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A model linking biology, behavior and psychiatric diagnoses in perpetrators of domestic violence

David T. George *, Monte J. Phillips, Linda Doty, John C. Umhau, Robert R. Rawlings

Laboratory of Clinical and Translational Studies, DICBR, National Institute on Alcohol Abuse and Alcoholism, National Institutes of Health, 10 Center Drive MSC-1540, Bldg 10 – Hatfield CRC Room 2-2352, Bethesda, MD 20892-1540, United States

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Summary Research indicates that perpetrators of domestic violence have abnormalities in central serotonin and testosterone metabolism, an increased sensitivity to anxiogenic stimuli, and an impaired neuro-connection between their cortex and the amygdala. Clinical evaluations show that perpetrators of domestic violence also have a distinguishing set of behaviors and diagnoses related to anxiety, depression, intermittent explosive disorder, and borderline personality disorder. In this paper we propose a model to understand how the biological abnormalities can potentially explain the behaviors and diagnoses exhibited by the perpetrators. Changes in the perpetrator's neurotransmitters lead to a heightened sensitivity to environmental stimuli, anxiety, and conditioned fear. Lack of cortical input to the amygdala impairs the perpetrator's ability to extinguish anxiety and/or conditioned fear and gives rise to either innate behaviors (e.g., fight, flight, and shut down) or learned fear avoidant behaviors designed to avoid anxiety (e.g., alcohol consumption, self-injurious acts, and obsessive behaviors). Linking conditioned fear and fear avoidance to the behaviors and psychiatric diagnoses will serve to change the way the medical community perceives and treats perpetrators of domestic violence.
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Background

Numerous studies have attributed domestic violence to either behavioral patterns learned in childhood [1–3] or to disinhibiting effects of alcohol [4,5]. These factors undoubtedly play a role in the etiology of domestic violence; however, at least 76% of perpetrators of domestic violence are violent when they are not drinking [6,7] and more than 40% are not exposed to abuse growing up [8,9]. These discrepancies led us to consider the possibility that other factors may be involved in the etiology of domestic violence.

Our early work [10,11], showing that perpetrators of domestic violence experience fear, auto-

* Corresponding author. Tel.: +1 301 435 9385; fax: +1 301 402 1543.
E-mail addresses: tedg@mail.nih.gov, tedg@niaaa.nih.gov (D.T. George).

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nomic activation, and an overwhelming need to defend themselves at the time of the violence, led us to conduct a series of studies designed to understand the etiology of these fear-related behaviors. Results from sodium lactate infusions showed that perpetrators were more likely to report feelings of panic and/or rage following administration of this anxiogenic agent than nonviolent controls [12]. Cerebral spinal fluid determinations showed that perpetrators had significantly different concentrations of serotonin and testosterone [13] than nonviolent controls. ^{18}F-2-fluoro-2-deoxyglucose (FDG) positron emission tomography (PET) studies showed that perpetrators had reduced correlations in glucose metabolism between various cortical structures and the amygdala when compared to nonviolent controls [14]. As a result of these findings, we concluded that perpetrators have abnormalities in the neuropathways that mediate conditioned fear and fear avoidance.

Based on in-depth clinical interviews and formal diagnostic evaluations performed on the 71 perpetrators who participated in the previously described studies, we found that the perpetrators exhibit a characteristic set of behaviors and psychiatric diagnoses. We hypothesize that many of these characteristic behaviors and diagnoses can be linked to fear conditioning and fear avoidance. This linkage provides the basis for a model to better understand the etiology of domestic violence and to gain new insights into treatment.

Behaviors of perpetrators

The perpetrators frequently reported that during their childhood they had repeated hostile interactions with their siblings and peers ranging from teasing, to bullying, to physical fights. As early as elementary school, perpetrators lost control, threw things, and turned over desks when confronted by authority figures. As the perpetrators reached their late teens or early twenties and left their family of origin, the focus of their aggressive behaviors typically shifted toward intimate relationships. This aggression could also be self-injurious (e.g., cutting themselves and/or taking overdoses of pills).

The majority of the perpetrators had little insight into their behavior. Typically, perpetrators did not acknowledge that they had a problem with aggression and in most cases blamed their violent behavior on their significant other. Perpetrators often felt that they were the victims of unreasonable demands and felt devalued and/or disrespected at work and especially at home. At home perpetrators often interpreted dinner not being ready, dishes not being done, and children not being attentive as personal affronts. When asked to do ''something'' by their significant other, the perpetrators felt bossed or nagged — to the point of feeling disrespected or threatened. This threat gave rise to an urge to ''defend themselves'' using either verbal or physical aggression. Yet, in spite of their propensity to project blame, most of the perpetrators were typically remorseful and vowed on numerous occasions that the violence would never happen again. The process whereby they ultimately acknowledged that they had an aggression problem was later in life when they lost a valued job or when their significant other whom they loved ended the relationship.

All of the perpetrators exhibited an affective instability that was typified by rapid changes in mood. The majority of perpetrators evidenced two sides. Typically, perpetrators were engaging and appeared calm provided everything was going their way. However, if challenged, perpetrators exhibited another side which was comprised of a number of different mood states ranging from anxious and fearful, to feelings of emptiness and depression, to anger and rage. These mood states were out of proportion to the situation and rapidly shifted in response to environmental stimuli that were perceived as irritating or threatening.

Further querying of the perpetrators about their moods revealed a profound dichotomy between the calm and engaging appearance which perpetrators projected in normal social situations versus the mental state they were actually experiencing. Descriptions of this mental state ranged from a non-specific sense of fear and anxiety to a ''motor running inside.'' Almost every perpetrator experienced a sense of racing or ''flipping'' thoughts (i.e., one idea triggered another idea, which in turn triggers another idea). The presence of these racing thoughts impaired their ability to focus. Demands, confrontations, and uncertainties increased the rapidity of the thoughts and culminated in a sense of threat, fear, and ''being out of control.''

The perpetrators' primary mode of coping with this sense of fear, anxiety, and racing thoughts was to emotionally ''shut down'' in order to decrease sensory stimulation. Perpetrators evidenced varying degrees of social withdrawal ranging from ''vegging'' in front of the television, not answering the telephone, to even more isolative behaviors. These isolative behaviors were often accompanied by changes in their mental state such that the racing thoughts were partially replaced by feelings of indifference, emptiness, numbness, and sadness.

When the isolative state was interrupted by confrontations or demands initiated by their significant other or by seemingly innocuous sensory stimuli (e.g., dinner being late, clutter in the house, kids playing), the perpetrators experienced a return of the rapid thoughts and anxiety. At this point, most perpetrators experienced a profound desire to escape from the situation (i.e., ''flight''). The attempt at leaving typically turned into a major spectacle where the perpetrators screamed, ''I'm out of here, I'm not putting up with this...'' and then slammed the door. At this point the perpetrators attempted to calm the racing thoughts by engaging in various activities such as jogging or driving their car recklessly at high speeds. Hours later, when the racing thoughts began to subside, the perpetrators returned home and acted like nothing had happened.

Physical aggression (i.e., ''fight'') occurred in a number of predictable situations. Aggression occurred when escape was not perceived as an option (e.g., the significant other blocked the door and said ''You are not leaving until you...'' or when the significant other continued the argument by following the perpetrator as he or she attempted to leave). Aggression was also precipitated by external stimuli such as ''tones of voice,'' ''looks,'' expectations (either internally or externally generated), confrontations, ''slights'' (e.g., perceptions of being ''devalued'' or ''not listened to''), or even something as simple as a child spilling milk at the dinner table. Occasionally, the aggression occurred without any identifiable precipitant. The perpetrators sought to discharge their feelings of anxiety and rage either by provoking a fight with their significant other or by using eye contact or a bump from a stranger to justify a litany of profanity and/or violence.

The significant others reported that they could tell when the violence was going to occur. The perpetrators paced the floor, waved their arms, and got in the significant others' face. The perpetrators' eyes ''shot daggers,'' their voice was harsh and intimidating, and their jaw was fixed. Attempts by the significant other to employ reason to stop the progression of events were typically unsuccessful; perpetrators were characterized as ''irrational''.

Perpetrators reported that the violence happened so quickly that they were unable to identify the emotions associated with the aggression. However, upon careful reflection, most perpetrators reported that prior to the violence they experienced not only an escalating sense of racing thoughts, anxiety, and fear, but also autonomic arousal (e.g., palpitations, increased breathing, and nervousness), extraordinary energy, and a compelling need to defend themselves. In all cases, the emotion of ''fear'' was out of proportion to any physical threat (e.g., the male perpetrators are physically larger than their significant others), and by their own account they were not in any physical danger.

Just prior to the onset of violence, perpetrators were largely unaware of the surroundings and the victim became the focus of their attention. There was no regard for the potential consequences of their actions. Perpetrators became grandiose and felt invincible. They felt no inhibition when they slammed doors, threw things, initiated name-calling, and were physically aggressive. They described feeling energized and devoid of any painful stimuli as they smashed the wall or struck their significant other.

The physical aggression (e.g., striking their significant other, hitting a wall with their fist, cutting themselves, etc.) served to diminish the perpetrator's racing thoughts and promoted an internal sense of peace. The sight of their significant other's cowering, being physically injured, and/or the sight of blood also served to terminate the aggression presumably by signaling that the ''threat'' was over. These examples of immediate relief are in contrast to the prolonged sense of anxiety and racing thoughts that perpetrators experienced when they fled from the confrontation.

If the significant other became emotionally distant or physically left the perpetrator, a different set of behaviors arose. The perpetrator interpreted the emotional distance and leaving as ''threat'' and developed an obsession about their significant other. Perpetrators became insanely jealous (to the point of paranoia such as imagining that their significant others were having an affair) and thought about their significant other incessantly. The perpetrator called them on the phone dozens of times per day begging for forgiveness and promising that things would be different. In some cases, perpetrators stalked their significant other by following them and/or driving by their new living arrangement even when there was a police protective-order forbidding such behaviors. In most instances the intent of the obsessive behaviors was to get their lives back to ''normal.'' However, occasionally the intent was to hurt their significant other.

Many of the perpetrators reported that alcohol and marijuana helped them to calm down when they were anxious and angry. However, alcohol was particularly problematic for many of the perpetrators since alcohol shortened their reaction time to a perceived threat and increased the likeli-

hood that they would respond to the perceived threat with ''fight'' rather than ''flight'' behaviors. Perpetrators under the influence of alcohol were also more likely to engage in impulsive types of self-injurious behaviors (e.g., cutting themselves, taking an overdose of pills).

Psychiatric diagnoses of perpetrators

The DSM-III-R diagnoses for the perpetrators studied (See Table 1), compared to individuals in the general population with alcohol dependence [15,16], show a high incidence of both Axis I (i.e., panic disorder, phobias, obsessive compulsive disorder, generalized anxiety disorder, post traumatic stress disorder) as well as Axis II, Cluster C disorders (i.e., avoidant, dependent, obsessive compulsive, and passive aggressive) that typify individuals who are anxious and fearful [17]. In addition, a high percentage of the perpetrators fulfilled criteria for major depression and borderline personality. All of the perpetrators exemplified the diagnostic criteria for intermittent explosive disorder (IED). However, the exclusionary criteria employed in the DSM-III-R for making the diagnosis of IED (i.e., intoxication with any psychoactive substance, presence of antisocial or borderline personality) resulted in only 9.9% of the perpetrators actually fulfilling the criteria for IED.

Linking biology, behavior, and psychiatric diagnoses

The neuropathways associated with conditioned fear and fear avoidance have been well characterized in animals. Amorapanth et al. [18] found that activation of the lateral amygdala by a conditioned stimulus triggers either a conditioned fear response via the central nucleus of the amygdala or a fear avoidance response via the basal nucleus of the amygdala. The conditioned fear and fear avoidance responses are engaged over different time scales [18,19]; conditioned fear responses are instantaneous responses to danger while fear avoidance responses are learned and require a longer time period.

Fear conditioning

Animal studies indicate that fear conditioning occurs when conditioned and unconditioned stimuli converge in the amygdala [20,21]. Conditioned fear responses result in the activation of autonomic (e.g., palpitations, increased respiratory rate, tremors, decreased pain sensation), behavioral (i.e., freezing), and hormonal (i.e., hypothalamic-pituitary-adrenal axis) responses that are expressed in the presence of danger [22]. In certain situations, these conditioned fear responses can result in a predictable set of innate behaviors

Table 1 DSM-III-R axis I and axis II diagnosis for 71 perpetrators of domestic violence

Axis I	Percent (%)	Axis II	Percent (%)
Mood disorders		Cluster A	
Major depression	47.9	Paranoid	22.5
Organic mood disorder	56.3	Schizoid	2.8
Anxiety disorders		Schizotypal	0
Panic disorder	8.5	Cluster B	
Agoraphobia w/o panic	8.5	Antisocial	32.4
Social phobia	31.0	Borderline	70.4
Simple phobia	18.3	Histrionic	9.9
Obsessive-compulsive disorder	9.9	Narcissistic	32.4
Generalized anxiety disorder	22.5	Cluster C	
Organic anxiety	23.9	Avoidant	29.6
Post traumatic stress disorder	39.4	Dependent	29.6
Impulse-control disorders		Obsessive-compulsive	46.5
Intermittent explosive disorder	9.9	Passive-aggressive	28.2
Psychoactive substance use disorders		Disruptive behavioral disorders	
Alcohol dependence	71.8	Attention-deficit/hyperactivity disorder	25.4
Cannabis dependence	40.8	Others	
Cocaine dependence	31.0	Self-defeating	49.3
Stimulant dependence	9.9		
Opiod dependence	9.9		
Hallucinogen dependence	12.7		

(i.e., fight, flight, and shut down) [23—25]. The following behaviors and diagnoses that characterize perpetrators are associated with conditioned fear responses

(A) Individuals with high anxiety and borderline personality have an intentional bias toward threat-related stimuli [26,27] and fear recognition [28], respectively. Individuals with high social anxiety evaluate interpersonal cues more negatively [29]. Individuals with alcohol dependence have an impairment in their ability to process emotional stimuli [30—32].

(B) Changes in central nervous system serotonin and testosterone metabolism modulate the processing of sensory stimuli and could contribute to the over-reactivity to environmental stimuli seen in perpetrators. ''Looks'', ''tones of voice'', ''slights'', etc., from their significant other activate the amygdala [33,34] and give rise to conditioned fear. Without cortical control of the amygdala, perpetrators interpret environmental stimuli quickly [21,35—40]. This interpretation is imprecise and contributes to the perpetrators' propensity to over-react to environmental stimuli with a sense of threat, jealousy, and/or paranoia.

(C) Significant others report that perpetrators at the time of the aggression become irrational and do not respond to reason. Garcia et al. [41] showed that threatening stimuli cause an increase in the firing rate of the neurons in the amygdala with a corresponding decrease in the firing rate of neurons in the medial prefrontal cortex. This decrease in cortical input in response to threat may affect the perpetrators' ability to use reason at the time of the violence.

(D) Activation of the neurons that mediate ''fight and rage'' are responsible for the loud harsh voice, facial grimacing, increased breathing, heart palpitations, and reduction in pain sensation evidenced by the perpetrators at the time of the aggression.

(E) Activation of the neurons that mediate ''flight'' give rise to feelings of panic and being ''trapped.'' Most perpetrators report a profound desire to terminate the discussion, storm out of the room, etc., when confronted with conflict.

(F) Activation of the neurons that mediate ''shut down,'' give rise to a state of withdrawal in animals. In the case of the perpetrators, shut down serves to decrease sensory stimulation and reduce autonomic activation. Shut down is associated with feelings of being numb, empty, and depressed. Since shut down occurs in response to sensory stimuli, the depression found in the perpetrators may have its etiology in the perpetrators' inability to modulate their response to environmental stimuli.

(G) The groups of neurons that mediate fight, flight, and shut down are in close proximity to each other in the periaquaductal gray (PAG) [23]. The dorsolateral PAG and lateral PAG are involved with active coping (i.e., fight and flight) while the ventrolateral PAG is involved with passive coping (i.e., shut down). Control of these behaviors occurs both at the local level of the hypothalamus and PAG as well as the amygdala and medial prefrontal cortex [23,25,42]. Interconnecting neurons and various neurotransmitter systems between these different groups of neurons serve to inhibit and/or facilitate each of the behaviors [24,43,44]. As environmental situations change, an animal or person may shift from one coping strategy to another. In this regard, some perpetrators demonstrate rapid shifts of mood and behavior ranging from depression (i.e., shut down) to panic (i.e., flight) to rage (i.e., fight). This affective instability is diagnostic for individuals with borderline personality (i.e., unstable and intense interpersonal relationships, impulsiveness, affective instability with depression and anxiety, intense anger and recurrent fights, suicidal threats and gestures, self-mutilation, chronic feelings of emptiness and fear of abandonment) [17].

(H) Racing thoughts, increased motor activity, feelings of grandiosity and invincibility reported by the perpetrators at the time of the violence are characteristics associated with rage as well as mania. These feelings theoretically serve to ready the perpetrator to respond to ''threat.''

(I) The connections between the cortex and amygdala are necessary to extinguish conditioned fear responses [33,45,46]. The decreased correlations in glucose metabolism between the cortex and the amygdala in perpetrators [14], are consistent with the fact that when perpetrators reached a threshold for threat, it often took them hours or days to calm down.

(J) Perpetrators often reported that alcohol decreased the time it took for them to respond to ''threat'' with intense anger or violent behavior. Animal studies show that the time between the electrical stimulation of neurons in the medial hypothalamus and the time it takes an animal to display defensive rage is

significantly reduced following the administration of alcohol [47]. The high prevalence of alcohol dependence found in perpetrators is consistent with the literature on domestic violence [48,49]. The high rate of marijuana dependence seen in the perpetrators has not been previously reported.

Fear avoidance

Poremba and Gabriel [50] along with Kubota et al. [51] have shown that the learning of an avoidance response involves the amygdala, limbic thalamus (anterior and medial dorsal thalamic nuclei), the posterior cingulate, and the striatal motor areas. The basolateral amygdala (BLA) and the orbitofrontal cortex interact in the learning of avoidance behavior [40,52] while the amygdala plays an essential role in the memory consolidation of inhibitory avoidance [53]. After sufficient repetitions, the amydgala activation is not required for the conditioned stimulus to trigger a premotor command from the anterior cingulate to the striatum for execution of avoidance responses [51].

Rosenkranz and Grace [54] have shown in animals that the BLA receives input from medial prefrontal and sensory cortical brain regions. In the presence of fear and anxiety, dopamine levels in the BLA increase. This increase in dopamine serves to decrease the inhibitory effect from the medial prefrontal cortex and facilitate sensory-driven affective behavior. In effect, the cortical control of behavior is attenuated so that a sensory cue can trigger a previously learned fear avoidance response. The following behaviors exhibited by perpetrators are possible examples of fear avoidant behaviors that serve to decrease fear and anxiety

(A) Isolative behaviors reduce external stimulation and decrease fear and anxiety. These isolative behaviors can become a learned fear avoidant behavior.
(B) Stalking occurs when the significant other becomes emotionally distant or physically leaves the perpetrator. Here, the emotional or physical abandonment is commensurate with threat and the perpetrator becomes obsessed with his/her significant other. Consistent with stalking literature [55], perpetrators report a sense of relief and a reduction in anxiety when communication is reestablished with the significant other. This form of stalking needs to be distinguished from a less frequent form of stalking where the perpetrator's goal is to hurt their significant other. This form of stalking is predatory, not fear-avoidant, and may arise from neurons in the hypothalamus [24].
(C) Perpetrators use alcohol and marijuana to decrease fear and anxiety. The use of alcohol is a well recognized method to reduce anxiety [56].
(D) Perpetrators report that self-injurious behaviors (e.g., cutting themselves, banging their hand and/or head) have a similar calming effect. There is a learning effect, which is reinforced by a reduction in anxiety that is potentially mediated by new sensory input to the thalamus and the amygdala.
(E) Perpetrators state that they feel calm after they have been violent. This calm has an obvious rewarding quality, which theoretically provides an incentive for the perpetrators to instigate fights with their spouse, or in some cases strangers, in order to reduce anxiety.

Implications for treatment

The model, linking behaviors and psychiatric diagnoses to fear conditioning and fear avoidance, indicates that the psychopathology of perpetrators lies in their biased assessment of the environment and their lack of control of the response (e.g., fight, flight, shut down, alcohol consumption, etc.). The following points provide an innovative framework to understand and treat perpetrators of domestic violence

(A) *Safety*. Perpetrators and significant others need to realize that domestic violence is very dangerous. Perpetrators may need to separate from their significant other until safety can be assured. In severe cases it may be necessary to hospitalize the perpetrator or involve the legal system.
(B) *Medical/psychiatric evaluation*. Medical causes of aggression need to be ruled out. Medications aimed at decreasing the perpetrator's reactivity to environmental stimuli should be considered.
(C) *Education*. Since perpetrators have little insight or understanding regarding their feelings and behaviors, they tend to project blame for their aggression onto others. The model provides a non-threatening way of helping the perpetrator to link their feelings (e.g., dis-

respected, discounted, overwhelmed, anxious/fearful, etc.) and behaviors (e.g., fight, flight, shut down, and alcohol consumption) with changes in brain function.

(D) *Responsibility*. By understanding their behavior, perpetrators are more likely to assume responsibility for their behaviors and seek help.

(E) *Abstinence*. Since alcohol can increase the likelihood that violence will occur, abstinence from alcohol is necessary. Treatment for alcoholism is essential.

(F) *Conflict resolution*. Conflict is typically perceived as threat and leads to predictable behaviors (e.g., fight, flight, shut down, alcohol consumption, as well as obsessive compulsive or self-injurious behaviors). fMRI studies show that the cognitive labeling of threat activates the cortex and calms the amygdala [33]. Perpetrators should be taught to identify and verbalize perceived threats before they are in a state of rage and unable to rationally process the conflict. Perpetrators, as well as their significant others, should be taught the importance of the perpetrator seeking a safe and non-stimulating place to calm down if the conflict cannot be resolved.

(G) *Expectations for change*. Perpetrators are consistently remorseful and vow that the violence will never occur again. The model holds that the aggression arises from a conditioned fear response. Since conditioned fear is intended to promote survival, it is logical that fear-response behaviors will be long lasting and difficult to extinguish.

Implications for future studies

It is unclear whether the anxiety reported by perpetrators gives rise to their heightened reactivity to environmental stimuli or whether their heightened reactivity to environmental stimuli gives rise to anxiety. Since serotonin has been implicated in the modulation of sensory stimuli [57–60], we are currently utilizing genotyping and PET ligands (to label the number of serotonin transporter sites) to expand upon our previous CSF study [13] assessing serotonin function in perpetrators. The administration of selective serotonin reuptake inhibitors to perpetrators will allow us to assess the effects of increased serotonin concentrations on the neuro-connections between the cortex and the amygdala and observe if the changes in the connections between the cortex and amygdala relate to changes in anxiety and fear-related behaviors.

Conclusion

Perpetrators of domestic violence have an increased sensitivity to environmental stimuli, increased anxiety, and disturbances in the control of fear conditioning and fear avoidance. Lack of cortical input to the amygdala impairs the perpetrator's ability to modulate their reaction to sensory stimuli. In this paper we identified characteristic behaviors and psychiatric diagnoses of perpetrators of domestic violence and linked them to conditioned fear and fear avoidance. The behaviors arising from fear conditioning can be broadly categorized into fight, flight, and shut down. The behaviors associated with fear avoidance can be broadly categorized into obsessive compulsive, self-injurious, and substance abuse.

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