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Biological and Behavioral Patterns of Emotion Dysregulation and Multisystemic Therapy Outcomes

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Biological and Behavioral Patterns of Emotion Dysregulation and Multisystemic Therapy Outcomes

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An abstract of
A thesis submitted to the Faculty of the
James T. Laney School of Graduate Studies of Emory University
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2013

Abstract

Biological and Behavioral Patterns of Emotion Dysregulation and Multisystemic Therapy Outcomes

By: Dominika Anne Winiarski

The present study examined whether cortisol and behavioral measures of emotion dysregulation assessed during the course of Multisystemic Therapy were associated with successful therapeutic outcome. The participants in the study were 180 adolescents (*n*=120 males), ranging in age from 12 to 17, enrolled in a Multisystemic Therapy program in clinics in the Denver Metropolitan area. Treatment outcome was assessed through therapist report and official arrest records. Changes in cortisol reactivity and changes in scores on an emotion dysregulation subscale of the Child Behavior Checklist (CBCL) were used as indicators of dysregulation changes throughout the course of therapy. Hierarchical linear modeling analyses were utilized to examine whether positive treatment response was associated with (a) cortisol reactivity measures collected early in treatment, (b) changes in these cortisol reactivity measures over the course of treatment (from early in treatment to mid-treatment to immediately post-treatment), (c) behavioral reports of emotion dysregulation reported early in treatment, and (d) changes in behavioral reports of emotion dysregulation over the course of treatment. In addition, sex was explored as a moderator of the above associations. Results confirmed that both cortisol and behavioral measures of emotional dysregulation early in treatment and over the course of therapy predicted treatment success. Furthermore, this relationship was moderated by sex such that girls were more likely to evidence a pattern of increasing emotion regulation prior to successful therapy outcome. Clinical implications are discussed.

Keywords: Multisystemic Therapy, cortisol, emotion dysregulation, delinquency

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Table of Contents

Biological and Behavioral Patterns of Emotion Dysregulation and Multisystemic Therapy Outcomes

Adolescent crime and delinquency cost the United States millions of dollars annually, and have devastating impacts not only on the individual, but on his or her family and community as well (Zigler, Taussig, & Black, 1992). Adolescents who engage in delinquent behaviors have problems in several areas of functioning, including interpersonal relationships with family (Barrett, Katsiyannis, & Zhang, 2010) and academic performance (Hinshaw, 1992). Delinquent youth also have an increased risk of comorbid substance abuse and a variety of mental health problems (Wade, 2001). Moreover, research supports the notion that young boys who display chronic physical aggression as early as elementary school have an increased risk of violent behavior well into adolescence, and are also more likely to engage in additional nonviolent delinquent acts. This trajectory appears to be sex-specific, as the same pattern was not observed for females (Broidy et al., 2003). Clearly, delinquency has deleterious consequences at the individual and societal levels, and as a result, additional research is needed to better understand how this complex phenomenon can be mitigated.

Multisystemic Therapy (MST) is an intensive treatment for adolescents displaying serious externalizing behavior. Given the devastating consequences of delinquency and its many contributing factors, it has been suggested that researchers and policy-makers take an ecological approach when employing interventions in order to more effectively help children achieve competence in various domains of life (Zigler et al., 1992). MST was developed on the basis of this multidimensional perspective, and its emphasis on the various components of an adolescent's life, such as family, neighborhood environment, and peer groups is one important

aspect of the treatment's potency (Henggeler, Schoenwald, Borduin, Rowland, & Cunningham, 1998). One of the primary strengths of MST is its firm grounding in extensive empirical work, and the fact that its clinical utility has been evaluated in numerous studies (Borduin et al., 1995; Schaeffer & Borduin, 2005; Timmons-Mitchell, Bender, Kishna, & Mitchell, 2006). Overall, these studies demonstrate that adolescents who participate in MST have significant reductions in re-arrest rates and improvements in various areas of functioning, including in the school, home, and community.

Though many interventions for delinquency have been proposed in the past, MST has been shown to yield long-term benefits that outweigh many of these other treatments. For example, when compared to standard individual therapy in which an adolescent undergoes one-on-one therapy, MST yields substantially greater benefits to potential victims of crime and to society as a whole. Specifically, it is estimated that taxpayers and crime victims will save an average of $9.51 to $23.59 per year for every dollar that is spent on MST (Klietz, Borduin, & Schaeffer, 2010). Likewise, more than a decade after participating in MST, participants still had 54% fewer arrests than adolescents who were referred for individual therapy (Schaeffer & Borduin, 2005). These robust findings suggest that MST is a worthwhile treatment program with positive long-term consequences.

Despite the fact that several studies demonstrate MST's effectiveness, it is by no means the silver bullet approach to eliminating the problem of delinquency from society. While there is evidence to support that this treatment works, we need to better understand which factors are involved in successful, and perhaps more importantly, unsuccessful, treatment outcome when MST is applied. The primary goal of the present study was to expand on the available literature by exploring possible predictors and moderators of MST treatment outcome. Specifically,

changes in cortisol reactivity and in emotional self-regulatory behaviors over the course of treatment were evaluated as predictors of therapy outcome, and sex was tested as a moderator of these relationships.

Assessing Treatment Outcome in Delinquent Youth

In general, research suggests that conduct problems can be treated successfully in children. However, there is currently no consensus about which individual factors contribute to successful or unsuccessful treatment outcome, and the success rate for empirically-supported interventions for conduct disorder hovers around 66 percent (Webster-Stratton & Hammond, 1997). Given these statistics, it is surprising that relatively few studies to date have focused on moderators of treatment outcome. Such studies are valuable in that they can inform new interventions targeting nonresponders who do not benefit from the current empirically supported approaches.

Existing research suggests that mother's age, paternal substance abuse, comorbid anxiety/depression in the youth, harsh parenting, and socioeconomic status can moderate treatment outcomes for conduct disorder (Beauchaine, Webster-Stratton, & Reid, 2005). Other researchers suggest that child age is an important factor, and that conduct problems are more difficult to treat in adolescence once these behaviors have already persisted for many years (Ruma, Burke, & Thompson, 1996). The current study adds to this literature by considering whether emotional processing in youth might be associated with treatment success in the context of MST.

Emotion Dysregulation in Externalizing Behavior and Delinquency

Emotion dysregulation is a deficit in the ability to regulate intense and shifting emotional states, and is fundamentally distinct from negative affect (Bradley et al., 2011). It occurs when

normal emotional patterns become disrupted and begin to interfere with functioning and impact other facets of life, such as attention or social functioning (Cole, Michel, & Teti, 1994). Emotion dysregulation has been implicated in a variety of psychological disorders across the lifespan (Weinberg & Klonsky, 2009), including borderline personality disorder (Selby & Joiner, 2009), binge eating (Clyne, Latner, Gleaves, & Blampied, 2010), and aggressive behavior in males (Cohn, Jakupcak, Seibert, Hildebrandt, & Zeichner, 2010).

Several studies have tied emotion dysregulation to prolonged exposure to social and environmental stressors. For example, emotion dysregulation has been found to mediate the positive association between maternal interpersonal sensitivity and child social deficits and deviations (Suveg, Jacob, & Payne, 2010). Children of mothers who experience high negative affect in social situations have negative expectations regarding social interactions, and if they are also emotionally dysregulated, these children are more likely to also display negative affect, which further contributes to unrewarding social interactions. Also, in a sample of women with a history of childhood maltreatment, emotion dysregulation mediated the relationship between the severity of the maltreatment and the women's self-efficacy for avoidance of risky sexual activities (Rellini, Zvolensky, & Rosenfield, 2012). Other studies have also linked social stress and emotion dysregulation in contributing to the development of various psychopathologies, most commonly the internalizing disorders (Han & Shaffer, 2012; McLaughlin & Hatzenbuehler, 2009; McLaughlin, Hatzenbuehler, & Hilt, 2009). Clearly, social factors appear to play a critical role in the development of emotion dysregulation, so it is important to explore how an intervention like MST, which is designed to alter the social environment of the youth, might be related to changes in emotion dysregulation over the course of treatment.

Research also suggests that deficits in emotion regulation are linked to increased levels of behavior problems and psychopathology (Blandon, Calkins, Keane, & O'Brien, 2008), including delinquent and aggressive behaviors. Using structural equation modeling, a recent study found that emotion dysregulation mediated the relationships between both peer victimization and stressful life events and aggressive behaviors (Herts, McLaughlin, & Hatzenbuehler, 2012). These authors suggested that emotion regulation strategies might have utility in interventions designed to treat aggressive behaviors in adolescents.

Emotion dysregulation can be assessed at the behavioral and physiological level. In the present study, emotion dysregulation was operationalized as high cortisol reactivity and high scores on a behavior rating scale tapping emotion regulation problems (see Table 1). Given the consequences emotion dysregulation may have on externalizing behavior, this factor seems to be an ideal candidate to explore as a potential predictor of treatment outcomes in MST.

Behavioral Measures of Emotion Dysregulation

One way of better understanding dysregulated emotional patterns in children with conduct problems is to study the behaviors themselves. For example, in a study by Snyder, Schrepferman, and St. Peter (1997), higher levels of emotion dysregulation and negative reinforcement of aggressive behavior were found to covary with subjects' irritability toward parents, and to predict child antisocial behavior. The authors suggested developing specific environmental contingencies in treatment protocols that would aim to treat specific problematic behaviors indicating emotion dysregulation in children.

Since previous researchers have established the role of emotion regulatory processes in aggressive behaviors, the next step is to utilize this research to design effective interventions for youth with behavioral problems. A recent review (Bradshaw, Goldweber, Fishbein, &

Greenberg, 2012) suggests that school-based interventions would benefit from incorporating social-emotional learning curricula since emotion regulatory factors are an important mechanism of change in children with behavioral and educational problems. Collectively, these studies highlight the importance of emotion dysregulation as a mechanism through which aggressive behaviors occur and can be modified/reduced. However, to our knowledge, behavioral measures of emotion dysregulation have not been examined as predictors of treatment outcome in children referred for externalizing behavior disorders. The current study fills this gap in the literature by examining how behavioral measures of emotion dysregulation predict outcomes in a treatment designed specifically for delinquency, as well as by exploring how this mechanism may differentially predict outcomes for males and females.

Cortisol Reactivity in Children with Externalizing Disorders

Biological indicators can also be used to explore emotion dysregulation. One commonly used physiological measure is the cortisol response to stress. Cortisol is a glucocorticoid produced by the adrenal gland that acts as a regulatory factor in the human stress response. The stress response is affected by the interplay of the sympathetic-adrenomedullary (SAM) and hypothalamic-pituitary-adrenal (HPA) systems. Whereas the former releases epinephrine, the latter is primarily responsible for releasing glucocorticoids like cortisol. Unlike epinephrine, cortisol has the ability to cross the blood brain barrier (Gunnar & Quevedo, 2007). Previous studies have suggested that prolonged exposure to certain kinds of stressors contribute to dysregulated HPA axis functioning (Fisher, Kim, Bruce, & Pears, 2012) and that dysregulation of the HPA axis is involved in the pathogenesis of child behavior and mood disorders (Tyrka et al., 2012). There is also evidence suggesting that the female HPA axis responds differently to social stress than does the male's (Oldehinkel & Bouma, 2011). Furthermore, dysregulated HPA

functioning has been implicated in delinquent behavior (Allwood, Handwerger, Kivlighan, Granger, & Stroud, 2011; Popma et al., 2006; Sondeijker et al., 2007). A recent study also suggests that the cortisol-externalizing behavior relationship may be even stronger in clinically referred samples than in community samples (Dietrich et al., 2012).

A small number of studies have examined cortisol levels as predictors of therapeutic outcome in children with externalizing behaviors. For example, in a previous study focused on MST outcomes (Schechter, Brennan, Cunningham, Foster, & Whitmore, 2012), high morning cortisol levels measured early in therapy predicted less of a decline in externalizing behaviors in males over the course of treatment. A separate study assessed basal cortisol and cortisol stress responsivity before and after a psychotherapeutic intervention for 22 children diagnosed with Disruptive Behavior Disorder (DBD; Van De Wiel, Van Goozen, Matthys, Snoek, & Van Engeland, 2004). The researchers found that, although baseline cortisol did not predict treatment outcome, cortisol reactivity did. Another recent study explored whether cortisol levels (measured at intake) and emotion dysregulation predicted the length of hospital stay among a group of children admitted for psychiatric care (Luebbe, Elledge, Kiel, & Stoppelbein, 2012). Researchers found that cortisol and dysregulated behavior both independently predicted the length of hospital stay. In addition, for those children who were previously hospitalized, higher levels of plasma cortisol were positively associated with dysregulated behavior. The finding that cortisol was related to length of hospital stay is among the first to find a relationship between a biological marker and length of inpatient psychiatric hospitalization.

Only a handful of studies have assessed adolescent cortisol levels and whether they change over time in a therapeutic context. One such study showed that, over time, diurnal patterns of cortisol changed as a result of a psychosocial intervention targeting behaviorally

disordered children. Specifically, boys diagnosed with DBD showed a significant decline in diurnal cortisol change over the course of a three-year treatment (Dorn, Kolko, Shenk, Susman, & Bukstein, 2011). One of the strengths of the present study is that it examines cortisol reactivity in response to a stressor across several time points, instead of relying solely on measures taken at the onset of treatment. Moreover, in an effort to build on the presently available literature, the current study will include females to better understand whether the cortisol-externalizing behavior relationship differs as a function of sex.

Previous research has documented the importance of understanding the role sex plays in explaining cortisol fluctuations in youth with disruptive behavior. Marsman and colleagues (2009) recently published a study in which they investigated the mediating effects of the HPA axis on the relationship between obstetric complications and externalizing behavior. They found that HPA-axis activity did *not* mediate the relationship between obstetric complications in their sample of adolescents and externalizing behavior. In an analysis of their findings, the authors discuss important evidence supporting the sex-specific mediating effects of the HPA axis. More specifically, they suggest that there may be a positive association between HPA-axis activity and externalizing behavior in girls, but an inverse relationship in boys. Earlier research also found elevated morning cortisol levels in females, but not in males, who had "pure" externalizing disorders (i.e., no comorbidities with other disorders; Marsman et al., 2008). Other studies corroborate the influence of sex on cortisol levels (Banks & Dabbs, 1996; Shirtcliff, Granger, Booth, & Johnson, 2005). More recently, researchers found that the relationship between morning cortisol levels and conduct symptoms was moderated by sex and mood symptoms, suggesting that the relationship between cortisol and conduct problems is far more complex than

once thought (Young, Sweeting, & West, 2012). Taken as a whole, these findings suggest that it is important to evaluate sex as a potential moderator of the cortisol-delinquency relationship.

Clearly, additional research is necessary to better understand the relationship between emotion dysregulation and delinquency. Simultaneously examining cortisol and behavioral measures of emotion dysregulation will advance the available research on MST outcome specifically, and also on treatments for adolescent delinquency in general. Moreover, incorporating both males and females into the analyses will enable researchers to explore whether treatment outcomes vary as a function of sex-moderated changes in cortisol levels.

The Importance and Utility of MST

MST is an intensive treatment that requires the therapist to be on-call 24 hours a day, 7 days a week during the treatment period (typically 3-5 months). During this time, the therapist maintains daily contact with the adolescent and his or her family, visits the home about three times per week, and maintains open lines of communication with the adolescent's school and community support groups. Every month, the caregiver fills out a questionnaire evaluating how closely their therapist is adhering to MST goals. Therapists are also required to evaluate how well the adolescent and his or her caretakers adhere to the goals they established at the onset of treatment. An MST therapist must understand how family life, individual variability, peer groups, and various environmental factors (i.e., housing, crime, etc.) all interact to exacerbate delinquent behavior. More importantly, each treatment approach is tailored to meet the needs of the individual adolescent.

As outlined above, MST actively involves the child's family and community in the treatment of the adolescent's problematic behavior. A fundamental tenet of MST is that the individual does not develop in isolation. Rather, in accordance with Urie Bronfenbrenner's

Ecological Systems Theory (Bronfenbrenner, 2004), MST therapists believe that various components of a child's life interact with, and are influenced by, the child to bring about adaptive or maladaptive outcomes. When evaluating developmental outcomes, it is also important to consider the active role an individual plays in shaping this development, instead of solely focusing on the context (Darling, 2007). That is the goal of the present study—to identify individual level factors that may act as predictors of treatment outcome in the context of MST. If decreases in emotion dysregulation are found to predict successful outcomes in MST, this might have utility in the design of strategies targeting those youth with lasting emotion dysregulation problems, so that their behavior problems can be better controlled.

Hypotheses

The purpose of the current study is to explore both behavioral and cortisol measures of emotion regulation and evaluate whether changes in these individual level factors throughout the course of therapy are associated with levels of treatment success. Specifically, hierarchical linear modeling analyses were used to examine whether positive treatment response was associated with (a) cortisol reactivity measures collected early in treatment, (b) changes in these cortisol reactivity measures over the course of treatment (from early in treatment to mid-treatment to immediately post-treatment), (c) behavioral reports of emotion dysregulation reported early in treatment, and (d) changes in behavioral reports of emotion dysregulation over the course of treatment. Furthermore, sex was explored as a moderator of the above-hypothesized relationships.

Method

Participants

The participants in the study were 180 adolescents (n = 120 males), ranging in age from 12 to 17 years, and their therapists and adult caregivers. Descriptive statistics are provided in Table 2. The overall sample of participants was ethnically diverse: Over 47% were Caucasian, 27.8% were Latino/a, 19.8% were African American, and 4.3% identified as "Other." All adolescent participants were enrolled in a Multisystemic Treatment (MST) intervention in clinics in the Denver Metropolitan area, and were referred by either the juvenile justice system or social service agencies. In order to be included in the present study, adolescents were required to meet the following criteria: (a) referral for crimes against others, property offenses, substance abuse, or other externalizing problem behaviors; (b) residence in the current caregiver's home without plans to relocate within the treatment timeframe; and (c) have one caregiver who was willing to participate in the study. Pregnant females (n=5) were excluded from analyses to control for a potential confound with cortisol fluctuations, as previous research has shown that HPA axis regulation differs as a function of parity status (Kivlighan, DiPietro, Costigan, & Laudenslager, 2008).

Multisystemic Therapy was provided by 52 therapists. Of these therapists, 73% were female (n=38) and the average therapist age was 31 years. The majority of therapists were Caucasian (80%, n=42). Therapists had to meet their agency's requirements for hiring and complete their agency's training requirements prior to participation. At the time of recruitment, therapists had accumulated an average of 9.51 (SD=17.35) months of experience using MST and 2.62 (SD=2.96) years of postgraduate training. A large majority of participating therapists (85%,

n=44) reported having attained a Masters degree in fields including Social Work (50%, *n*=25), Counseling (19%, *n*=9), Psychology (15%, *n*=7), and Marital and Family Therapy (12%, *n*=6).

This study was approved by the Institutional Review Boards at the University of Colorado, the Medical University of South Carolina, and Emory University. Caregivers and therapists provided consent for study participation, and adolescents provided assent.

Measures

Cortisol measure of emotion dysregulation. Saliva samples taken before and after a stressor task were used to assess cortisol reactivity, a biological measure of emotion regulation. Cortisol levels are of interest because they reflect the adolescents' physiological responses to stressful situations. The stressor task was a math task, in which youth were instructed to count backwards by thirteen from high numbers, and were provided with very stern critical evaluations of their performance. Cortisol was collected via passive drool directly before and about 20 minutes after the math task.

Approximately 1 cc of saliva was needed for the purpose of assaying cortisol. Once saliva samples were collected, they were frozen at -20°C and then shipped on dry ice to the Endocrine Core Laboratory at the Yerkes National Primate Research Center at Emory University, where the samples were again stored at -20°C until they were ready to be assayed. On the day of assay, samples were thawed, vortexed, and centrifuged to remove any particulate matter, and cortisol was assayed using an enzyme immunoassay kit (DSL, Webster, TX), catalogue number DSL-10-67100. Each sample was assayed in duplicate, and duplicate tests that generated errors of more than 20 percent were retested. Changes in cortisol over time were evaluated by measuring differences in cortisol reactivity (calculated as post-stressor task level minus pre-task level) across three different time points in treatment (T1: early in treatment, T2:

mid-treatment, and T4: at the end of treatment). If a child demonstrates elevated levels of cortisol post-stressor task at T1, one possibility is that with successful treatment, he or she would show less reactivity at the later time points (e.g. T4).

Behavioral measure of emotion dysregulation. The Child Behavior Checklist (CBCL; Achenbach, 1991) is an empirically validated measure frequently used in studies of externalizing behaviors, and was used in this study to assess behavioral emotion regulation. The CBCL consists of 112 items that require the caregiver to answer whether the youth has engaged in certain behaviors in the last thirty days. Responses are coded on a scale of 0 (Never) to 2 (Almost Always). For the purposes of the present study, a subset of items that were originally conceptualized as the Post-Traumatic Stress Disorder (PTSD) scale (Wolfe, Gentile, & Wolfe, 1989) was used. Since its development, this scale has been redefined by other researchers as a broader indicator of emotion dysregulation in children, rather than a specific measure of PTSD (Althoff, Ayer, Rettew, & Hudziak, 2010). As per Althoff and colleagues, we used a modified scale using 14 of the original 20 PTSD-scale items as our behavioral scale of emotion dysregulation (See Table 1). The items selected for this scale encompass a range of behaviors suggestive of problems in regulating and maintaining a consistent, stable emotional state. With successful treatment, one might expect an emotionally dysregulated child to learn to better manage his or her emotions in periods of stress, and consequently to not externalize their emotional state. In order to evaluate changes in emotion regulation over time, the caregivers' reports on this scale were collected at T1, T2, and T4, and decreases in scores were considered to reflect reductions in emotion dysregulation over the course of treatment. The items on the emotion dysregulation scale evidenced high internal consistency at T1, T2, and T4 (alphas>0.8).

Successful MST response. In the present study, MST treatment response was measured in a variety of ways. First, we assessed the success of the MST response using adolescent arrest records. Individuals who were not arrested post MST treatment were considered positive treatment responders according to this measure. Second, we used the Case Discharge Summary (CDS), a measure originally developed to study MST transportability (Schoenwald, Sheidow, Letourneau, & Liao, 2003), to assess treatment response. The CDS required therapists to complete two questions assessing discharge circumstances: (a) reason for discharge, and (b) who made the decision to discharge. Using Schoenwald et al.'s (2003) scoring system, a successful MST response was indicated by a therapist assessment that the family met or partially met treatment goals, and had control and involvement over discharge decisions collaboratively with the therapist. Schoenwald et al. (2003) provided data indicating that these scores of treatment success had acceptable construct validity.

The third measure of MST treatment success was the 20-item Therapist Perception of Treatment Outcome (TPTO) scale (Crandal, 2012). This measure is a 20-item questionnaire on which therapists are asked at the conclusion of treatment to rate how strongly they agree with statements about caregiver and youth responses to treatment on a six-point Likert scale (1-Agree Strongly; 6-Disagree Strongly). Examples of these items include: "The caregivers follow through with what needs to be done to manage the youth", and "The youth's problem behavior has improved." Crandal (2012) found that the TPTO scale administered to the therapists in this sample at T3 and T4 evidenced high internal consistency (alphas>0.9). High scores on the TPTO indicated more favorable treatment outcome.

Control Variables

Previous studies have suggested that several variables, including health variables and pubertal development could influence HPA axis activity (DeSantis et al., 2007; Kirschbaum, Kudielka, Gaab, Schommer, & Hellhammer, 1999; Kudielka & Kirschbaum, 2003; Netherton, Goodyer, Tamplin, & Herbert, 2004). Youth and their caregivers were asked about the youth's physical health before the assessments at each time point. Height and weight were also measured at each time point. The Petersen Pubertal Developmental Scale (PPDS; Petersen, Crockett, Richards, & Boxer, 1988) was also administered to evaluate youth puberty status. This measure contains 5 items about youth physical changes associated with adolescence, including growth spurt, body hair, changes in skin, and changes in voice. Response choices range from 1 (not yet started) to 4 (seems completed). A total puberty score was calculated by summing the individual items and dividing by 5 (to maintain the original metric).

Procedure

A longitudinal design was employed in the present study, with data collected at three time points, T1, T2, and T4. T1 corresponds to treatment onset, T2 to the middle of treatment, and T4 to the conclusion of treatment. This design allows for a closer inspection of how, over time, biological and behavioral measures of emotion regulation predict MST treatment outcome, and how these relationships might be moderated by participant sex.

Data (with the exception of arrest records and treatment discharge notes) were collected in the participant's home. Research assistants brought all necessary study materials (i.e., laptops for questionnaire administration, cortisol collection kits, etc.) to each scheduled meeting at each of the time points in the study. All data were obtained from the caregiver (CBCL), therapist (TPTO and CDS), or the adolescent (cortisol), except for arrest records, which were acquired

from the Judicial Branch's Integrated Colorado Online Network database approximately six months to a year after treatment discharge. In addition to being the primary database of the Colorado Department of Youth Corrections, it also includes information about participants who, upon re-arrest, were charged as adults.

Statistical Analyses

Hierarchical Linear Model (HLM; Raudenbush, Bryk, & Congdon, 2011) techniques were used to investigate the primary hypotheses, and to evaluate sex as a possible moderator of each of these hypotheses. Hierarchical linear modeling is frequently used in developmental research when investigators are concerned with measuring growth trajectories for individuals (Raudenbush & Bryk, 2002). The data gleaned from the present study are particularly well suited for HLM because they meet three important criteria: (a) there are at least three waves of data (T1, T2, T4); (b) there is an interest in change over time (cortisol and behavioral dysregulation ratings); and (c) there is a sensible metric for evaluating change over time (Singer & Willett, 2003).

Results

Descriptive Analyses

Correlations between the youth regulation and treatment outcome measures used in this study are presented in Table 3. Behavioral dysregulation scores and cortisol reactivity were significantly and negatively correlated with case discharge assessments of treatment success and TPTO. Among the therapy outcome variables, only treatment success and TPTO were significantly correlated with one another. Cortisol and behavioral dysregulation measures (time varying at Level 1) were not significantly correlated with one another.

Preliminary Data Analysis

Before beginning the analyses to test the primary hypotheses, it was necessary to assess whether therapist effects accounted for significant variance in the Level 1 variables. If significant therapist effects were noted, 3 Level models (time point nested within youth nested within therapist) would be appropriate for hypothesis testing. Intraclass Correlation Coefficients (ICCs) were computed for models that included behavioral regulation and cortisol reactivity variables separately at Level 1, nested within youth (Level 2), which were nested within therapists (Level 3). Time was scored as months since enrollment in the study and entered at T1. The ICCs for level 3 ($\tau_\beta/(\tau_\beta+\tau_\pi+\sigma^2)$ in these models were minimal ($ICC_{Behavior}$=0.0003; $ICC_{Cortisol}$=0.001), suggesting that there were no differential effects on treatment outcome based on the therapist assigned to a family. Once a higher level of the model (Level 3) is found not to cause interdependence of the data at a lower level, it can be excluded from the model (Raudenbush, Bryk, Cheong, Congdon, & Toit, 2004). Therefore, 2 Level HLM models were used for hypothesis testing with changes in behavioral ratings and cortisol reactivity included at Level 1, and all therapy outcome variables (i.e., post-treatment arrest, case discharge success rating, and TPTO scores) included in separate models at Level 2. Additionally, to test for sex moderation, an interaction term between sex and the therapy outcome variable was added to each of the equations at level 2. In cases where this sex by treatment outcome interaction term was significant, results were reported for each sex separately. In cases where sex did not moderate the association between dysregulation and therapy outcome, results are reported for the sample as a whole.

Unconditional Model: Cortisol reactivity and behavioral dysregulation as outcomes.

HLM analyses were performed to examine the trajectory of cortisol reactivity across treatment. First, an unconditional model was run with cortisol reactivity as the outcome variable and time as the predictor at Level 1. The trajectory is represented in the following Level 1 Equation:

$$\text{CortisolReactivity}_{ti} = \pi_{0i} + \pi_{1i}(\text{time}_{ti}) + e_{ti}$$

The Level 1 intercept (π_{0i}) and slope (π_{1i}) were modeled by the following Level 2 equations:

$$\pi_{0i} = \beta_{00} + r_{0i}$$

$$\pi_{1i} = \beta_{10} + r_{1i}$$

The estimated mean slope of cortisol change was 0.009 (*SE*=0.005). Based on this mean trajectory, measures of youth's cortisol increased at an average of 0.009 points per observation point from onset of treatment to termination. The slope in this model was not significant at $p<0.09$, suggesting that there was not a significant change across treatment for the sample as a whole. However, the variance component of the slope in this model suggests that there was significant variation among slopes of cortisol reactivity for the individuals in our sample ($\chi^2=189.95$, $p=0.05$), which suggests that some individuals showed declines in cortisol reactivity, whereas others did not.

To determine whether behavioral measures of emotion dysregulation changed significantly over the course of treatment, an unconditional model was run with behavioral measures of emotion dysregulation as the outcome variable and time included as a predictor at Level 1. The trajectory is represented in the following Level 1 equation:

$$\text{Behavioral Measures of Emotion Dysregulation}_{ti} = \pi_{0i} + \pi_{1i}(\text{time}_{ti}) + e_{ti}$$

The Level 1 intercept (π_{0i}) and slope (π_{1i}) were modeled by the following Level 2 equations:

$$\pi_{0i} = \beta_{00} + r_{0i}$$

$$\pi_{1i} = \beta_{10} + r_{1i}$$

The estimated mean slope of behavior change was -0.63 (*SE*=0.08). Based on this mean trajectory, youth's behavioral dysregulation scores (Table 2) decreased at an average of 0.63 points per observation point from onset of treatment to termination. The slope in this model was significant at $p<0.001$, suggesting significant change across treatment. Furthermore, the variance component of the slope in this model suggests that there was significant variation among slopes of behavior for the individuals in our sample ($\chi^2=182.14$, $p=0.03$).

Testing for confounds. Prior to the start of analyses for hypothesis testing, potential time varying confounds were examined at Level 1 and youth varying confounds were examined at Level 2 in HLM. Baseline cortisol prior to the start of the math stressor task was controlled for in all cortisol analyses. Variables previously identified in the literature as potential confounds for cortisol, including weight, height, length of time between sample collection and awakening, cigarette smoking, stimulant use, steroid use, and cold medication use were tested as potential Level 1 confounds. Only minutes after awakening ($p=0.01$) and height ($p=0.001$) were significant and included as Level 1 controls in all subsequent cortisol analyses. Additionally, puberty, sex, age, SES, and ethnicity were tested as potential confounds at Level 2. Only SES ($p=0.04$) and ethnicity ($p< 0.05$) were significant. Both variables were only significant in the intercept equations. A similar procedure was followed to identify time varying and youth varying confounds for all behavior dysregulation analyses. Age, sex, ethnicity, SES, and puberty status were tested in HLM. No Level 1 confounds were identified, and only SES ($p=0.003$) and ethnicity ($p=0.02$) were significant and thus controlled for at Level 2. SES was only controlled

for in the intercept equation, but because ethnicity was significant in the slope equation, it was controlled for in both intercept and slope Level 2 equations.

Hypothesis Testing

Results for associations between therapy outcome and changes in behavioral measures of emotion dysregulation and cortisol reactivity over time are grouped by the type of time-varying variable (i.e., cortisol and behavioral measures of dysregulation). As noted above, in cases where sex was a significant moderator between regulation/reactivity and treatment outcome, results are presented for each sex separately.

Cortisol reactivity over time. In the first set of HLM analyses, cortisol reactivity was tested as the outcome at Level 1 with time and time varying confounds included as predictors in the Level 1 equation and youth level confounds included as predictors at Level 2. Specifically, associations between treatment outcome measures (tested separately at Level 2) and cortisol reactivity over time (Level 1) were assessed with the following equations:

Level 1 Equation:

$$\text{CortisolReactivity}_{ti} = \pi_{0i} + \pi_{1i}(\text{PreMathCortisol}_i) + \pi_{2i}(\text{MinutesAwake}_{ti}) + \pi_{3i}(\text{Height}_{ti}) + \pi_{4i}(\text{Time}_{ti})\, e_{ti}$$

Level 2 Equations:

$$\pi_{0i}\ (\text{Intercept}) = \beta_{10} + \beta_{11}(\text{SES}_i) + \beta_{12}(\text{Ethnicity}_i) + \beta_{13}(\text{Treatment Outcome}_{slope}) + r_{1i}$$

$$\pi_{4i}\ (\text{Slope}) = \beta_{40} + \beta_{43}(\text{Treatment Outcome}_{slope}) + r_{4i}$$

In these and all HLM models tested in this study, time in therapy was uncentered, and therefore the intercept term represents the value of the youth dysregulation variable at treatment onset (T1). As seen in Table 4, results indicate that the cortisol reactivity measure at T1 was significantly and negatively associated with TPTO scores at the end of treatment. In other

words, higher levels of cortisol reactivity at the onset of treatment were related to less successful therapy outcomes as rated by therapists. In addition, and as hypothesized, the slope of cortisol reactivity across the course of treatment was significantly and negatively related to therapy success as measured by the TPTO. This suggests that in cases where cortisol reactivity decreased across treatment, youth were more likely to have more favorable TPTO ratings.

As can be seen in Table 4, the interaction term between sex and the treatment outcome variable of arrest (entered at Level 2) significantly predicted both the cortisol reactivity intercept and the slope of cortisol reactivity over time. To further understand the pattern of these sex interaction effects, the overall sample was split into male and female only files, and each was run separately to test for associations between cortisol intercept and slope and the treatment outcome variable of arrest. As can be seen in Table 4, both a higher level of cortisol reactivity at treatment onset (intercept), and reductions in cortisol reactivity across the course of treatment (slope) were related to a significantly greater likelihood of post-treatment arrest for males. Opposite, but nonsignificant associations between cortisol reactivity and arrest were observed in the female-only sample.

Behavioral dysregulation over time. In the next set of analyses, behavioral measures of emotion dysregulation were tested at Level 1 with time included as a predictor in the Level 1 equation and youth level confounds included as predictors at Level 2. Associations between treatment outcome measures (tested separately at Level 2) and behavioral measures of emotion dysregulation over time (Level 1) were assessed with the following equations:

Level 1 Equation:

$$\text{Behavioral Measures of Emotion Dysregulation}_{ti} = \pi_{0i} + \pi_{1i}(\text{time}) + e_{ti}$$

Level 2 Equations:

$$\pi_{0i} \text{ (Intercept)} = \beta_{00} + \beta_{01}(\text{SES}_i) + \beta_{02}(\text{ethnicity}_i) + \beta_{03}(\text{Treatment Outcome}_i) + r_{0i}$$

$$\pi_{1i} \text{ (Slope)} = \beta_{10} + \beta_{12}(\text{ethnicity}_i) + \beta_{13}(\text{Treatment Outcome}_i) + r_{1i}$$

As can be seen in Table 5, and consistent with the present hypothesis, the slope of behavior dysregulation over the course of treatment was significantly and negatively related to therapy success as measured by the CDS. This suggests that, if a youth's behavior became less dysregulated over the course of treatment, clinicians rated the intervention as more successful at the end of treatment. Next, the arrested outcome variable was entered into the Level 2 equation, and again consistent with the proposed hypothesis, a more successful outcome (i.e., no post treatment arrest) was associated with a decrease in behavioral measures of emotion dysregulation over the course of treatment.

As can be seen in Table 5, a significant interaction was noted between sex and TPTO outcome at Level 2 in the prediction of slope of behavioral measures of emotion regulation over time. To further understand this pattern, the overall sample was split into male and female only files, and each was run separately to test for the TPTO outcome variable at Level 2. As can be seen in Table 5 and consistent with the present hypothesis, reductions in behavioral indicators of emotion dysregulation across the course of treatment (slope) were related to a significantly more favorable TPTO score in females. This pattern was not observed in the male-only sample.

Discussion

This study adds to the aggression and delinquency literature by providing empirical evidence that biological and behavioral markers of emotion regulation are associated with treatment outcome in a clinical sample of youth with externalizing behavior problems. Previous studies (Allwood et al., 2011; Popma et al., 2006; Sondeijker et al., 2007) have found that

dysregulated HPA functioning is related to delinquent behavior, and that this relationship appears to be stronger in clinical than community samples (Dietrich et al., 2012). The participants in the present study were referred to MST by either the juvenile justice system or social service agencies, and thus represent more extreme ("clinical") cases of aggressive and delinquent behavior. Our findings are also consistent with those of Luebbe and colleagues (2012), who found that cortisol and dysregulated behavior independently predicted the length of psychiatric hospital stay for children. Our study extends these previous findings by demonstrating that both emotion dysregulation at the onset of treatment and changes in emotion regulation over the course of therapy predict treatment outcome for externalizing disorders. Collectively, these results lend support to suggestions made in previous studies that treatments designed to reduce emotion dysregulation may be beneficial for children with externalizing behavior problems (Blandon et al., 2008; Herts et al., 2012).

The results of the present study expanded what is known in the literature by finding evidence for differential outcome predictors based on sex. Many previous studies exploring the relationship between HPA axis functioning and delinquency have excluded females from final analyses due to sample size limitations. The inclusion of females is a methodological strength of this study because it allowed for the exploration of the differential impact of reductions in emotion dysregulation on successful treatment outcome. Importantly, results were stronger and consistently in the predicted direction for females. In order to rule out the possibility that the specific effect observed for behavior dysregulation in females was not better accounted for by a reduction in internalizing symptoms over the course of treatment, post-hoc analyses were performed in which the CBCL internalizing scale from T1, T2, and T4 was substituted for the CBCL behavior dysregulation scales from the same time points, and associations between

internalizing problems and the TPTO scale were examined. The results were nonsignificant for both intercept and slope equations, which further bolsters the interpretation that decreases in behavioral measures of emotion dysregulation, rather than decreases in internalizing behaviors per se, are associated with more successful treatment outcomes in MST.

Our study included multiple measures of treatment success. While arrest records provide an objective measure of outcome (i.e., positive treatment responders have fewer arrest rates post-treatment), previous research indicates the presence of sex differences in patterns of offending and suggests that females oftentimes must experience much more aversive experiences before engaging in serious crime (Davis, Banks, Fisher, Gershenson, & Grudzinskas, 2007). Since youth are more likely to be *arrested* for serious crimes, arrest records may in fact be an underrepresentation of a youth's involvement in delinquent activities. As a result, it is necessary to include other measures of treatment outcome. The Case Discharge Summary (CDS) reflects the therapist's rating of whether or not treatment termination was a collaborative process between the therapist and the family. As such, this measure essentially taps into the family's perspective of the adolescent's success in treatment. Finally, The Therapist Perception of Treatment Outcome (TPTO) scale is a newly developed 20-item scale that enables the clinician to rate the adolescent's treatment success, taking into account the changes in both caregiver and youth behaviors. A final methodological strength of the present study is the use of HLM to model change in two measures of emotion dysregulation over the course of treatment. The use of this method provides a more comprehensive look at how emotion dysregulation fluctuates over the course of treatment.

Although most hypotheses were supported in the direction predicted, the finding that decreases in cortisol reactivity over the course of treatment predicted more arrests for males

during a six-month follow up is unexpected. There are several possible explanations for this result. First, we performed multiple tests of our hypotheses with several different measures of treatment success, and therefore it is possible that this result is due to Type 1 error. Second, previous research has noted that sex moderates the direction of the association between cortisol and externalizing behaviors such that high levels of cortisol are associated with externalizing behaviors in girls, and low levels of cortisol are associated with externalizing behaviors in boys; our finding is consistent with this sex moderated pattern (Marsman et al., 2009). Third, there may be subtypes of youth for whom different patterns of cortisol reactivity predict differently to treatment outcome. For example, previous research has shown that individuals with psychopathic traits, especially callous-unemotional traits are likely to have lower levels of cortisol (Cima, Smeets, & Jelicic, 2008; Honk, Schutter, Hermans, & Putman, 2003), so it is possible that different treatment strategies may need to be employed for youth with different cortisol reactivity patterns.

These results may have clinical implications for those treating or conducting treatment outcome studies of delinquent youth. First, they lend support to suggestions by researchers like Herts et al. (2012), who argued that clinicians should include emotion regulatory strategies in treatment protocols with delinquent youth. Second, our results suggest that, not only should clinicians include emotion regulation strategies in their treatment designs, but they should also consider closely monitoring changes in emotion dysregulation over the course of treatment in order to identify particular delinquent youth who may not be meeting therapeutic goals outlined at the onset of treatment. Related to this, the results presented here suggest that differential treatment predictors exist for males and females, and that clinicians should attend to sex differences when designing interventions for adolescent delinquency.

Potential Limitations and Future Directions

The findings of the present study should be interpreted in light of several limitations. Most notably, this study lacks a control comparison group. It is therefore possible that more positive treatment outcome might just reflect a natural decrease in externalizing problems over time, rather than a true effect of treatment. However, because this study used case discharge and therapist ratings of outcome, the lack of a control group may be less of concern. Therapists likely make subjective comparisons to other clients and to normative teenage populations when they complete treatment outcome assessments. In addition, epidemiological data suggest that externalizing problems continue at a high rate throughout the teenage years, and so a decrease in these behaviors is not likely due to the effects of normative development. As stated earlier, MST has been shown to yield more favorable outcomes than other established psychological treatments (e.g. individual therapy) in previous randomized controlled effectiveness and efficacy studies. Furthermore, since the purpose of this research is to evaluate MST responders versus non-responders, not treatment efficacy per se, the lack of a control group does not necessarily minimize the significance of the study.

Future studies may want to examine the trajectories of cortisol reactivity using a latent class growth analysis, to see whether one or more patterns of cortisol change over time (e.g., an increase followed by a plateau, or a consistent low level over time) are related to increased risk for negative treatment outcomes, and characterize different "categories" of patients. Related to this, researchers should continue including females in analyses where statistical restrictions allow, and should also expand the analyses of treatment utility to include samples of ethnically diverse populations. Inclusion of females and diverse populations would enable future

researchers to continue exploring whether differential patterns of change are predictive of treatment outcome.

One way to ensure that greater numbers of females are included in analyses is to conceptualize outcome differently. Many studies of delinquents look at arrest as an outcome measure, which may be misrepresenting treatment success and/or reductions in delinquent behavior. Future studies should continue to evaluate the utility of treatment outcome scales like the TPTO, which provide another way of evaluating successful outcomes for youth with externalizing behavior problems. As indicated by the findings from the present study, the TPTO scale may be a powerful tool in measuring different facets of treatment success, and could provide unique information about the differential factors contributing to successful outcomes in males and in females.

Finally, as was discussed above, previous studies have suggested the importance of evaluating mood symptoms as a potential mediator in the relationship between stress and externalizing behavior (Young et al., 2012). The current study did not include measures of environmental stress, but this might be an important factor to consider in future research. Emotion regulation changes over the course of therapy may be affected by environmental factors affecting the youth and his or her family. Further knowledge about relevant stressors and their impact on emotion regulation may enable interventions to be targeted or revised according to the needs of particular youth.

Conclusions

This study explored the relationship between two markers of emotion dysregulation (cortisol and behavior measures) and three measures of treatment outcome (TPTO, CDS, and arrest records) in the context of an intervention for youth with severe behavioral problems. Sex

was explored as a moderator of this relationship. The results of several individual hierarchical linear analyses confirmed that both cortisol and behavior measures of emotional dysregulation early in treatment and over the course of therapy predicted treatment outcome. Furthermore, this relationship was moderated by sex. As predicted, females were more likely to evidence a pattern of increasing emotion regulation prior to successful therapy outcome. Contrary to the hypotheses, as cortisol reactivity across treatment for males decreased, males were in fact, more likely to be arrested. These findings should be considered as future treatment programs are designed for delinquent youth, and suggest that researchers should explore different treatment options for males and females who evidence problems with emotion regulation.

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Table 1

Emotion Dysregulation Items from the Child Behavior Checklist

3. Argues a lot
8. Can't concentrate, can't pay attention for long
9. Can't get his/her mind off certain thoughts (obsessions)
11. Clings to adults or too dependent
31. Fears he/she might think or do something bad
34. Feels others are out to get him/her
45. Nervous, high-strung, or tense
47. Nightmares
50. Too fearful or anxious
52. Feels too guilty
69. Secretive, keeps things to self
87. Sudden changes in mood or feelings
103. Unhappy, sad, or depressed
111. Withdrawn, doesn't get involved with others

Table 2

Descriptive Statistics for Predictor and Outcome Variables

Variable	N	Mean	Standard Deviation
Cortisol Reactivity			
Time 1	164	-0.05	0.18
Time 2	136	-0.03	0.22
Time 4	147	0.01	0.25
Behavioral Dysregulation			
Time 1	180	8.27	5.12
Time 2	146	5.73	4.60
Time 4	164	5.30	4.59
Clinician Rated Treatment Success	166	0.36	0.48
TPTO	157	65.44	17.99
Arrested Post Treatment	180	0.26	0.44

Table 3

Intercorrelations for Study Variables

Variable	1	2	3	4	5
Level 1 Variables					
1. Cortisol	-	-0.02	-0.12*	-0.15**	0.08
2. Behavior		-	-0.15**	-0.13**	-0.02
Level 2 Variables					
3. Case Discharge Summary			-	-0.54**	-0.06
4. TPTO				-	-0.14
5. Arrested					-

** p<0.05* ***p<0.01*

Table 4

Model 1: Cortisol Reactivity Over Time and MST Treatment Outcome

Outcome	Coefficient	p-value	S.E.	t
Case Discharge Summary				
Intercept	-0.03	p=0.11	0.02	-1.63
Slope	-0.01	p=0.19	0.009	-1.57
Case Discharge by Sex Interaction				
Intercept	0.03	p=0.41	0.04	0.83
Slope	0.01	p=0.52	0.02	-0.64
TPTO				
Intercept	-0.001	**p=0.04**	0.0006	-2.04
Slope	-0.0007	**p=0.01**	0.0003	-2.75
TPTO by Sex Interaction				
Intercept	0.0001	p=0.92	0.001	0.10
Slope	-0.0008	p=0.12	0.0005	-1.57
Arrest				
Intercept	0.04	p=0.12	0.03	1.57
Slope	-0.02	p=0.15	0.01	-1.44
Arrest by Sex Interaction				
Intercept	-0.11	**p=0.04**	0.05	-2.08
Slope	0.06	**p=0.04**	0.03	2.11
Males-Arrest				
Intercept	0.07	**p=0.03**	0.03	2.18
Slope	-0.03	**p=0.01**	0.01	-2.68
Females-Arrest				
Intercept	-0.04	p=0.39	0.05	-0.86
Slope	0.03	p=0.26	0.03	1.15

Table 5

Model 2: Behavioral Regulation Over Time and MST Treatment Outcome

Outcome	Coefficient	p-value	S.E.	t
Case Discharge Summary				
Intercept	-0.68	p=0.35	0.72	-0.95
Slope	-0.42	**p=0.01**	0.15	-2.81
Case Discharge by Sex Interaction				
Intercept	-0.69	p=0.65	1.55	-0.45
Slope	-0.48	p=0.11	0.30	-1.60
TPTO				
Intercept	-0.03	p=0.13	0.02	-1.51
Slope	-0.005	p=0.22	0.004	-1.22
TPTO by Sex Interaction				
Intercept	0.04	p=0.40	0.05	0.85
Slope	-0.02	**p=0.01**	0.009	-2.49
Males- TPTO				
Slope	0.001	p=0.79	0.005	0.005
Females-TPTO				
Slope	-0.02	**p=0.02**	0.008	-2.53
Arrest				
Intercept	-0.97	p=0.20	0.76	-1.28
Slope	0.41	**p=0.03**	0.19	2.22
Arrest by Sex Interaction				
Intercept	1.21	p=0.54	1.96	0.62
Slope	-0.10	p=0.80	0.39	-0.25