observers. The main result is that, in all three sections of Table 2, the correlations along the diagonal are quite high; this suggests that there is stability in the physiological responses of violent men across different types of affective moments.

Relationship between the typology variable and other physiological variables. Using the participant as the unit of analysis, point-biserial correlations between husband physiology and the dichotomous husband reactivity grouping showed that Type 2 men had significantly lower finger pulse amplitude in all three thirds of the interaction: for respective thirds, $r = -.22$, $p = .043$; $r = -.25$, $p = .029$; $r = -.28$, $p = .015$. However, the blood of wives of Type 1 men was flowing significantly faster than the blood of wives of Type 2 men in all three thirds of the interaction: for respective thirds, $r = -.22$, $p = .044$; $r = -.22$, $p = .045$; $r = -.23$, $p = .041$. Also, there was a marginally significant effect for wives of Type 1 men to have higher skin conductance in all three thirds of the interaction: for respective thirds, $r = .18$, $p = .080$; $r = .20$, $p = .064$; $r = .21$, $p = .051$. It thus seems that the Type 1 men were calmer on other physiological variables related to the cardiovascular system, but their wives were not. No other point-biserial correlations were significant. Because the observational coding and the physiological data were synchronized by the video time code, it was possible to construct a relational database and compute point-biserial correlations of the group variable with the husband physiology during specific episodes in the interaction related to the marital interaction codes we have been investigating. Means for each of the husband physiological variables were computed for each type of behavior episode. In the husbands' baselines, no physiological variable was related to the grouping variable. For episodes of husband anger, Type 2 husbands had significantly less finger pulse amplitude, $r = -.34$, $p = .016$; this was also true during episodes of husband sadness, $r = -.47$, $p = .005$.

Table 2
Consistency of the Physiological Change Variables Across Different Types of SPAFF Moments (Change From Eyes-Open Baseline to All 15 Minutes of the Marital Interaction)

	Husband belligerent moments: change from baseline in				
Other moments	IBI	FPA	FPT	ACT	SCL
Contempt					
Husband IBI change	.84**	.16	−.14	.31	−.02
Husband FPA change	.22	.85**	.04	.25	−.15
Husband FPT change	−.05	−.10	.82**	−.21	.00
Husband ACT change	.28	.26	−.23	.97**	−.26
Husband SCL change	−.03	.07	.04	−.28	.97**
Neutral affect					
Husband IBI change	.57**	.22	−.47*	.12	.04
Husband FPA change	.19	.90**	−.12	.22	.00
Husband FPT change	−.12	−.27	.68**	−.46*	.02
Husband ACT change	.25	.23	−.20	.96**	−.12
Husband SCL change	−.06	.08	.09	−.18	.94**
Validation					
Husband IBI change	.57**	.22	−.47*	.12	.04
Husband FPA change	.19	.90**	−.12	.22	.00
Husband FPT change	−.12	−.27	.68**	−.46*	.02
Husband ACT change	.25	.23	−.20	.96**	−.12
Husband SCL change	−.06	.08	.09	−.18	.94**

Note. SPAFF = Specific Affect Coding System; IBI = interbeat interval; FPA = finger pulse amplitude; FPT = finger pulse transit time; ACT = activity; SCL = skin conductance.
$^{*}p < 01$. $^{**}p < 001$.

During listening with defensiveness, Type 2 husbands had faster blood flow, $r = -.25$, $p = .039$. Also, using our relational data base, point-biserial correlations with Type showed that Type 2 men's blood flowed faster than Type 1 men's when their wives showed disgust; furthermore, Type 2 men had less finger pulse amplitude (suggestive of a general alarm response) than Type 1 men when the men were sad, when the men or the women stonewalled, when the women listened with sadness, or when the men listened with tension. Because so many correlations were computed in these analyses, these results should be viewed as hypothesis generating and suggestive rather than hypothesis testing. No other husband correlations were significant. To summarize, we found that, for specific episodes of husband negative affect, the Type 1 men were found to be calmer that Type 2 men on other physiological variables related to the cardiovascular system.[7]

[7] For exploratory purposes, we also computed the mean physiology of husbands for all emotional SPAFF codes and compared these means across groups for all the SPAFF moments. These ANOVAs use the episode as the unit of analysis rather than the participant. For husband mean gross motor activity, there was no significant difference across groups, $F(1, 1699) = 2.01$, *ns*. For husband mean skin conductance, there was no significant difference across groups, $F(1, 1699) = 1.08$, *ns*. For husband mean finger pulse amplitude, there was a significant difference across groups: $F(1, 1699) = 65.78$, $p < .001$;

Vagal tone and its regulation. What is the physiological mechanism that Type 1 men are using to lower their heart rates from the baseline to the beginning of the marital conflict discussion? One physiological mechanism that is a likely candidate for reducing heart rate below the eyes-closed baseline is an increase in the tonic firing of the parasympathetic nervous system's vagus nerve, a parameter called *vagal tone*. Heart rate can also be reduced by decreasing sympathetic nervous system activity, but sympathetic activity is unlikely for heart rates below the heart's intrinsic pacemaker rhythm of approximately 100 beats/min (Rowell, 1986). Using time-series analysis, vagal tone can be computed as the amount of heart rate variability within the range of the respiratory rhythm. Porges has shown that baseline vagal tone is related to the ability to focus attention; however, he has also suggested that during continued engagement with the environment, vagal tone must be down regulated, and he has found that the inability to down regulate vagal tone is related to behavior disorders among children (Porges, 1984, 1986, 1991, 1992). Hence, we are interested in two dimensions of vagal tone: baseline vagal tone and its down regulation in the first 5 min of the marital interaction. The Porges computer programs—VEDIT, for data cleaning, and MXEDIT (Porges, 1989), for analysis of vagal tone—were used in these computations with the prorated second–by–second husband interbeat intervals as input. We conducted a 2 × 2 repeated measures ANOVA on the husbands' vagal tones, with one between-subjects factor (Type 1 vs. Type 2) and one within-subjects factor (baseline to the first 5 min of marital interaction). There was no significant group effect or Group × Time interaction. The mean baseline vagal tone for Type 1 husbands was 5.27; for Type 2 husbands it was 5.49. The mean marital interaction vagal tone was 6.37 for Type 1 husbands and 6.21 for Type 2 husbands. There was a significant time effect, $F(1, 49) = 26.47$, $p = .000$. All violent husbands increased significantly in vagal tone from the baseline to the first 5 min of interaction. These results are puzzling because vagal activation leads to heart rate decreases. Clearly, we do not yet understand the physiological mechanisms that underlie our heart rate reactivity data.

Time-series analyses. To deal with rival hypotheses about our baseline, we conducted two kinds of within-subjects interrupted time-series analyses within each subject. An interrupted time-series analysis statistically compares a set of time-series data before and after an event (see Gottman, 1981). In our analyses, the pre- and postinterruption data were fit with straight lines that have an intercept and a slope, and these intercepts and slopes were then compared statistically, controlling for autocorrelations in the data. The results of the analysis were a t ratio for change in intercept and a t ratio for change in slope.

The first rival hypothesis concerned potential problems with trend in our eyes-closed baseline; for example, if the participants were tense and calming down during the baseline, there could have been differential amounts of trend across participants in the baselines. Because the baseline periods might have had trends for some participants but not for others, we conducted a series of interrupted time-series analyses comparing, for each participant, the 5 s of baseline data with the highest interbeat interval (lowest heart rate) containing no trend with the 5 s of interbeat interval data following each belligerence or contempt SPAFF code during the marital interaction. We then entered the change in level and change in slope t ratios from the time-series analyses into ANOVAs. We could have conducted a nonparametric test between groups, but we wished to gauge the relative sizes of the t ratios for change in intercept and slope across groups.

A positive t ratio for IBI intercept means that right after the SPAFF code, the participant's heart rate decreased. If the t ratio for slope was then negative, this would mean that the participant's heart rate began to return to baseline. If our hypotheses are correct about Type 1 men, we would expect their heart rates to decrease following an aggressive event, whereas we would expect the heart rates of Type 2 men to increase. This change in heart rate would be reflected in the difference between the types of violent men in the intercept comparisons. The slope comparisons tell us whether there are differences between the two types of men in the

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Type 1 $M = .02$, Type 2 $M = .01$. For husband mean pulse transit time, there was a significant difference across groups: $F(1, 1699) = 36.99$, $p < .001$; Type 1 $M = 208.25$ ms, Type 2 $M = 198.48$ ms. These analyses also suggest that Type 1 men's blood was flowing slower than Type 2 men's blood.

rate of heart rate recovery, but we should bear in mind that the recovery is likely to be in opposite directions if our hypotheses hold up: Type 1 men return to baseline by increasing their heart rates, whereas Type 2 men return to baseline by decreasing their heart rates. For our analyses we used the Crosbie (1993) interrupted time-series analysis computer program (see also Crosbie & Sharpley, 1989).

The results were as follows: Compared to baseline, following aggressive moments, Type 2 husbands' IBI intercepts dropped significantly compared to Type 1's: Type 1 $M = -.25$, Type 2 $M = -1.89$; $F(1, 1721) = 80.04$, $p < .001$. Compared to baseline, following aggressive moments, Type 2 husbands' IBI slopes increased significantly compared to Type 1's: Type 1 $M = -.12$, Type 2 $M = .66$; $F(1, 1721) = 47.76$, $p < .001$. This means that, as predicted, Type 2 husbands' heart rates increased significantly more than Type 1's following aggressive SPAFF codes (compared to baseline levels) and then returned to baseline. There was no such effect for wives' IBIs: $F(1, 1721) = 0.01$ for intercept; $F(1, 1721) = 0.40$ for slope. Also, for positive affective moments (validation, affection, and humor), both groups of husbands showed significant drops in intercept (Type 1 $M = -2.27$, Type 2 $M = -2.38$), but the groups were not significantly different, $F(1, 635) = .10$. However, the Type 1 men's heart rates showed a significantly faster return to baseline as indicated by slope differences: Type 1 $M = 1.40$, Type 2 $M = 0.70$; $F(1, 635) = 9.21$, $p < .01$.

The second rival hypothesis concerned the adequacy of the baseline. The 2-min baseline may have been too short, thus allowing the participants to adapt to the laboratory situation. To deal with this rival hypothesis, we conducted a series of interrupted time-series analyses selecting the 5 s prior to any aggressive SPAFF code compared to the 5 s including and after any selected SPAFF code. The results were as follows. For all aggressive moments, there was a significant change in intercept between groups: Type 1 $M = 0.23$, Type 2 $M = -.18$; $F(1, 1721) = 6.25$, $p < .05$. Thus, Type 2 men decreased their IBI intercepts (i.e., increased their heart rates) after an aggressive code, whereas Type 1 decreased their heart rates. For *change in slope*, the difference was also significant: (Type 1 $M = -.21$, Type 2 $M = 0.11$; $F(1, 1721) = 5.66$, $p <$ 05. This means that both Type 1 and Type 2 men's heart rates were returning to baseline, one from an elevated heart rate (Type 2) and one from a reduced heart rate (Type 1). There were no such effects for women's heart rates: intercept $F(1, 1721) = 1.88$, *ns*; slope $F(1, 1721) = 2.34$, *ns*. For positive affect moments, again we found no significant differences across groups; both Type 1 and Type 2 men decreased their IBI intercepts: Type 1 $M = -.89$, Type 2 $M = -.47$; $F(1, 635) = 1.99$, *ns*. Also, both returned to baseline: Type 1 $M = 0.62$, Type 2 $M = 0.23$; $F(1, 635) = 2.44$, *ns*. For positive affect moments with women, there were also no significant effects for intercept: wives of Type 1 husbands, $M = -.63$; wives of Type 2 husbands, $M = -.41$; $F(1, 635) = .47$, *ns*. Nor were there significant effects for slope: wives of Type 1 husbands, $M = .35$; wives of Type 2 husbands, $M = .12$; $F(1, 635) = .97$, *ns*.

Because we could analyze specific moments, we compared moments in which the wives initiated the aggressive SPAFF code with the husbands' IBI data. For moments initiated by the wives, the husbands' IBI intercept data were significantly different: Type 1 $M = 0.49$, Type 2 $M = -.12$; $F(1, 946) = 6.25$, $p < .05$. Also, the husbands' slope data were significantly different: Type 1 $M = -.32$, Type 2 $M = .19$; $F(1, 946) = 6.00$, $p < .05$. There were no significant differences when the husband initiated the aggressive SPAFF code: intercept $F(1, 773) = 1.51$, *ns*; slope $F(1, 773) = 0.47$, *ns*. Hence, during the interaction, right after an aggressive act by the wife, Type 1 husbands lowered their heart rates and then returned to baseline, whereas Type 2 husbands increased their heart rates and then returned to baseline.

Summary of time-series analyses. Figure 1 is a schematic summary of the results of the time-series analyses. As we can see from this figure, Type 1 and Type 2 husbands had opposite physiological responses as compared to their baseline behaviors and also as compared to a baseline immediately before an aggressive behavior initiated by their wives.

Null findings when splitting on wife physiology. There were no significant findings on any variable in the present report when we split the data on wives physiological reactivity.[8]

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[8] As a check on the classification of batterers by the husbands' heart rate reactivities, we performed the identical analyses classifying couples by the wives' heart rate reactivities. No results were statistically significant for either group.

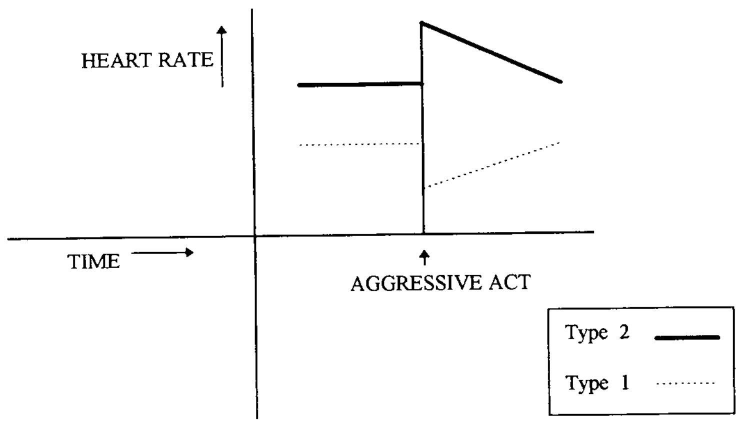

Figure 1. Summary of the interrupted time-series analyses. Type 1 = men whose heart rates decreased during marital conflict; Type 2 = men whose heart rates increased during marital conflict.

Discussion

This study involved violent couples who we think are reasonably representative of the types of severely violent couples often seen in clinical samples. This was the first study to combine observational, psychophysiological, and self-report perspectives. In this article we have identified a physiological marker variable that serves as a discriminator of violent men on a number of interesting dimensions. The men who lowered their heart rates (Type 1) from an eyes-closed baseline to the first 5 min of marital interaction were different in a number of ways from the violent men who increased their heart rates (Type 2). Our basic finding was that Type 1 men were more belligerent and contemptuous that Type 2 men, particularly in the first 5 min of marital interaction. Our recording of the SPAFF data raises questions about the initial null results with respect to husband anger: On recoding, we found that Type 1 husbands were more angry than Type 2 husbands.

The Type 1 men were not more violent in their marriages than the Type 2 men, but they were more generally violent outside the marriage toward friends, strangers, and coworkers or bosses. They were more likely to have witnessed physical violence between their parents. They were more likely to be assessed as antisocial, drug dependent, and aggressive–sadistic using the MCMI–II (Millon, 1987). On 2-year followup, their marriages had a separation–divorce rate of zero, compared to the marriages of other violent men (Type 2 men) for whom the separation–divorce rate was quite high: 27%.

Thus, the data on this lowering of the heart rate suggests the hypothesis that there may a physiologically based typology of male batterers. There have been a number of attempts at creating typologies of men who batter their wives (see Holtworth-Munroe & Stuart, 1994). These typologies have been based on a variety of data sources, and there is a consensus in these classifications that there is a group of severely abusive men who are also violent outside the marriage. There is also consensus that there is another group of wife abusers who are not generally violent outside the marriage. Our results support these general conclusions about two types of batterers and offer a physiological marker, reduced heart rate reactivity, as a potential index variable for building a typology.

Our results are quite consistent with the research on the physiological correlates of criminality. That literature has consistently suggested that there is a link between lower reactivity and criminality. However, our results suggest a modification of their interpretation. The most commonly accepted hypothesis for the lowered physiological baseline levels and lowered reactivity of criminals is a sensation seeking hypothesis: Presumably, criminal behavior is an attempt to seek sensations and risky situations that raise physiological levels from an aversive low to within an optimal range. However, our data suggest that Type 1 men are lowering their physiological arousal, not increasing it to some more optimal level. They are concomitantly striking out with high levels of initial emotional aggression in the very beginning of the marital interaction. The lowering of heart rate may be in the service of focused attention, and the task of the focused attention may be manipulation and control of the wife so that the expression of wife anger is minimized and the expression of wife defensiveness (our index of fear) is maximized. That interpretation would be a better fit to our results than the sensation seeking hypothesis. We should mention the caveat that, to our knowledge, no one who has published in the literature on criminality has ever conducted a test to see whether criminals have lower heart rate reactivity compared to noncriminals (but that both groups increase heart rate over a baseline) or whether criminals actually lower their heart rates from baseline when they are in stressful situations. Those who study Type A personalities need to do this type of definitive analysis for us to be able to compare our results with theirs and for them to test their optimal arousal and sensation seeking hypothesis.

The Type 2 men behave as though they were the alter egos of the Type 1 men. Our time-series analyses showed that they increased their heart rate, particularly when their wives were belligerent or contemptuous, whereas the Type 1 men decreased their heart rates. The Type 2 men became increasingly more aggressive as the interactions unfolded, whereas the Type 1 men started the interactions with high levels of aggression and decreased these levels as the interactions unfolded.

Assuming that we are talking about hostility when we describe belligerence and contempt, our results appear to contradict the predictions one might have made using the link between heart rate reactivity and hostility in the Type A personality. However, Type A researchers have not studied the degree of hostility manifested in this battering population. Still, it is interesting to have discovered some limitations, and indeed a reversal, for the suggested link between heart rate reactivity and hostility.

Our data speak to the clinical observation that violent marriages are stable. Indeed, the marriages of Type 1 men appear to be quite stable, but the marriages of Type 2 men appear to be very unstable. In our experience, the separation–divorce rate for Type 2 marriages was very high for a 2-year period: 27%. The usual question, "Why do battered women stay in these marriages?" must be qualified in the light of our results to "Why do battered women stay with these Type 1 men when they seem quite able to leave Type 2 men?" Our impressions are that two factors are operating. We suspect that the first factor is that some of the women married to Type 1 men are genuinely afraid to leave them; evidence for this is that the type of intimidation Type 1 men inflict is successful in inhibiting their wives' expressions of anger. We also have found that a significant portion of the women married to Type 1 men are themselves antisocial and may be more habituated or comfortable in a violent relationship than others would be (Waltz, Babcock, Jacobson, & Gottman, 1995).

Our negative group differences on vagal reactivity are puzzling to explain. We clearly need more investigation of the physiological basis for the heart rate reactivity differences. The differences between Type 1 and Type 2 men are evident in both their heart rate changes and changes in their amount of peripheral vasoconstriction. How are these physiological effects being mediated? We do not know. However, if we think of the research literature on the physiology of emotion, the result of lowering the heart rate during belligerent and contemptuous marital interaction suggests an interesting interpretation of our data. Recent work by Ekman, Levenson, and Friesen (1983); Levenson, Ekman, and Friesen (1990); Levenson, Carstensen, Friesen, and Ekman (1991); and Levenson, Ekman, Heider, and Friesen (1992) demonstrates consistently that emotional expression and internal emotional experience generate specific autonomic responses. Furthermore, they find that anger consistently increases heart rate, whereas disgust tends to lower it. Shortt, Bush, McCabe, Gottman, and Katz (1994) found this same pattern with children. Thus, it could be the case that, despite the fact that we have described the belligerent and contemptuous codes as falling on an anger axis, the emotional basis for these codes might engage more of a disgust axis than an anger axis for Type 1 men and more of an anger axis for Type 2 men (R. Levenson, personal communication, October 15, 1994). This interpretation is consistent with research on heart rate reactivity by Siegman, Anderson, and Berger (1990). They found that when people use an angry voice to recall angry events, measures of reactivity increase significantly.

Thus, angry emotional behavior generally increases cardiovascular reactivity.

The wives of the two types of husbands were also different from each other. Wives were most defensive and sad and least angry when interacting with Type 1 husbands. Thus, the wives are not unaffected by their husbands' increased contempt and belligerence. We believe that the defensiveness code is our best index of fear in this context. Hence, the wives of Type 1 men can be interpreted as responding very emotionally to their husbands, with affects that range between fear and sadness and with a suppression of anger. In general, we found that wives were more angry when interacting with husbands who had been violent toward them (Jacobson et al., 1994). However, wives married to violent Type 1 men showed remarkably low amounts of anger. Perhaps wives married to violent Type 1 men did not feel safe expressing anger and feared a heightened aggressive response if they did show anger. Thus, we think that the pattern of the wives' responses to these Type 1 men is a fear response. If this is true, perhaps it explains the zero separation–divorce rate of these marriages compared to a 27% separation–divorce rate for Type 2 men. The wives may be afraid to divorce these Type 1 men.

The lack of differences in severity of violence between the two types was surprising to us. Perhaps it is the case that the different marital interaction patterns of the two types of violent men is not reflected in increased domestic violence, but rather only the pathways the men take toward violence against their wives are different. However, our measure of violence severity, the CTS, may not be sensitive to the functions of violent acts or to the extent of the damage caused (e.g., two different shoves could results in different effects depending on where the wife was standing when shoved), and we should not rule out a potential difference between the types of men in the nature of the violence they generate. Some evidence for our suspicion that the null findings on the CTS are an artifact of measurement problems comes from a study by Murphy, Meyer, and O'Leary (1993). They used the MCMI-II (Millon, 1987) with physically aggressive men and found that they differed from other groups only on antisocial and aggressive scales of the MCMI–II. They also found that the abuse of the mother in the family of origin was associated with higher levels of physical aggression toward the partner. These results are so similar to our findings with Type 1 men that we suspect that we may find antisocial Type 1 men to be higher in physical aggression toward their wives. We also suspect that Type 1 men systematically use violence or its threat to create greater intimidation in their wives.

Babcock, White, O'Connor, Gottman, and Jacobson (1994) suggested the hypothesis that the two types of men differ primarily in what moves them into a psychologically abusive and violent loop in the marital interaction. Type 1 men are driven to become belligerent by their wives' reasonable demands for greater cooperation in the marriage, for intimacy, and for respect. They are not at all threatened by increasing independence moves by the wives; on the contrary, our informal observations suggest that the Type 1 men impel their wives toward greater independence. The perception that their wives are trying to control them leads them to begin manipulating their own physiology to affect calm and to begin manipulating their partner's emotions by becoming threatening, belligerent, and contemptuous. This behavior is effective in suppressing their wives' anger and in obtaining compliance. The Type 2 men, on the other hand, are threatened by greater independence moves by their wives; they fear abandonment so they respond with jealousy, fear, and loss of emotional control as their heart rate rises. Eventually, the Type 2 men lose control emotionally and become abusive, not in an attempt to suppress their wives' anger, but in an attempt to engage her and keep her in the field of interaction.

Although our results are interesting, they are also preliminary. Only 20% of our batterers lowered their heart rates from the eyes-closed baseline to the beginning of the marital interaction. This is quite a small number. There is a distinct possibility that our recruiting methods may have undersampled Type 1 men because we used wife reports to recruit the couples. If the wives of Type 1 husbands are more afraid of these men, they may have been less willing to volunteer to participate in the research. We also need to replicate these results. First, we must assess the stability of this heart rate reactivity response over time within the same individuals. We must use longer and more stable baselines to ensure that we are indeed collecting a valid baseline for each type of man. We need to assess the replicability of our findings with this one variable and the generalizability of the physiological result to other physiological channels. We need to understand precisely what it is that Type 1 and Type 2 men are doing, both psychologically and physiologically. Finally, assuming these results are stable and this pattern of relationships is stable, we also need to understand the physiological underpinnings of these responses. What are the underpinnings of this lowering of heart rate? Is it related to the specificity of the internal experience of belligerence and contempt in the marital interaction; that is, is it a disgust versus anger axis? Is it related to vagal activation of the Type 1 men and an inability to regulate this vagal activation (which would suggest that the mediating mechanism is a focusing of attention)?

Nevertheless, if replicated, our findings suggest that Type 1 batterers may not have impulse control problems at all. If anything, they may have the opposite problem: too much control over their physiology. Treatment programs that are based on the assumption that batterers lack impulse control may constitute a mismatch for the Type 1 men. In fact, on the basis of issues raised in the previous paragraph, we suspect that Type 1 men form a much higher percentage of the batterers who enter the criminal justice system than the 20% found in our study. If one examines the profile of batterers who typically enter the criminal justice system and are sent by judges to currently available treatments, they fit the profile of our Type 1 men considerably better than they do the Type 2 men. This suggests the possibility that currently existing treatments may be mismatched with a large portion of those who receive them. Is it reasonable to suppose that batterers who calm down when they argue, and who have abusive family histories, antisocial personality disorders, a history of general violence, and drug dependence are good candidates for psychotherapy? Only future research can answer such questions.

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