Child Abuse & Neglect 34 (2010) 507–515

Contents lists available at ScienceDirect

Child Abuse & Neglect

Child abuse and autonomic nervous system hyporesponsivity among psychiatrically impaired children☆

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ARTICLE INFO

Article history:
Received 1 August 2008
Received in revised form
10 November 2009
Accepted 12 November 2009

Keywords:
Child abuse
Autonomic nervous system

ABSTRACT

Objective: Sexually or physically abused children are at risk for neurobiological dysregulation as well as for internalizing and disruptive behavior disorders. Stress-related autonomic nervous system (ANS) down-regulation has been proposed as a sequela of abuse and was investigated in the present study.
Methods: Child Protective Services documented incidents of abuse were recorded for children in a sample of 262 pediatric psychiatric inpatients, as well as demographic, physical and intellectual functioning, and diagnostic and medication prescription data. Before and after a mildly stressful blood draw, noninvasive assessments of ANS activity were obtained.
Results: Controlling for all other variables in logistic regression analyses, a history of physical abuse (45% overall prevalence) was associated with poststressor ANS hyporesponsivity (i.e., heart rate deceleration).
Conclusions: Results suggest that a history of physical (but not sexual) abuse is associated with stressor-related ANS down-regulation in psychiatrically impaired children and adolescents.
Practice implications: Stressor-related autonomic hyporesponsivity secondary to physical abuse may contribute to the impairment of severely emotionally disturbed children. Differential diagnosis of psychiatrically impaired children should include identification of those who have a history of physical abuse, and their treatment should address stressor-related hyporeactivity.

Introduction

Although autonomic nervous system (ANS) over-reactivity is a consistent correlate of PTSD (Southwick et al., 2007), there also is evidence that abuse in childhood may result in ANS down-regulation (MacMillan et al., 2009). For example, "tonic immobility" (TI) (Marx, Forsyth, Gallup, Fuse, & Lexington, 2008) has been described as an organizing construct for the biological adaptations made by survivors of sexual assault. Based on extensive experimental and ethological animal research across a variety of species, TI is postulated to be a fourth phase in the psychobiological response to attack by a predator, preceded by phases involving freezing, flight, and fight responses. If neither flight nor fight is successful, TI emerges involuntarily in the form of autonomic deceleration, muscle paralysis, and immobility—classically in the form of rolling over on the back and "playing dead."

☆ The study was supported in part by a grant from the Devereux Foundation, Daniel F. Connor, Principal Investigator, and by a grant from the National Institute of Mental Health (MH01889-01A1), Julian D. Ford, Principal Investigator.

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0145-2134/$ – see front matter © 2010 Elsevier Ltd. All rights reserved.
doi:10.1016/j.chiabu.2009.11.005

The function of TI is not definitively established, but it has been observed to result in a suspension of predator assault and is theorized to be protective by signaling the predator to cease both restraint and attack of the victim (Marx et al., 2008). TI-like behavioral and physiological reactions have been reported by adult survivors of sexual assault, including involuntary paralysis, inability to resist, trembling, and feeling of numbness or cold that are consistent with the colloquial expression, "frozen with fear" (Marx et al., 2008). These sequelae are noted clinically as dissociation, emotional numbing, social detachment, loss of motivation, and behavioral resignation and helplessness. These motivational, affective, and arousal deficits may involve hyporesponsivity of the autonomic nervous system (Finkelhor, Ormrod, & Turner, 2007).

A study by Pollak, Vardi, Putzer Bechner, and Curtin (2005) investigated abused 4- and 5-year-old children's autonomic reactions to observing interpersonal events. They reported that despite no baseline differences (compared to nonabused 4 year olds) the abused children showed greater heart rate deceleration than nonabused children after hearing an angry interaction in a period of "unresolved" anger. Moreover the abused children were less likely to recover from the heart rate deceleration in a subsequent conflict resolution period. The findings, combined with prior results with behavioral and brain indices of attentional and perceptual processing, were interpreted as suggesting that physical abuse results in a preconscious attentional bias (vigilance) in relationship to anger as a potential threat.

Several unanswered questions from the Pollak et al. (2005) study are addressed in the current investigation. First, whether the interpersonal nature of the stressor event(s) is specifically necessary to elicit heart rate deceleration warrants examination. Vigilance to threat by physically abused children may occur mainly in relation to interpersonal stressors due to their similarity to abuse contexts, but it also is possible that physically abused children are vigilant in response to noninterpersonal threats. Second, the extent to which the autonomic nervous system down-regulation observed by Pollak et al. (2005) is a lasting change that can persist beyond early childhood was not investigated because all of the participants were 4 or 5 years old. Third, the specificity of stressor-related autonomic down-regulation to physical abuse has not been established, and the research evidence of post-traumatic TI cited above suggests a specific association of autonomic down-regulation with a history of childhood sexual abuse.

Fourth, abused children are at risk for a variety of psychopathological problems which involve altered autonomic nervous system reactivity and attentional biases (e.g., affective and disruptive behavior disorders), so the question of whether the autonomic down-regulation phenomenon is generalizable to physically abused children with serious psychiatric disorders warrants investigation. Psychiatrically impaired children present an important clinical sub-population with which to examine the question of abuse and ANS reactivity because physical abuse is prevalent in child psychiatry samples (Ford et al., 2000).

The present study therefore was designed to replicate and extend the Pollak et al. (2005) study by assessing the association of stress-related changes in ANS activity with a history of either or both physical or sexual abuse among children and adolescents who briefly experienced a mildly painful noninterpersonal stressor. We chose routine, clinical venipuncture as the mild stress in this study. Although routine venipuncture as a stressor in the examination of ANS responsivity has not previously been used in pediatric trauma research, there exists documentation of the effects of blood draw in nontraumatized children. This procedure routinely causes distress, fear, and anxiety in children and adolescents (Windich-Biermeier, Sjoberg, Dale, Eshelman, & Guzzetta, 2007). These emotions are routinely accompanied by changes in the ANS (Lansimies, Jokela, & Hanninen, 1994). Given previous research suggesting high rates of aggression and conduct problems in traumatized children (Connor, Melloni, & Harrison, 1998), and given research suggesting ANS down-regulation in youths with aggression and conduct problems (Raine, 1996), we thought it reasonable that venipuncture would be useful as a stressor in our study sample.

Measures used to assess ANS, such as heart rate and blood pressure and the stress of venipuncture, are routine clinical procedures undergone by all youngsters admitted to inpatient psychiatric facilities. However, several potential confounding variables require methodological attention. On a physiological level, obesity involves alterations in ANS activity. Therefore, body mass index was included as a covariate. Affective, disruptive behavioral, developmental, and psychotic disorders and the medications prescribed to treat these disorders (i.e., stimulants, antipsychotics, antidepressants, anticonvulsants, alpha-adrenergic agonists) may affect adrenergic tone and activity (Connor, Boone, Steingard, Lopez, & Melloni, 2003; Pappadopulos et al., 2006). Therefore, in this study both diagnoses and medications were documented and included as covariates in analyses if they had a statistically significant bivariate relationship with measures of autonomic reactivity.

It also was considered important to determine if the effects of abuse are distinct from those of psychiatric disorders that often are sequelae of abuse, including externalizing or disruptive behavior problems such as conduct disorder (CD) (Caspi et al., 2002; Shields & Cicchetti, 1998), self-reported tendencies to violence (Caspi et al., 2002), and oppositional-defiant disorder (ODD) (Ford et al., 2000). The disruptive behavior disorder sequelae of child abuse may involve ANS hypoarousal that is associated with what has been described as a callous and unemotional style of engaging in relationships which is thought to be relatively intractable to mental health treatment (Frick & White, 2008; Nouvion, Cherek, Lane, Tcheremissine, & Lieving, 2007). Childhood abuse also has been shown to be associated with risk of developing internalizing problems such as anxiety and affective disorders (Schumm, Briggs-Phillips, & Hobfoll, 2006; Widom, DuMont, & Czaja, 2007). Anxiety and affective disorders tend to be associated with stress-related autonomic nervous system hyper-reactivity, especially when the stressors involve fear-evoking (for anxiety disorders) or rejection-related (for depressive disorders) experiences (Pine, Helfinstein, Bar-Haim, Nelson, & Fox, 2009). However, among children with anxiety or affective disorders, there is evidence of stressor-triggered autonomic nervous system hyporeactivity consistent with an attention bias to threat (Pine et al., 2009). Thus, the presence of internalizing psychiatric disorders also warrants attention in studies of abused children's autonomic down-regulation.