
Lactate-Induced Rage and Panic in a Select Group of Subjects Who Perpetrate Acts of Domestic Violence

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Background: *Perpetrators of domestic violence frequently report symptoms of autonomic arousal and a sense of fear and/or loss of control at the time of the violence. Since many of these symptoms are also associated with panic attacks, we hypothesized that perpetrators of domestic violence and patients with panic attacks may share similar exaggerated fear-related behaviors. To test this hypothesis, we employed the panicogenic agent sodium lactate to examine the response of perpetrators to anxiety/fear induced by a chemical agent.*

Methods: *Using a double-blind, placebo-controlled design, we infused 0.5 mol/L sodium lactate or placebo over 20 min on separate days to a select group of subjects who perpetrate acts of domestic violence and two nonviolent comparison groups. We compared their behavioral, neuroendocrine, and physiologic responses.*

Results: *Lactate administration elicited intense emotional responses in the perpetrators of domestic violence. Perpetrators evidenced more lactate-induced rage and panic and showed greater changes in speech, breathing, and motor activity than did nonviolent control subjects. There were no significant differences between the groups for any neuroendocrine or physiologic measure.*

Conclusions: *These results are consistent with our hypothesis that some perpetrators of domestic violence have exaggerated fear-related behavioral responses. Biol Psychiatry 2000;47:804–812 © 2000 Society of Biological Psychiatry*

Key Words: Domestic violence, lactate, rage, panic

Introduction

Domestic violence is a problem of major proportions in the United States (McCauley et al 1995; Satcher 1995; Straus and Gelles 1990). Acts of domestic violence account for at least 20% of all emergency room visits (Goldberg and Tomlanovich 1984; McLeer et al 1989) and frequently result in physical injury and severe emotional distress. Federal Bureau of Investigation statistics indicate that 30% of all the women murdered in the United States are killed by their spouse or significant other (Federal Bureau of Investigation, Criminal Justice Information Services Division 1997).

Current theories concerning the etiology of domestic violence leave many unanswered questions. Numerous studies have attributed domestic violence to either effects of alcohol (Bergman and Brismar 1994; Collins and Messerschmidt 1993; Leonard and Blane 1992) or behavior patterns learned in childhood (Fitch and Papantonio 1983; Hotelling and Sugarman 1986; Smilkstein et al 1994). Although these factors undoubtedly play a role in domestic violence, the fact remains that at least 76% of perpetrators have been violent when they were not drinking (Eberle 1982; Kantor and Straus 1992), and more than 40% were not exposed to abuse growing up (Caesar 1988; Widom 1989a, 1989b).

Perpetrators of domestic violence frequently experience a constellation of symptoms (e.g., palpitations, increased respiration rate, tremor, a sense of losing control, feelings of fear and/or being trapped) immediately before an episode of domestic violence (Bitler et al 1994). Since many of the above symptoms are associated with panic attacks (American Psychiatric Association 1987) and conditioned fear responses (Davis et al 1994; LeDoux 1994), we hypothesized that some acts of domestic violence are triggered by fear.

Fear is an appropriate response to an identified threat. It leads to a predictable set of behaviors. For example, a cat confronted by a predator will freeze. If pursued, the cat will respond with either fight (i.e., arched back, broadside stance, raised tail, loud vocalizations, bared teeth, and

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unsheathed claws) or flight behavior. We propose that patients with panic attacks and perpetrators of domestic violence share an exaggerated response to a perceived danger. In the case of patients with panic disorder, it takes the form of a flight response with a profound desire to escape. In contrast, among perpetrators it takes the form of a fight response with rage and aggression.

We employed sodium lactate as a chemical agent to induce fear in a controlled research setting using a double-blind, placebo-controlled design. In numerous studies lactate has been shown to specifically induce panic in 70–90% of patients with panic attacks but in less than 10% of healthy control subjects (Kelly et al 1971; Liebowitz et al 1984; Pitts and McClure 1967) or patients with other DSM-III-R (American Psychiatric Association 1987) Axis I disorders (e.g., obsessive–compulsive disorder [Gorman et al 1985], social phobia [Liebowitz et al 1985a], and major depression [McGrath et al 1988]). If perpetrators and patients with panic attacks have a similar exaggerated response to a perceived threat, we reasoned that perpetrators should also be susceptible to the effects of lactate but experience a fight rather than a flight response.

Methods and Materials

Subjects

Subjects were classified into three groups: perpetrators of domestic violence (perpetrators), nonviolent alcoholic comparison subjects (NV ALCs), and healthy comparison subjects (HCSs).

The perpetrator group consisted of 27 male and seven female subjects who were recruited with newspaper advertisements seeking people who “lose control and are violent toward their spouse or significant other.” Only those subjects who had a history of inflicting repeated acts of significant physical violence (e.g., hitting, pushing, choking, using a weapon) toward a significant other were included. These acts of domestic violence were not premeditated and typically occurred 1) in response to a “look” or a “statement” from the significant other that the perpetrator perceived as a threat to his self-esteem and 2) in association with an escalating sense of anxiety/fear and the need to “defend themselves” or to “get their point across.” Since numerous studies (Bergman and Brismar 1994; Collins and Messerschmidt 1993; Leonard and Blane 1992) have attributed domestic violence to the effects of alcohol, we elected to study only perpetrators who had a history of initiating at least some (but not necessarily all) acts of domestic violence when they were not drinking alcohol.

Perpetrators consisted of both men and women from a broad range of socioeconomic backgrounds, ranging from executives to unemployed individuals. Their violence frequently had a devastating effect on their lives, leading to broken relationships, poor self-esteem, and trouble with the law. Perpetrators typically externalized the blame for their violence and attributed it to the

“antagonistic” behaviors of their significant others. Following the violence, most perpetrators reported a sense of remorse. Some perpetrators, usually after extensive psychotherapy and multiple failed relationships, acknowledged that they had a problem. All perpetrators had little insight regarding the cause of or ways to control their violent behavior.

To address the possibility that chronic heavy alcohol ingestion could result in physiologic changes that could effect the lactate response, we also administered sodium lactate to a nonviolent alcoholic comparison group. The NV ALC group fulfilled DSM-III-R criteria for alcohol abuse or dependence and included 17 males and five females. The third group, HCSs, consisted of 19 males and four females who had no history of alcohol abuse, alcohol dependence, or interpersonal aggression. They did not fulfill criteria for any lifetime DSM-III-R Axis I diagnosis. The two groups of nonviolent comparison subjects were recruited from the community, the National Institutes of Health volunteer office, and the clinical program of the National Institute on Alcohol Abuse and Alcoholism.

Subjects with a history of seizures, head trauma (defined as a period of unconsciousness exceeding 1 hour), or medical conditions requiring chronic medications were excluded from participation. Subjects with a DSM-III-R diagnosis of either bipolar illness or schizophrenia were also excluded. Subjects underwent extensive clinical and physical examinations to ensure that they were in good health. All perpetrators had an electroencephalogram and magnetic resonance imaging of the brain to rule out central nervous system pathology that could contribute to violent behavior. The DSM-III-R psychiatric diagnoses were derived using the Structured Clinical Interview (Spitzer et al 1992), which was administered by a social worker with extensive training in interviewing. All subjects were medication free for at least 3 weeks before the infusion studies. Subjects with a history of alcohol and/or drug abuse were abstinent for at least 3 weeks, whereas other subjects abstained for at least 72 hours before the studies. All subjects had a negative urine drug screen for illicit drugs. Each subject was interviewed to determine if he or she had witnessed or had been the recipient of domestic violence growing up.

Subjects were assessed for age, alcoholism (Michigan Alcohol Screening Test; Selzer 1971), socioeconomic status (Hollingshead Four Factor Index of Social Position; Hollingshead and Redlich 1958), depression (Hamilton Depression Inventory; Hamilton 1967), anxiety (Spielberger State and Trait Anxiety Inventory; Spielberger et al 1970), and aggression (Brown Goodwin Scale [Brown et al 1979] and Buss Durkee Hostility Inventory [Buss and Durkee 1957]). We also administered the Straus Conflict Tactics instrument (Straus 1979, 1990), consisting of 19 questions rating the frequency of specific behaviors (e.g., insulting, kicking, or hitting their significant other) on a scale of 0 (never) to 6 (every day). Specific subscores were derived from the Straus instrument for reasoning (e.g., rational discussion to resolve conflict), verbal aggression, and physical violence. The study was approved by the National Institute on Alcohol Abuse and Alcoholism’s institutional review board. After a complete description of the study was given to the subjects, written informed consent was obtained.

Infusion Study

PROCEDURE. After overnight bed rest and fast, an intravenous cannula was placed in the antecubital fossa and kept open with a slow infusion of normal saline. Approximately 1 hour after the placement of the cannula, a 10-mL/kg infusion of either 0.5 mol/L sodium lactate dissolved in sodium chloride or 0.9% sodium chloride (placebo) was administered over 20 min. Each infusion was administered on a separate day using a random-order, double-blind design. Before each infusion all subjects were informed that the administration of sodium lactate could result in a number of symptoms that might be similar to those associated with a panic attack and/or rage response. During each infusion, subjects were queried every 3 min by a psychiatrist for the presence of cognitive as well as somatic symptoms typically associated with rage and panic.

PSYCHOLOGIC EFFECTS. The Spielberger State Anxiety Inventory (Spielberger et al 1970) was administered before and after each infusion. To quantify the cognitive and somatic effects of lactate, subjects were asked to complete a symptom checklist (SCL) using a scale of 0 to 100 to rate the following symptoms: shortness of breath, heart pounding, chest pain, choking, dizziness, feelings of unreality, tingling, hot and/or cold flashes, sweating, faintness, fright, loss of control, and nausea. The sums of the individual symptoms on the SCL were calculated for both time 0 and the end of the infusion. A calculated value of the end of infusion sum minus the time 0 sum (CSCL) was obtained for each subject. We also calculated subscores (COGNITIVE, SOMATIC) using the SCL for cognitive (feelings of unreality, fright, and loss of control) and somatic (all symptoms listed above excluding cognitive) symptoms.

VIDEOTAPE. All infusions were videotaped and independently evaluated by two psychiatrists who were blind to both infusion type and patient diagnosis. After reviewing the entire videotape, the psychiatrists completed a videotape rating questionnaire (see Appendix 1) assessing the subject's physical appearance and verbal responses to the questions posed during each infusion. The variable FEAR is a specific question in the questionnaire. The variables PANIC and RAGE are the respective overall ratings in the questionnaire. The variable BEHAVIORAL, representing the behavioral changes during lactate infusion, was defined as the sum of the video ratings for speech, breathing, facial grimacing, motor activity of the hands/arms, and legs. The sum of all the questions comprising the videotape evaluation was used as an overall rating (VIDEO_{SUM}). The reliability and validity of the VIDEO_{SUM} was determined.

PHYSIOLOGIC EFFECTS. Heart rate and blood pressure were determined every 3 min throughout each infusion using an automated Dinamapp recorder. Blood was obtained at baseline and immediately after each infusion. Radioimmunoassays were performed by the Hazelton Corporation (Reston, VA) to determine the effect each infusion had on norepinephrine, epinephrine, and vasopressin plasma concentrations. Osmolality was also determined using a Hitachi (Tokyo) autoanalyzer (model 736-30).

Table 1. DSM-III-R Axis I Lifetime Diagnoses

	NV ALC (N = 22)	Perpetrators (N = 34)
Major depression	4	18
Panic disorder	0	3
Panic attack	2	12
Agoraphobia with panic	0	3
Social phobia	5	12
Simple phobia	5	7
Obsessive compulsive	0	3
Generalized anxiety	0	8
Organic mood	12	14
Organic anxiety	2	6
Posttraumatic stress disorder	4	13
Intermittent explosive	0	2
Alcohol dependence	22	22
Alcohol abuse	0	5
Cannabis dependence	7	12
Cocaine dependence	6	5

Statistical Analysis

The analyses employed were analyses of variance (ANOVAs) or covariance (ANCOVAs), repeated-measures ANOVAs, or Kruskal–Wallis (K/W) analyses. The validity of each parametric model was examined in each analysis, and appropriate nonparametric models were used when the parametric models were not adequate. Because of the number of tests performed we used a significance level of .005.

Results

Subjects

The DSM-III-R Axis I diagnoses for all of the perpetrators and nonviolent alcoholics are shown in Table 1. Seventy-eight percent of the perpetrators fulfilled criteria for either alcohol dependence or alcohol abuse. Perpetrators had a higher prevalence of anxiety-related disorders than the nonviolent alcoholics. Although all of the perpetrators reported behavioral symptoms characteristic of intermittent explosive disorder (IED), only two subjects (most subjects had other psychiatric diagnoses that precluded making a DSM-III-R diagnosis of IED) fulfilled criteria for the disorder.

There were no significant differences among the groups for age, height, weight, or socioeconomic status (see Table 2). Perpetrators (57%) had either witnessed or been the recipients of family violence (verbal/physical) more often than NV ALCs (27%) or HCSs (14%). Perpetrators had significantly higher Spielberger Trait Anxiety and Hamilton Depression scores than HCSs. As expected, perpetrators scored higher for all of the measures related to aggression or acts of domestic violence (e.g., Brown Goodwin, Buss Durkee Hostility Inventory, and Straus Conflict Tactics scales).

Table 2. Subject Characteristics

	HCSs	NV ALCs	Perpetrators	ANOVA (<i>F</i>) or K/W test (<i>p</i>)
Age (years)	37.5 ± 8.0 <i>N</i> = 23	39.5 ± 8.6 <i>N</i> = 22	38.2 ± 6.7 <i>N</i> = 34	<i>F</i> (2,76) = 0.4, <i>p</i> = .690
MAST ^a	0.7 ± 1.6 <i>N</i> = 23	36.9 ± 22.8 <i>N</i> = 22	24.7 ± 22.0 <i>N</i> = 34	<i>F</i> (2,76) = 21.9, <i>p</i> < .001
Hollingshead Social Position Index	4.1 ± 0.7 <i>N</i> = 23	3.9 ± 0.6 <i>N</i> = 22	3.8 ± 1.2 <i>N</i> = 34	<i>F</i> (2,76) = 0.5, <i>p</i> = .590
Brown Goodwin Aggression Scale ^a	5.0 ± 4.2 <i>N</i> = 23	8.3 ± 4.9 <i>N</i> = 22	16.2 ± 8.0 <i>N</i> = 29	<i>F</i> (2,71) = 23.2, <i>p</i> < .001
Buss Durkee Hostility Inventory ^a	16.3 ± 9.1 <i>N</i> = 22	25.5 ± 7.8 <i>N</i> = 21	44.1 ± 13.9 <i>N</i> = 32	<i>F</i> (2,72) = 43.7, <i>p</i> < .001
Hamilton Depression Inventory ^a	1.8 ± 2.5 <i>N</i> = 23	4.4 ± 4.0 <i>N</i> = 22	7.8 ± 6.6 <i>N</i> = 34	<i>F</i> (2,76) = 9.9, <i>p</i> < .001
Spielberger Trait Anxiety ^a	29.4 ± 8.1 <i>N</i> = 23	35.4 ± 11.1 <i>N</i> = 22	43.8 ± 11.9 <i>N</i> = 33	<i>F</i> (2,75) = 12.6, <i>p</i> < .001
Straus Conflict Tactics				
Verbal Reasoning score	59.4 ± 32.6 <i>N</i> = 20	76.5 ± 30.8 <i>N</i> = 22	47.4 ± 23.7 <i>N</i> = 30	K/W = 10.2, <i>p</i> = .006
Verbal Aggression score ^a	6.8 ± 6.2 <i>N</i> = 20	5.4 ± 4.9 <i>N</i> = 22	39.6 ± 17.9 <i>N</i> = 31	K/W = 50.0, <i>p</i> < .001
Violence score ^a	0.3 ± 0.7 <i>N</i> = 19	0.1 ± 0.4 <i>N</i> = 19	8.6 ± 5.5 <i>N</i> = 26	K/W = 48.5, <i>p</i> < .001

Means ± SDs. HCSs, healthy comparison subjects; NV ALCs, nonviolent alcoholic comparison subjects; ANOVA, analysis of variance; K/W, Kruskal-Wallis; MAST, Michigan Alcohol Screening Test.

^aSignificant group effect.

Infusion Study

Lactate administration frequently elicited a very intense emotional response in perpetrators. The following case report illustrates the clinical characteristics of a typical perpetrator and their response to the lactate infusion:

CASE STUDY. The patient is a 34-year-old separated male with a history of multiple incarcerations for violent behavior. During elementary school, when antagonized by a classmate, he overturned a desk and struck a teacher. Throughout his teen years he had multiple fights with family members and neighborhood peers. As an adult, the majority of his verbal (e.g., cursing, derogatory comments) and physically aggressive behaviors (e.g., blows to the head, choking, punching, arm twisting, pushing) were directed toward his significant others. Although his aggressive behavior was worse when he was intoxicated, he also initiated domestic violence when he was sober. At the time of the domestic violence, he reported palpitations, increased breathing, nervousness, a sense of fear, and losing control. Usually the domestic violence was precipitated by circumstances that caused him to feel either insecure or rejected. On one occasion when he falsely perceived that his wife was having an affair, he became enraged and rammed his car into her car. He subsequently got out of his car and broke her windshield with his fist. During a clinical interview the subject was articulate, cooperative, and freely admitted that he had a problem with losing his temper.

On the day of the placebo infusion, the patient reported no discernible effects. Under the lactate condition, he reported experiencing a number of physical symptoms (e.g., deep breathing, gritting of his teeth, tenseness in his face, agitation) as well as feelings of confusion, panic, and a fear that he did not know what he was going to do. During the infusion he initially felt like the police were after him and he had a desire to run (i.e., panic); however, several minutes later, he felt like it was too late to run. At this point he reported an intense urge to yell, curse, and throw things. He stated that “this is how I feel when I hit my girlfriend.”

PSYCHOLOGIC EFFECTS. The Spielberger State Anxiety scores were examined with a four-way ANOVA with two repeated measures, drug and time, and one group factor and an order factor. Perpetrators had a significantly larger group effect than did the two control groups [*F*(2,69) = 14.4, *p* < .005]. There was also a significant drug by time effect [*F*(1,69) = 137.5, *p* < .005]. There was a significant simple effect for time under the lactate condition [*F*(1,69) = 126.4, *p* < .005]. There was also a significant simple effect for drug at the end of the infusion [*F*(1,69) = 163.7, *p* < .005].

The following variables were examined with K/W analyses. The CSCL did not show a significant difference among groups during placebo infusions (HCSs: *N* = 22, 11.0 ± 39.4; NV ALCs: *N* = 21, -2.6 ± 9.2; perpetrators: *N* = 34, 13.0 ± 45.2; K/W test 1.7, *p* = .424) or lactate

Table 3. Lactate Infusion Videotape Results

	HCSs	NV ALCs	Perpetrators	K/W test
BEHAVIORAL ^a	2.1 ± 2.0 N = 22	2.9 ± 1.4 N = 18	4.9 ± 3.3 N = 27	16.5, <i>p</i> < .001
FEAR ^a	0.5 ± 0.7 N = 22	0.3 ± 0.3 N = 19	1.1 ± 0.8 N = 27	12.9, <i>p</i> = .002
PANIC ^a	0.5 ± 0.7 N = 22	0.4 ± 0.4 N = 19	1.2 ± 1.0 N = 28	10.8, <i>p</i> = .005
RAGE ^a	0.1 ± 0.3 N = 22	0.1 ± 0.3 N = 18	0.9 ± 0.8 N = 28	27.1, <i>p</i> < .001
VIDEO _{AVE} ^a	4.5 ± 4.9 N = 23	5.1 ± 2.8 N = 19	13.3 ± 9.3 N = 28	21.1, <i>p</i> < .001

Means ± SDs. HCSs, healthy comparison subjects; NV ALCs, nonviolent alcoholic comparison subjects; K/W, Kruskal–Wallis; BEHAVIORAL, sum of the video ratings for speech, breathing, facial grimacing, and motor activity of the hands/arms and legs.

^aSignificant group effect.

infusions (HCSs: *N* = 21, 242.5 ± 207.5; NV ALCs: *N* = 21, 202.7 ± 154.3; perpetrators: *N* = 32, 260.1 ± 391.3; K/W test 8.3, *p* = .016). However, during the lactate infusions there was a significant group difference for COGNITIVE (HCSs: *N* = 22, 15.7 ± 32.1; NV ALC: *N* = 22, 16.4 ± 25.2; perpetrators: *N* = 33, 56.1 ± 61.9; K/W test 11.7, *p* = .003) but not for SOMATIC (HCSs: *N* = 21, 216.8 ± 188.6; NV ALCs: *N* = 21, 176.7 ± 137.0; perpetrators: *N* = 32, 300.9 ± 188.8; K/W test 6.1, *p* = .046). Specifically, examining the somatic variable “shortness of breath” in a K/W analysis we did not find a significant group difference (HCSs: *N* = 23, 23.9 ± 28.5; NV ALCs: *N* = 21, 27.4 ± 28.4; perpetrators: *N* = 34, 38.0 ± 31.9; K/W test 3.5, *p* = .17).

VIDEOTAPE. The reliability of the videotape ratings was examined by measuring the intraclass correlation between the two VIDEO_{SUM} ratings during the lactate infusion. The pooled within-groups intraclass correlation was .77 for *N* = 70, indicating a sufficiently reliable measure. The variable VIDEO_{AVE} was defined as the average of the VIDEO_{SUM} ratings for the two raters. The correlation of the VIDEO_{AVE} ratings and the CSCL during lactate infusion, *r* = .61, supports the conclusion that the videotape ratings were a valid measure of lactate response. Also, the Spielberger State score at the end of the lactate infusion day was correlated, *r* = .51 with VIDEO_{AVE} and *r* = .62 with CSCL.

Kruskal–Wallis analyses were performed using VIDEO_{AVE} for both placebo and lactate infusion days. Videotapes made during the placebo infusion showed no significant effects (data not shown).

Kruskal–Wallis analyses of the lactate infusion showed perpetrators had significantly greater fear, rage (e.g., anger, aggressive feelings), and panic (e.g., desire to run) responses than NV ALCs and HCSs. Perpetrators also had significantly greater scores for the BEHAVIORAL variable. The VIDEO_{AVE} was also significantly higher for the perpetrator group (see Table 3).

PHYSIOLOGIC EFFECTS. Four-way repeated-measures analyses showed that there were no significant four-way interactions, order effects, or group effects for norepinephrine, epinephrine, cortisol, vasopressin, osmolality, diastolic blood pressure, systolic blood pressure, and heart rate. There were no significant effects for cortisol epinephrine and diastolic blood pressure. There was a significant drug by time interaction for norepinephrine, vasopressin, osmolality, systolic blood pressure, and heart rate. The subsequent simple-effects tests showed that there was a significant drug effect at the end of the infusion and a significant time effect for lactate (see Table 4).

COVARIATES. To control for group differences in the exposure to family violence and state anxiety levels, we repeated all previous analyses with these two variables as covariates in ANCOVAs. RAGE was the only variable that had a significant [*F*(2,58) = 6.4, *p* < .003] group difference, which was higher among the perpetrators.

Discussion

In this study we infused the panicogenic agent sodium lactate to explore the possibility that some perpetrators of domestic violence may have difficulty in the regulation of fear-related behaviors. Videotapes of the lactate and placebo infusions were independently assessed by two psychiatrists who were blind to patient diagnosis and infusion type. During the lactate infusions, perpetrators exhibited significantly greater fear, rage, and panic reactions as well as greater changes in the BEHAVIORAL variable (i.e., sum of the video ratings for speech, breathing, facial grimacing, and motor activity of the hands/arms and legs) than both groups of nonviolent comparison subjects. Perpetrators also scored higher than nonviolent comparison subjects on the SCL for the COGNITIVE subscale (feelings of unreality, fright, and loss of control).

Fifty-seven percent of the perpetrators acknowledged

Table 4. Lactate-Induced Changes in Physiologic Measures

	HCSs (<i>N</i> = 23)	NV ALCs (<i>N</i> = 22)	Perpetrators (<i>N</i> = 34)
Blood chemistry			
Norepinephrine (pg/mL)			
T = 0	216.6 ± 141.3	189.0 ± 88.2	177.4 ± 66.7
End of infusion	243.8 ± 179.8	282.0 ± 143.0	277.5 ± 180.1
Epinephrine (pg/mL)			
T = 0	18.8 ± 22.0	18.0 ± 13.3	19.8 ± 11.0
End of infusion	30.4 ± 56.4	21.6 ± 11.0	22.9 ± 9.8
Cortisol (μg/dL)			
T = 0	10.9 ± 4.7	10.4 ± 2.8	11.0 ± 4.1
End of infusion	11.2 ± 4.3	9.9 ± 3.5	10.3 ± 4.0
Vasopressin (pg/mL)			
T = 0	0.6 ± 0.3	0.5 ± 0.1	0.5 ± 0.2
End of infusion	5.4 ± 4.4	2.7 ± 2.3	3.7 ± 4.9
Osmolality (mOsm/kg)			
T = 0	281.1 ± 5.4	283.4 ± 4.0	281.6 ± 5.5
End of infusion	298.8 ± 7.0	300.4 ± 6.4	293.1 ± 47.9
Diastolic blood pressure (mmHg)			
T = 0	70.1 ± 10.0	70.1 ± 8.6	68.0 ± 8.1
End of infusion	71.6 ± 13.1	69.1 ± 9.0	69.4 ± 12.9
Systolic blood pressure (mmHg)			
T = 0	115.5 ± 13.2	115.9 ± 14.4	117.8 ± 13.4
End of infusion	132.8 ± 16.2	128.3 ± 12.2	133.6 ± 14.8
Heart rate (beats/min)			
T = 0	61.8 ± 9.8	64.1 ± 7.2	63.4 ± 10.1
End of infusion	98.5 ± 7.7	96.8 ± 7.4	98.3 ± 11.2

Means ± SDs. HCSs, healthy comparison subjects; NV ALCs, nonviolent alcoholic comparison subjects.

that they had been the recipients of violence growing up. Perpetrators also showed higher levels of both trait and state anxiety. When covariate adjustments for history of family violence and state anxiety were performed, perpetrators still showed significantly more rage than the nonviolent comparison subjects. This, along with the fact that only 26% of perpetrators fulfilled criteria for either panic or organic anxiety disorders, suggests that perpetrators are more likely to display rage than panic in response to perceived threatening stimuli.

Consistent with the findings of previous studies (Gondolf 1988; Kantor and Straus 1992; Saunders 1992; Van Hasselt et al 1985), a high percentage (79%) of the perpetrators in this study fulfilled DSM-III-R criteria for alcohol abuse or dependence. The fact that the NV ALC group had significantly smaller panic and rage responses than the perpetrator group implies that the lactate response evidenced by perpetrators was not due to the effects of alcohol abuse.

All of the subject groups showed a significant increase in heart rate, systolic blood pressure, and plasma concentrations of norepinephrine. There were no corresponding group differences in the activation of the autonomic nervous system (i.e., norepinephrine, epinephrine, heart rate, and blood pressure determinations), the hypothalamic–pituitary–adrenal axis (cortisol), or the posterior hypo-

thalamus (vasopressin). The absence of group differences for these physiologic measures is consistent with previous lactate studies involving panic patients (Liebowitz et al 1985b).

In interpreting these results it is important to emphasize that domestic violence is the culmination of a complex set of interactions between the perpetrator, the victim, environmental circumstances, and cultural mores. The mechanism whereby lactate administration causes the differential behavioral responses found in perpetrators and nonviolent comparison groups does not appear to be related to baseline states of trait anxiety, since perpetrators and nonviolent alcoholics had similar levels. It is possible that the nonspecific symptoms of autonomic arousal associated with lactate administration may be interpreted by the perpetrator as panic/rage on the basis of past experiences and/or expectations inherent in the experimental situation. Alternatively, it is possible that lactate, as a result of either its anxiogenic or its biochemical properties, causes the activation of specific neural pathways in the perpetrators that mediate fear-related fight and/or flight behaviors.

Conclusion

We have demonstrated the following: 1) the instruments used to quantify the lactate response were reliable and

valid, showing a correlation between the subjects' self-reports and objective video responses; 2) the perpetrator group displayed significantly larger lactate responses in the BEHAVIORAL, FEAR, PANIC, and RAGE variables; 3) all groups displayed significant increases in heart rate, systolic blood pressure, and plasma concentrations of norepinephrine; 4) alcohol dependence did not explain the perpetrators' lactate behavioral response; 5) high anxiety levels did not explain perpetrators' behavioral response; and 6) a group difference in the RAGE variable remains after performing a covariate adjustment for state anxiety and exposure to family violence. These results support our hypothesis that some perpetrators have exaggerated fear-related responses to perceived threats. This has important implications for treatment because antidepressant medications have been shown to reduce symptoms of anxiety and panic as well as rage (George et al 1989; Marshall 1997).

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Appendix 1

Videotape Rating Questionnaire

Reactions observed by rater during infusions

Physical

Speech

0. Normal rate and volume
1. Mildly elevated rate or volume
2. Moderately elevated rate or volume, may be pressured or insistent
3. Severely elevated rate and volume (e.g., angry yelling)

Breathing

0. No abnormality, quietly breathing
1. Mildly increased rate or depth, includes sighs
2. Moderately increased rate or depth
3. Severely increased rate and depth (i.e., hyperventilation)

Facial grimacing

0. None, relaxed facial expression
1. Vaguely unsettled or irritated appearance (e.g., eyes transiently narrowed, eyes widened once)
2. Obviously angry or scowling appearances, or eyes widened with fright or frequent changes
3. Severely menacing, angry, frightened, frightening appearance, or sustained changes

Motor activity of hands and arms

0. None; calm, open, relaxed palms
1. Vague changes, occasional flexing or some transient movements
2. Moderately restless or sustained motion, fists occasionally clench or hands frequently flex
3. Severe, agitated movements; pounding or punching motions

Motor activity of legs

0. None, calm
1. Some vague transient movements
2. Moderately restless movements
3. Severe, agitated movements

Shaking, movements in unison

0. None
1. Mild, transient shaking
2. Moderate, sustained shaking
3. Severe, sustained vigorous shaking

Physical tension

0. No physical tension
1. Vague or transient appearance of tension (e.g., stretches once)
2. Obvious signs of tension, stiffening back and trunk, may attain a freezing posture
3. Severe sustained whole body tension, may have prolonged freezing

Affect

Sadness

0. Normal
1. Mildly or vaguely sad, or dysphoric
2. Moderately sad or dysphoric
3. Markedly sad, tearful, or dysphoric

Fear

0. Appears calm
1. Mildly or vaguely fearful
2. Obviously but moderately fearful
3. Severely frightened

Inappropriate affect

0. Normal affect
1. Mild, does not appear normal for the situation
2. Moderate (i.e., inappropriate giggling or other inappropriate expressions)
3. Severe (i.e., maniacal laughter or other inappropriate expressions)

Dissociation

Detachment or withdrawal

0. Appropriately engaged with the situation, may be a little bored
1. Appears detached, may be staring or avoiding eye contact with examiner
2. Moderately detached, may have difficulty reorienting to the situation, may be somewhat confused
3. Markedly detached or disoriented, may not respond readily

Posttraumatic symptoms

0. None
1. Reports vague or transient thoughts, or image about a past event
2. Reports an obvious intrusion of thoughts or images of a specific past traumatic event
3. Reports severe distressing recollections, illusions, or flashbacks of a specific traumatic event

Cognition

Cognitive effort exerted to remain calm or in usual state

0. None
1. Mild effort apparent or expressed (e.g., laying with eyes closed and apparently concentrating)
2. Moderate effort to remain calm or return to normal (e.g., patient mentions once an activity they do to calm themselves down or discharge the feeling)
3. Exerting considerable effort to remain calm or return to normal (i.e., patient repeatedly describes activities he or she does to calm down or discharge the feeling, or describes barely holding it together)

Patient reports that he or she drinks or uses drugs to calm down, discharge the feeling, or change their state

0. No/no report
1. Yes

Patient reports that the current feeling is similar to a past episode of violence or a feeling preceding violence

0. No/no report
1. Yes

Patient reports that the current feeling is similar to a past episode of panic or a feeling preceding panic

0. No/no report
1. Yes, panic

Patient reports a feeling similar to being victimized or attacked

0. No/no report
1. Yes

Overall

Overall appearance of panic

0. Normal
1. Mildly or vaguely apprehensive, or anxious
2. Obviously apprehensive or anxious
3. Seriously frightened or panicked

Overall appearance of rage

0. Normal
1. Mildly or vaguely angry, or irritable
2. Obviously angry or irritable
3. Severe anger, irate, or full of rage