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Date

Stress, Cortisol, and Externalizing Behavior in Adolescent Males: An Examination in the  
Context of Multisystemic Therapy

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B.S., Cornell University, 2007

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A thesis submitted to the Faculty of the  
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## Abstract

### Stress, Cortisol, and Externalizing Behavior in Adolescent Males: An Examination in the Context of Multisystemic Therapy

By Julia C. Schechter

Aggression and delinquency are associated with an array of emotional, behavioral, and health problems (Loeber, Burke, Lahey, Winters, & Zera, 2000). Additionally, a multitude of variables are thought to lead to the development of externalizing disorders in adolescent males. The purpose of the current study was to investigate the relationship among stress, cortisol, and externalizing behaviors in males, specifically in a treatment context. In an effort to examine potential differential effects of stressor types, measures of stress were delineated into lifetime, current episodic, and daily hassles sub-categories. This study examined data from a sample of 120 adolescent males (mean age = 15 years) referred to Multisystemic Therapy (MST) for externalizing problems. Partial correlations were used to examine concurrent relationships among self-reported stress, morning cortisol, and externalizing problems (parent reports of aggression and delinquency) at time of referral. Analyses did not yield significant relationships between stress or cortisol and externalizing behavior prior to treatment. Regression analyses were used to measure whether cortisol or stress predicted treatment outcome for youths with externalizing behavior problems. Results indicated that compared to youth who had experienced fewer hassles, youth that had experienced more daily hassles had higher levels of externalizing behavior after treatment. This relationship was moderated by cortisol levels at awakening, such that youth with more daily hassles and high levels of cortisol had the worst outcome at post treatment. This interaction remained significant after controlling for post treatment internalizing disorders. Implications and future directions for treatment are discussed.

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STRESS, CORTISOL, AND EXTERNALIZING BEHAVIORS IN ADOLESCENT  
MALES: AN EXAMINATION IN THE CONTEXT OF MULTISYSTEMIC THERAPY

Youth externalizing behavioral disorders are the most commonly diagnosed juvenile mental health disorders, accounting for one-third to one-half of all clinical referrals made by mental health services (Kazdin, 1995). These externalizing disorders are associated with high levels of impairment in childhood and a poor long-term prognosis, including higher rates of antisocial personality disorder and psychopathy in adulthood (Loeber, Burke, Lahey, Winters, & Zera, 2000). The public expenditures associated with childhood delinquency can exceed \$70,000 over a seven-year period for every child diagnosed with a disruptive disorder (Foster & Jones, 2005). With externalizing disorders occurring in nearly 16% of the general population (American Psychiatric Association, 2000), these disorders are clearly a costly problem, both emotionally and economically.

In order to best meet the needs of this population, it is critical to gain a better understanding of the risk factors associated with the development of externalizing behaviors. Externalizing disorders are believed to arise from a complex combination of psychosocial and biological risk factors (Burke, Loeber, & Birmaher, 2002) and are more commonly found in males than females (Maughan, Rowe, Messer, Goodman, & Meltzer, 2004). Although a number of factors are likely associated with the development of these disorders, stress appears to be one that is worthy of further consideration and study. Stress has been consistently cited in the development of many emotional and behavior problems (Grant, Compas, Thurm, McMahon, & Gipson, 2004), and studies have repeatedly found stress to be linked to increased levels of internalizing and externalizing

behaviors (Grant et al., 2003). Evidence indicates that the body's stress response system can be changed by stressful events experienced throughout the lifespan, and that these changes contribute to the development of later antisocial behavior (Susman, 2006).

Importantly, it has been suggested that different types of stressors, such as lifetime stress, current episodic stress, and daily hassles may have a differential or a compound effect on the development of externalizing behavior (Banez & Compas, 1990). However, few studies have looked at these three different types of stress when investigating factors that lead to the development of externalizing behaviors.

Psychological and psychosocial stress directly impact biological functioning. The hypothalamic–pituitary–adrenal (HPA) axis is a central component in the body's stress response system. It has been suggested that early and/or prolonged exposure to certain types of stress leads to a dysregulation of the HPA axis (Fries, Hesse, Hellhammer, & Hellhammer, 2005; Susman, 2006; Van Goozen, Matthys, Cohen-Kettenis, Buitelaar, & van Engeland, 2000a; Weinstock, 2005). Many studies have utilized cortisol, a hormone produced by the HPA axis, as a biological marker of the responsiveness of this system. However, the literature regarding cortisol and stress is mixed and no definitive conclusions have been drawn, particularly with regards to the relationship of these factors to externalizing behaviors (Van Goozen, Fairchild, Snoek, & Harold, 2007). Although a majority of studies indicate that lower basal cortisol levels are associated with increased levels of disruptive disorders in males (Hawes, Brennan, & Dadds, 2009; Van Goozen, Fairchild, Snoek, & Harold, 2007), some studies have found the opposite, with conduct disorder and aggression being associated with higher levels of cortisol (Alink et al., 2008; Van Bokhoven et al., 2005). Because existing studies of aggression and cortisol rarely



examine stressful life events, there is a need for further research elucidating the connection between stress, cortisol, and disruptive behaviors.

In addition to gaining a better understanding of the factors that may lead to an increase in externalizing disorders, it is essential to investigate any factors that may affect treatment for these youth. A paucity of literature regarding the specific contributions of different types of stressors on treatment outcome has left many questions unanswered. Unfortunately, treatment results for externalizing behaviors in adolescence have been variable and no clear consensus has emerged from the literature regarding how certain factors predict, mediate, or moderate treatment success for youth with these problems (Beauchaine, Webster-Stratton, & Reid, 2005; Eyber, Nelson, & Boggs, 2008; Nock, 2003).

Although certain types of interventions, particularly those involving parent-training, have been well-established for treating disruptive disorders (Eyber, Nelson, & Boggs, 2008; Nock, 2003), even evidence-supported treatments have been shown to be effective for only about two-thirds of participants (Webster-Stratton & Hammond, 1997). More research is needed to identify and address the mechanisms that may be associated with the development of these disorders and the success of treatment for some youth and not others. As noted by Moffitt (2005, p. 534), “Valuable resources have been wasted because intervention programs have proceeded on the basis of risk factors without sufficient research to understand causal processes.” The goal of this study was to provide a better understanding of the relationships between stress-related risk factors for disruptive disorders and the potential connections between these risk factors and treatment outcome.

*Types of Stress*

Most studies of stress focus on exposure to major life events, such as the death of an immediate family member, the experience of abuse, or violence victimization. Often exposure to stressful life events is examined across early childhood, from gestation through the onset of puberty or up to 18-years of age, with the most common forms of early life stress in humans being sexual, physical, emotional maltreatment, and neglect (LaPrairie, Heim, & Nemeroff, 2010). A higher amount of lifetime stress and traumatic events or exposure to violence early in life has been associated with a multitude of behavior and mood disorders in later childhood and adolescence (Lubit, Rovine, DeFrancisci, & Eth, 2003; Weber et al., 2008). For example, Stouthamer-Loeber et al. (2001) found that maltreatment (e.g. physical or sexual abuse) occurring across the lifetime (before age 18) was significantly associated with increased levels of aggression in adolescence. Similarly, Smith and Thornberry (1995) found that individuals who were maltreated before the age of 18 were more likely to be involved in delinquent acts and to be arrested during adolescence. In a 2001 study by Thornberry et al., researchers were interested in identifying whether stress, specifically maltreatment such as physical or sexual abuse, neglect, or emotional abuse, that occurred during different periods of life (i.e. birth through age 5, between ages 6 and 11, etc.) was associated with externalizing behavior in adolescence. Researchers found that maltreatment that was childhood limited (i.e. occurring before the age of 11) did not significantly predict delinquency in adolescence. However, adolescent-only and persistent maltreatment throughout the lifetime did increase the risk of delinquency in adolescence.

Episodic, current life stress includes negative events that have occurred recently, typically in the past year. Studies have linked current life stress to higher rates of delinquency and externalizing behaviors. For example, McKnight et al. (2002) found that a greater number of stressors occurring in the past year were positively related to levels of externalizing and internalizing behaviors in middle and high school students. Both Hoffman and Su (1997) and Aseltine Jr. et al. (2000) also found that increased levels of stress in the past year predicted adolescent delinquency. Notably, these results were also observed in pre-adolescents (ages 7-13) indicating that current, episodic stress may be associated with externalizing behaviors for a wide age range in youth, not just those in later adolescence (Jackson & Warren, 2000).

Fewer studies have considered the role of daily hassles on the development of antisocial behavior in adolescence. Daily hassles are frustrating demands and stressors that occur during everyday interactions between the person and his or her environment (Holm & Holroyd, 1992; Kanner, Coyne, Schaefer, & Lazarus, 1981). They differ from lifetime events and recent life stressors in that they occur on a regular basis and have less readily identifiable beginnings and endings (Wright, Creed, & Zimmer-Gembeck, 2010). Higher rates of reported daily hassles have been associated with poorer overall health (DeLongis, Coyne, Dakof, Folkman, & Lazarus, 1982; Jandorf, Deblinger, Neale, & Stone, 1986) and increased hospitalizations for illnesses (Williams, Zyzanski, & Wright, 1992). Interestingly, some studies have found that daily hassles have a greater association with adults' psychological wellbeing than major life events (Kanner, Coyne, Schaefer, & Lazarus, 1981; Russell & Davey, 1993). Adolescent psychological wellbeing and adjustment, including depression and self-concept, have been found to be negatively

related to daily hassles alone (Sim, 2000) and in combination with distal, major life events (Rowlinson & Felner, 1988).

Relatively few studies have looked at child and adolescent self-reported levels of daily hassles in relation to externalizing behaviors (Banez & Compas, 1990). However, some preliminary evidence suggests that examining daily hassles separate from major episodic stressors might be fruitful in this area of research. For example, Compas et al. (1989) found that when stressful events were broken down into major life events and daily hassles, daily stressors were a better predictor of behavior problems during adolescence. In a Korean sample, Sim (2000) found that hassles specifically related to interactions with parents were the best predictor of antisocial behavior during adolescence. Tolan (1988) also found that daily hassles were positively correlated with increased self-reported externalizing behavior. More research is needed to determine the relative associations between different types of life stress and adolescent externalizing behaviors.

### *Stress Exposure and Cortisol*

Increases in stress have been shown to lead to maladaptations and dysfunction of the HPA axis in both the animal and human literatures (Susman, 2006; Van Goozen, Matthys, Cohen-Kettenis, Buitelaar, & van Engeland, 2000a). General trends have been identified regarding cortisol levels and their relationship to different types of stress (e.g. major life events versus daily hassles). Specifically, both the animal and human literatures suggest that stressful events occurring early in development can lead to long-lasting or permanent changes in HPA axis functioning and subsequent cortisol production (Susman, 2006; Van Goozen, Matthys, Cohen-Kettenis, Buitelaar, & van Engeland,

2000a; Weinstock, 2005). Specifically, early life stress has been linked to a hypoactivity in the HPA axis (Fries, Hesse, Hellhammer, & Hellhammer, 2005; Van Goozen, Matthys, Cohen-Kettenis, Buitelaar, & van Engeland, 2000a). For example, blunted morning cortisol levels have been observed in rhesus monkeys repeatedly separated from their mothers at birth (McCormack et al., 2003). In humans, these lower levels of cortisol were observed in individuals who had experienced early trauma, such as a poor relationship with a primary caregiver (Susman, 2006) and childhood sexual or physical abuse (Heim et al., 2002; Weissbecker, Floyd, Dedert, Salmon, & Sephton, 2006). This presumed downregulation in the HPA axis is likely due to overactivation of the stress response system in early life. This downregulation could be an adaptive mechanism as continuous arousal and excessive use of energy can have harmful results, such as negative long-term pathophysiological consequences and death (Van Goozen, Fairchild, Snoek, & Harold, 2007).

Lower basal cortisol is also often associated with chronic, long-term stressors (Dadds & Rhodes, 2008; Bruce, Fisher, Pears, & LeVine, 2008). Like early life stress, chronic stress is thought to lead to a downregulation of the HPA system and lower cortisol levels at awakening (Gunnar & Vazques, 2001; Heim & Nemeroff, 2001). On the other hand, the literature suggests that individuals who have suffered acute, short-term stress appear to have higher levels of cortisol due to hyperarousal of the HPA axis system (Bruce, Fisher, Pears, & LeVine, 2008; Dadds & Rhodes, 2008; Wust, Federenko, Hellhammer, & Kirschbaum, 2000). For example, studies have found that adults who perceived themselves as having had increased levels of current stress within the last year had higher amounts of cortisol at awakening (Wust, Federenko, Hellhammer, &

Kirschbaum, 2000). In that same vein, daily hassles have been associated with higher levels of cortisol secretion in both healthy (Van Eck, Berkhof, Nicolson, & Sulon, 1996) and depressed adults (Sher, 2004). Parsing out the different types of stress may provide important clues to determining the specific effects of stress on HPA axis functioning.

#### *Cortisol and Externalizing Problems*

Research regarding cortisol levels and aggression in adolescence has yielded mixed results (see review by Van Goozen, Fairchild, Snoek, & Harold, 2007). The majority of studies have found a pattern of lower basal cortisol levels linked to increased externalizing behaviors (e.g. Alink et al., 2008; McBurnett, Lahey, Rathouz, & Loeber, 2000; Oosterlaan, Geurts, Knol, & Sergeant, 2005; Shoal, Giancola, & Kirillova, 2003). For example, Oosterlaan et al. (2005) found lower levels of cortisol related to higher rates of conduct disorder in adolescence and Popma et al. (2007a) found lower levels of cortisol during the awakening response (the peak occurring the hour after awakening) in minors with disruptive behavior disorders. This relationship was not found for adolescents in a meta-analytic review by Alink et al. (2008). Instead, the results from this meta-analysis suggested that age moderated the relationship between basal cortisol levels and externalizing behavior, where cortisol levels were positively related to externalizing behaviors in preschool children (younger than 5) and negatively related to behaviors in school age children (between 5 and 12). These mixed findings illustrate the importance of examining different factors that may be associated with cortisol and behavior across development.

Several researchers have theorized about the connection between cortisol and aggression, with a primary focus on the association between under-reactivity of the HPA

axis and externalizing behaviors. Antisocial and aggressive adolescents have been shown to have lower levels of reactivity compared with healthy controls (Raine, 1993). This same lowered emotional reactivity is a trait of adult psychopathy, a condition linked to some childhood disruptive disorders (Raine, 1993). It is hypothesized that under-reactivity is linked to reduced comprehension of distress cues, which is associated with a lack of empathy and behavioral inhibition (Marsh et al., 2008). Additionally, low cortisol levels are thought to be associated with a reduced fear response (Cima, Smeets, & Jelicic, 2008), which could be related to persistent aggressive behavior in childhood (McBurnett, Lahey, Rathouz, & Loeber, 2000).

The link between low arousal and disruptive behavior has been explained in two ways (Popma et al., 2007a). First, the fearlessness theory suggests that individuals with reduced arousal levels are more likely than those without reduce arousal levels to engage more often in acts of aggression, such as physical fights and delinquency, presumably because they do not care about negative consequences (Raine, 1993). Alternatively, the sensation seeking theory (Zuckerman, 1978) claims that low arousal levels are physiologically aversive and individuals in this state seek stimulation to increase arousal to a normal level. Both theories imply that low levels of cortisol should be linked to increased disruptive behavior.

On the other hand, a growing literature suggests the link between low cortisol and aggressive behavior is weaker than previously believed (Hawes, Brennan, & Dadds, 2009). For example, Van Bokhoven et al. (2005) found a positive relationship between cortisol levels and aggressive behavior in longitudinal studies with adolescent boys. Other studies have found no link at all between cortisol and disruptive behaviors (Alink

et al., 2008; Scerbo & Kolko, 1994; Van Goozen et al., 2000b). In reviewing these divergent findings, Hawes et al. (2009) proposed two pathways to antisocial behavior—one of which links stress exposure to high cortisol and aggression, and the other which links low cortisol to aggression through callous-unemotional traits. Psychological and behavioral functioning in this second group is hypothesized to be unrelated to stress exposure. Lopez-Duran et al. (2009) also found that cortisol levels in response to a stressor differed as a function of whether aggression was considered reactive or proactive. These studies offer explanations for the divergent findings in the cortisol and externalizing behavior literature. However, further research is needed to parse out the many factors that may be contributing to the dysregulation of the HPA axis and aggression.

In their review of the HPA axis and aggression literature, Van Goozen et al. (2007) reported multiple reasons for the discrepant findings between cortisol and aggressive behavior and cited the importance of methodological differences when considering comparisons across studies. For example, Van Goozen and colleagues note that it is essential to be aware of different methods of cortisol collection (e.g., basal conditions versus during stress), types of behavioral measures (e.g., self-report versus multiple informants), and potential methodological problems (e.g., a lack of control for the time of day of cortisol collection). As mentioned previously, differing types of externalizing problems (e.g., aggression versus delinquency or proactive versus reactive aggression) may be associated with different levels of cortisol (Hawes, Brennan, & Dadds, 2009). All of these factors are important to keep in mind when investigating the



relationship among stress, cortisol levels, and externalizing behaviors and when considering cortisol and stress as factors influencing treatment outcome.

### *Internalizing Disorders*

Internalizing characteristics include emotional and cognitive distress, such as anxiety and mood disorders (Achenbach, 1991). Adolescent internalizing disorders, particularly depression, have been linked to lifetime stress, stress experienced only during adolescence (Thornberry, Ireland, & Smith, 2001), and daily hassles (Compas, Howell, Pares, Williams, & Giunta, 1989; Sher, 2004). HPA axis dysregulation has been associated with internalizing disorders such as anxiety disorders (Heim & Nemeroff, 2001) and clinical depression in adolescents (Kaufman & Charney, 2001; Forbes et al., 2006).

Although factor analytic studies of psychiatric disorders have found support for separate internalizing and externalizing factors (Krueger et al., 2001), the literature suggests that these disorders are often comorbid (Hewitt et al., 1997; Hinshaw, 1987). Additionally, externalizing behavior with and without internalizing problems may be associated with different patterns of cortisol (McBurnett, et al., 1991; Van den Bergh et al., 2008). For example, McBurnett et al. (1991) found that boys diagnosed with comorbid conduct disorder and anxiety disorder had higher cortisol levels than boys diagnosed only with conduct disorder. In addition, the presence of comorbid externalizing and internalizing behaviors has been associated with treatment response (Beauchaine, Webster-Stratton, & Reid, 2005; Lavigne et al., 2008).

Due to the strong associations previously noted between internalizing disorders, stress, and cortisol, and the high comorbidity of internalizing and externalizing disorders,

it is important to control for internalizing problems when examining the relationships among stress, cortisol and externalizing behavior problems. In the current study, I predicted that comorbid internalizing problems will not account for direct associations between cortisol and externalizing problems or stress and externalizing problems in adolescent males as much evidence suggests that there is a relationship between cortisol and externalizing behaviors regardless of the presence of internalizing behavior (e.g., Van Goozen, Fairchild, Snoek, & Harold, 2007).

#### *Treatment Outcome*

The literature suggests that different types of stress and subsequent cortisol levels can influence levels of aggression. These factors may also play a role in predicting treatment outcome for externalizing problems. In recent years treatment researchers have begun to ask, “For whom does this treatment work?” and “When is this treatment not enough?” (Nock, 2003; Brestan & Eyberg, 1998). However, relatively few studies have attempted to answer these questions for youth suffering from disruptive disorders (Nock, 2003).

One study, by Beauchaine et al. (2005), combined results from six randomized controlled trials for youth with early-onset conduct problems in an effort to elucidate moderators, mediators, or predictors of treatment outcome. They found that having a younger mother, a father with a history of substance abuse, and child comorbid symptoms of anxiety/depression predicted better treatment response. A study by Lavigne et al. (2008) looking at Oppositional Defiant Disorder (ODD) in 3-6 year-olds found that mothers’ total life stress was associated with greater improvement following treatment. Mothers’ education level was also negatively related to ODD symptoms at post-

treatment, suggesting that socioeconomic status (SES) is a factor that should be explored when examining treatment outcome.

Stress experienced directly by clients and their families has also been found to influence treatment outcome for youth. For example, Willemen et al. (2008) investigated whether stressful life events that occurred prior to the referral of youth suffering from behavioral and mood disorders to an outpatient psychiatric clinic was related to internalizing and externalizing behaviors at the beginning of treatment, and if stressors that occurred after the referral differentiated recovery time for these problems.

Researchers found a history of increased levels of stressful life events was associated with higher levels of parent-reported internalizing and externalizing problems. They also found that stressors that occurred after referral and throughout the four-year longitudinal study were associated with a slower recovery of internalizing but not externalizing problems. Similarly, Mathijssen et al. (1999) found that parent-reports of a child's stressful life events in the past year predicted a lack of change in externalizing behavior at post treatment.

Few studies have looked at cortisol as a marker for later disruptive behavior, and only one study to date has looked at this relationship in a treatment context. Lower basal cortisol levels have been associated with increased aggressive behavior in boys 2-years (McBurnett, Lahey, Rathouz, & Loeber, 2000) and 5-years (Shoal, Giancola, & Kirillova, 2003) following sample collection. This finding was replicated in a 2-year longitudinal study by Sondejker et al. (2008) but results were significant only for youth with higher levels of disruptive disorders at the onset of the study. These researchers also found that low evening HPA axis activity predicted increased disruptive behavior for boys 2-years

later. In contrast, Van Bokhoven et al. (2005) found that higher cortisol levels were associated with particularly aggressive behavior in boys with Conduct Disorder one year after the cortisol assessment. Van de Wiel et al. (2004) looked at basal cortisol levels in boys ages 8-13 in the context of treatment and found that lower basal cortisol was associated with increased externalizing behaviors at the beginning of treatment, but was not associated with levels of aggression at post treatment. However, results from this study showed that lower cortisol in response to a stressor was related to increased levels of aggression at post treatment. These preliminary results suggest that further investigation of cortisol as a potential predictor of treatment success for boys with externalizing problems is warranted.

*Cortisol as a Moderator of the Relationship between Stress and Externalizing Behavior*

To further explore the connections among stress, cortisol, and behavior, this study will investigate the moderating role of cortisol on the relationship between stress and externalizing behaviors. Cortisol has previously been found to moderate the relationship between testosterone and aggression, with some findings indicating a positive relationship between testosterone and aggression for individuals with lower levels of cortisol (Popma et al., 2007b). Cortisol has also been shown to interact with markers of the sympathetic nervous system (SNS; e.g. skin conductance levels) such that higher level of cortisol were positively related to higher levels of internalizing and externalizing behaviors among children with higher SNS activity (El-Sheikh, Erath, Buckhalt, Granger, & Mize, 2008).

Few studies have specifically explored the interaction between stress and cortisol in the prediction of externalizing problems. Murray-Close et al. (2008) found that

aggression was more strongly related to cortisol levels for nonmaltreated youth than for maltreated youth. Similarly, Cicchetti and Rogosch (2001) found that lower morning cortisol was related to externalizing behaviors in nonmaltreated boys, but not in their maltreated counterparts. Interestingly, it has been suggested that stress and cortisol may have differential impact for specific subtypes of aggressive boys (Hawes, Brennan, & Dadds, 2009). Lower basal cortisol levels have been found in adolescent boys higher in callous-unemotional traits (Loney, Butler, Lima, Counts, & Eckel, 2006), a pattern also seen in adult psychopathic offenders (Cima, Smeets & Jellicic, 2008). Hawes et al. (2009) suggest that associations between stress and aggression may be weaker for these aggressive youth, and stronger for youth with more hyperactive responses of the HPA axis. The current study will test this hypothesis by examining cortisol as a moderator of the relation between stress and concurrent externalizing problems, as well as stress and changes in externalizing behaviors in response to treatment.

#### *Multisystemic Therapy (MST)*

Multisystemic Therapy (MST) is an intensive, individualized intervention that uses a variety of treatments and procedures to meet the needs of antisocial adolescents and their families (Eyberg, Nelson, & Boggs, 2008). The intervention operates on a family and community level, as MST is based on the concept that behavior develops in the context of multiple environments and that it is necessary to address the interaction between these ecologies to change behavior (Association for Behavior and Cognitive Therapies, 2009, para. 2). Therapists provide MST according to an MST manual and receive at least weekly meetings with an MST trained supervisor (Henggeler & Schoenwald, 1998). Although a large component of MST is parent training, other

treatments include behavior therapies, cognitive-behavioral therapy, and pragmatic family therapies (Henggeler, 1999). MST has been shown to be an efficacious treatment, reducing rearrest rates up to 70% in some studies, and has been deemed as either demonstrating effectiveness or showing great promise in curbing antisocial behavior by the United States Surgeon General (USDHHS, 1999; U.S. Public Health Service, 2001; National Institute on Drug Abuse, 1999; Center for Substance Abuse Prevention, 2001). We will take advantage of data available from an MST treatment study to explore the relationships among stress, cortisol, and externalizing behavior problems in males. Specifically, we will examine inter-relationships among these factors at treatment onset, and determine whether stress and/or cortisol measures at the onset of therapy predict changes in externalizing behavior in response to MST.

### *Hypotheses*

First, we hypothesize that higher levels of self-reported stress (lifetime stress, current episodic stress, and daily hassles) will be associated with increased externalizing behavior problems before treatment. Second, we predict that disruption of the HPA axis (higher or lower levels of cortisol) will be related to increased levels of externalizing problems at pretreatment. Third, we hypothesize that HPA axis dysfunction will moderate the relationship between stress and levels of externalizing behaviors at pretreatment, such that youth who experienced increased stress, and who have dysregulated HPA axis functioning, will show increased externalizing behaviors prior to treatment. Fourth, we hypothesize that stress and HPA axis dysfunction will predict treatment response, such that increased levels of stress and HPA axis dysregulation (both alone and in interaction with one another) at pretreatment will lead to lower reductions in

externalizing behaviors in response to MST treatment. Finally, we hypothesize that the above relationships will remain significant when internalizing disorders are statistically controlled.

## **Method**

### *Design*

A longitudinal treatment design was used to investigate the relationships between different types of self-reported stress and externalizing behaviors before and after an intensive treatment. This design allowed for the examination of stress and HPA axis dysregulation as predictors of treatment outcome. Participants were studied in the context of MST. At the onset of treatment, youth participants were given self-report questionnaires to measure stress and trauma occurring throughout their lives. Current episodic stressors and daily hassles were also gathered via self-report from the youth and salivary cortisol was collected from the youth at awakening at the onset of treatment. Caregivers completed questionnaires concerning the behavior problems exhibited by the youth in the last month. Participants and their caregivers underwent MST with a licensed therapist. Duration of MST was agreed upon by the participant, caregiver, and therapist and was based on the child's progression through the therapy. Following completion of the treatment, parents reported current levels of externalizing problems in the youth.

### *Participants*

The sample included 120 males ages 12 to 18 with a mean age of 15.47 ( $SD=1.30$ ) years. Fifty one percent of the participants were European American, 26% of the participants were Latino American, 20% of the participants were African American, and 3% of the participants identified as "other." The participants were recruited to

participate in the MST study through four MST provider agencies in the Denver metropolitan area. SES was calculated using the widely used Hollingshead SES scale (Hollingshead, 1975), which takes into account parental education and occupation. The median family income was \$27,000. The mean Hollingshead score was 30.28 with a standard deviation of 11.27.

Inclusion criteria included (1) youth age between 12 and 17 years (2) referral for MST by social service agencies or juvenile justice courts due to involvement with substance abuse, crimes against another person, or a property offense; (3) availability to participate in current MST treatment; and (4) a consistent living arrangement within a caregiver's home for at least a month prior to treatment. Informed consent was obtained from the caregiver and assent obtained from the youth participant. This study was approved by the Institutional Review Boards at the University of Colorado, the Medical University of South Carolina, and Emory University.

### *Measures*

*Externalizing Problems.* The Child Behavior Checklist (CBCL; Achenbach, 1991), a well-validated measure of child behavior, was used as the measure of externalizing behavior problems. The primary caregiver completed CBCL questionnaires at the onset and termination of MST treatment. The CBCL includes 113 behavioral items, and is used to measure an array of behavior problems in youth ages 2 to 18. This study looked specifically at the CBCL items measuring externalizing behaviors; however, CBCL internalizing scores were also used to evaluate hypothesis 5. Treatment outcome was operationalized as CBCL externalizing behavior scores reported by the caregiver at treatment completion controlling for caregiver reported externalizing behavior at



pretreatment. The descriptive statistics for the CBCL subscales used in this study can be seen in Table 1.

*Stress.* Three measures of stress were used in this study—a lifetime stress measure, a measure of negative recent life events, and a measure of daily hassles. Descriptive statistics for these three measures are presented in Table 1 and the intercorrelations between these stress measures can be seen in Table 2.

Lifetime stress was measured with an 11-item questionnaire filled-out by the youth participants at treatment onset. This scale was adapted and extended from a measure by Kessler and Magee (1993), and includes major negative life events such as “Has your mother or your father died?” and “Did your parents have a lot of conflict in their marriage?” Youth are asked to circle “yes” or “no” as to whether each of these events happened in their lifetime, and the total number of yes responses was tabulated as the measure of lifetime stress.

Youth were asked to complete an episodic stress measure at treatment onset called Recent Life Events (Tiet et al., 2001). This scale is a 26-item checklist that asks youth to report on stressors that have occurred in the past 30 days and to classify the event as a “mostly good” or “mostly bad” experience. Measures on the item include, have you experienced “loss of a close friend,” “parental divorce,” and “started going to a new school.” In this study, items endorsed as being “mostly bad” were totaled and used as a measure of negative recent life events.

Youth participants also completed the Urban Hassles Index (Miller & Townsend, 2005), a measure of daily hassles encountered by adolescents growing up in urban environments. This scale asks adolescents to report how often certain events have

happened to them in the past 30 days. Items on the scale include how often have you been “asked for money by a drug addict,” “nervous about gunshots at night,” and “pressured to carry a weapon for protection.” Youth were asked to indicate if these events have (1) never, (2) sometimes, (3) often, or (4) very often happened to them in the past month. Responses were summed across items to form a total score representing self-reported daily hassles.

*Cortisol Collection and Immunoassay Protocols.* Levels of cortisol secretion were measured at awakening. Morning cortisol levels have been shown to be an indicator of stress and behavioral risk and, as such, have been used in a multitude of studies investigating the link between biology and aggression (see review by Van Goozen, Fairchild, Snoek, & Harold, 2007).

One strength of the current study is the method by which participants’ salivary cortisol samples were obtained. A research assistant visited each youth’s home and woke him to collect a saliva sample at the time he indicated that he normally wakes up. This method not only controls for any error that could be attributed to having subjects collect the sample themselves, but it also ensures that samples accurately reflect morning cortisol levels. Samples were collected by having the participants spit directly into a plastic tube. Once collected, saliva samples were stored in an adult size lunch box with an ice pack for the duration for the home visit. The samples were then transported to the research lab where they were frozen and stored at  $-20^{\circ}\text{C}$  for an average of three months before being sent overnight for assay at the Yerkes National Primate Research Lab at Emory University. Upon arrival to Yerkes, saliva samples were stored at  $-20^{\circ}\text{C}$  until the day of assay. On the day of assay, samples were thawed, vortexed, and centrifuged to remove

any particulate matter. Salivary cortisol was assayed using an enzyme immunoassay kit (DSL, Webster, TX), catalogue number DSL-10-67100. This assay procedure has an analytical sensitivity of 0.10 mg/dl, using 25 ml of saliva. The intra- and inter-assay coefficient of variation is 4.1 and 7.2%, respectively. Each sample was assayed in duplicate. Duplicate tests with an error more than 20% were retested. Duplicate test results were averaged and this value for cortisol was used in analyses.

## Results

### *Preliminary Analyses*

Internalizing and externalizing scores were correlated at pretreatment ( $r=.61$ ,  $p<.001$ ) and at post treatment ( $r=.77$ ,  $p<.001$ ). Table 2 presents the inter-correlations between stress measures. As can be seen, lifetime stress did not correlate with either of the other stress measures. Negative recent life events and daily hassles were positively correlated. Table 2 also depicts the significant correlation between daily hassles and basal cortisol levels. Cortisol sampled at pretreatment was not significantly associated with recent negative life events or lifetime stress.

### *Potential Confounds*

Preliminary analyses revealed that the time of day that cortisol was collected was significantly associated with cortisol levels at awakening ( $r=.20$ ,  $p<.05$ ) and this variable was controlled for in all further analyses examining HPA axis dysregulation. Number of hours slept the night before collection, as well as the use of cigarettes, chewing tobacco, prescription medication, antihistamines, marijuana, steroids, sleep medications, allergy medications, cold/flu medication, and caffeine were not significantly related to cortisol levels at awakening.

Youth age was not significantly correlated with externalizing behaviors, cortisol, or any of the stress measures. This nonsignificant correlation runs counter to some findings in the literature (Alink et al., 2008). However, our sample was restricted to adolescence, as we sampled only from youth aged 12 to 18 years.

In this study, SES was positively correlated with externalizing behaviors at pretreatment ( $r=.24, p<.01$ ). SES was also significantly correlated with ethnicity such that Latino youth had significantly lower SES ( $r=-.35, p<.001$ ) and white youth had significantly higher SES ( $r=.35, p<.001$ ). SES was controlled for in all analyses.

An ANCOVA controlling for SES revealed ethnic group differences for externalizing behaviors, such that youth who were White had higher externalizing behaviors at pretreatment. No significant differences between ethnicities were found for externalizing behaviors at post treatment. All further analyses exploring externalizing behavior at pretreatment statistically controlled for ethnicity (using a dummy coded variable). Zero-order correlations between stress, basal cortisol, and pretreatment externalizing behavior are presented in Table 5.

Another consideration is that self-report measures are susceptible to response sets and styles and can lead to spurious results. Researchers in this study attempted to control for the effect of negative affectivity on responses to the self-report questionnaires. Negative affectivity is a higher-order dispositional dimension that constitutes an individual's tendency to be upset, distressed, or to have a negative self-concept (Watson & Clark, 1984). Negative affectivity has been shown to be related to responses on self-report questionnaires; specifically, findings suggest that individuals higher on negative affectivity report more distress across situations (Watson & Clark, 1984). Post hoc

analyses using CBCL anxiety scores as a proxy for negative affectivity revealed that anxiety was not significantly correlated with any of the self-report stress measures.

As MST is an individualized treatment, the number of therapy sessions completed by each participant was agreed upon by the MST therapist and the family and based upon child's progression through treatment. Total number of treatment sessions completed by the youth was not significantly associated with pretreatment or post treatment externalizing behaviors, stress, or basal cortisol levels.

### *Hypotheses Testing*

The first hypothesis in this study was that higher levels of stress would be correlated with increased externalizing behaviors prior to treatment. A partial correlation controlling for ethnicity and SES did not yield significant correlations between the different types of stressors and externalizing behavior (see Table 3). Regression analyses testing for a curvilinear relationship between cortisol and externalizing behaviors at pretreatment also yielded nonsignificant results ( $F$  Change=.14). The second hypothesis was that dysregulation of the HPA axis, indicated by higher or lower levels of cortisol, would be correlated with externalizing behaviors before treatment. This hypothesis was not supported. A partial correlation controlling for ethnicity, SES, and time of cortisol collection did not yield significant results (see Table 3). Multiple regression analyses were used to test the third hypothesis that that HPA axis dysregulation would moderate the relationship between stress and externalizing behaviors at pretreatment. Both independent variables (cortisol and the stress measures) were centered and cortisol X stress interaction terms were computed. Ethnicity, SES, and time of cortisol collection were entered into Block 1, the centered cortisol and stress variables were entered into

Block 2, and the interaction terms were entered into Block 3. Results from the analysis did not support this hypothesis (see Table 4).

The fourth hypothesis was that stress and HPA axis dysregulation would predict treatment response, such that more self-reported stressors and HPA axis dysregulation at pretreatment would be related to less of a reduction in externalizing behavior following MST treatment. This hypothesis was supported for daily hassles and higher levels of cortisol. A partial correlation controlling for SES and pretreatment levels of externalizing behaviors revealed a significant positive relationship between daily hassles and externalizing behavior at post treatment ( $r=.30, p<.005$ ; see Table 3). A second partial correlation controlling for SES, time of cortisol collection, and externalizing behavior at pretreatment revealed a positive relationship between cortisol levels and externalizing behaviors after treatment ( $r=.22, p<.05$ ).

Multiple regression analyses were used to test for the moderating role of cortisol on the relationship between stress and externalizing behaviors at post treatment. Both independent variables (cortisol and the stress measures) were centered and cortisol X stress interaction terms were computed. SES, time of cortisol collection, and pretreatment externalizing scores were entered into Block 1, the centered cortisol and stress variables were entered into Block 2, and the interaction terms were entered into Block 3. Analyses revealed a significant interaction between daily hassles and cortisol levels ( $\beta =.15, F=4.73, p<.05$ ; see Table 4). Splitting the sample at the median cortisol level revealed a strong, positive association between daily hassles and externalizing behavior for males in the upper 50<sup>th</sup> percentile of cortisol levels ( $\beta =.31, F=3.87, p=.06$ ). Essentially no

relationship between daily hassles and externalizing problems was found for males in the lower 50<sup>th</sup> percentile ( $\beta = .06, F = .04, p = .83$ ).

The final, exploratory hypothesis was that the relationships found in hypotheses 1-4 would remain significant when internalizing disorders were statistically controlled. This hypothesis was largely supported, as the majority of results were unchanged when internalizing disorders were controlled. The only differences that were noted were found in the results for hypothesis 4. While main effects for daily hassles and cortisol were no longer significant in predicting post-treatment externalizing problems, the interaction between cortisol and daily hassles remained significant ( $\beta = .12, F = 4.29, p < .05$ ). In addition, after controlling for internalizing scores at post treatment, a significant interaction was found between negative recent life events and cortisol predicting post treatment externalizing problems. Follow up analyses revealed a stronger relationship between negative recent events and post treatment externalizing behaviors for males with higher levels of basal cortisol ( $\beta = .32, F = 3.93, p = .06$ ). This relationship was not apparent for males with lower levels of cortisol ( $\beta = .002, F = .0001, p = .99$ ).

### **Discussion**

This study investigated relationships between stress and externalizing behaviors in adolescent male juvenile offenders. Stress was delineated into lifetime, current, and daily hassles in an effort to parse out the specific associations between different types of stress and the development of externalizing behaviors. The dysregulation of the HPA axis was also examined as a potential factor associated with externalizing behaviors. Finally, the role of the stress and cortisol in response to MST treatment was explored.

The results from the pretreatment phase of the present study run counter to theories suggested in current literature, as well as the researcher's expectations. Stress occurring earlier in life (Lubit, Rovine, DeFrancisci, & Eth, 2003; Smith & Thornberry, 1995; Stouthamer-Loeber, Loeber, Homish, & Wei, 2001; Weber et al., 2008), recent life stressors (Aseltine Jr., Gore, & Gordon, 2000; Hoffman & Su, 1997; McKnight, Huebner, & Suldo, 2002), and daily hassles (Compas, Howell, Phares, Williams, & Giunta, 1989; Sim, 2000; Tolan, 1998) have all previously been linked to adolescent externalizing behavior. Additionally, the dysregulation of the HPA axis has been found repeatedly to be associated with externalizing behaviors, though the direction of this relationship is unclear (Van Goozen, Fairchild, Snoek, & Harold, 2007).

The nonsignificant findings between stress and externalizing behavior at pretreatment may be attributed to sampling effects. The range and variability of externalizing behaviors may have been restricted in the sample, as the youth must have exhibited antisocial behavior in order to be referred for treatment and included in the study. Similarly, the stress measures may have had a restricted range compared with those noted in community samples (Smith & Thornberry, 1995; Stouthamer-Loeber, Loeber, Homish, & Wei, 2001; Thornberry, Ireland, & Smith, 2001). For example, all youth began the study soon after they had committed a crime and been referred for treatment. These events, in and of themselves, are stressful and were experienced by all study participants. Thus, correlations involving externalizing behavior and stress may have been reduced.

Findings between cortisol and externalizing behavior at pretreatment were also nonsignificant, including post hoc analyses investigating a potential curvilinear



relationship between these two factors. Theories attempting to explain the complex relationship between cortisol levels and aggression have posited that different subtypes of aggressive youth, such as those with and without callous-unemotional traits (Hawes, Brennan & Dadds, 2009), as well as different types of externalizing behaviors, such as proactive versus reactive aggression (Murray-Close, Han, Cicchetti, Crick, & Rogosch, 2008), are linked to specific levels of cortisol. Potentially, significant associations between cortisol and aggression may not have been detected in this study because delineations between different subgroups of aggressive youth and/or different types of externalizing behaviors were not addressed by the measures. Thus, examining externalizing behaviors at a global level may have masked any potential relationships at the subtype level.

In contrast to the nonsignificant results noted at pretreatment, several associations were found between stress, cortisol, and post treatment externalizing problems. In terms of stress, boys reporting more daily hassles at pretreatment did worse following MST treatment. This finding supports the previous literature regarding the impact of daily hassles on problematic behavior during adolescence (Compas, Howell, Phares, Williams, & Giunta, 1989; 1989; Sim, 2000; Tolan, 1988). In addition, these results may allow for a better understanding of the role of daily stressors and antisocial behavior in a treatment context. The Urban Hassles Scale used in this study reflects daily situations experienced in low SES environments. A meta-analysis exploring potential moderators of treatment success with children exhibiting disruptive disorders showed that families from lower SES backgrounds were the least responsive to treatment (Lundahl, Risser, & Lovejoy, 2006). The current study accounted for SES in the analyses and continued to find a

significant relationship between daily stressors and externalizing behavior at post treatment. Findings from the current study suggest, therefore, that perhaps the relationship between SES and behavior can be further explained by the daily hassles encountered by youth in low SES environments.

In addition, items on the Urban Hassles Scale tap both the presence of daily stressful situations and the perceptions of these events; the Lifetime Stress and Recent Life Events questionnaires simply assess whether certain events have occurred in the youths' lives. For example, the Urban Hassles Index asks if the youth are "nervous about gunshots at night" or feel they have been "pressured to join a gang," while the Lifetime and Recent Life Event measures ask if youth have experienced parental divorce or the death of a close friend. According to their transactional model of stress, Lazarus and Folkman (1984) suggest that perceived stress may contribute to behavioral problems overtime. Evidence supports this association between subjective levels of stress and internalizing (Martin, Kazarian, & Breiter, 1995) and externalizing behaviors (Willemen, Koot, Ferdinand, Goossens, & Schuengel, 2008). Thus, the relationship observed between daily hassles and treatment outcome may be partially attributed to youths' perception of daily stressors.

Results from this study also suggest that higher levels of cortisol may be related to behavior problems that are not ameliorated by MST treatment. This observed positive correlation contributes to the complicated conceptualization of the relationship between cortisol levels and externalizing behavior. While a negative relationship between externalizing behavior and cortisol has been previously well-supported, recent literature has questioned the strength and direction of this association (Hawes, Brennan, & Dadds,

2009; Van Goozen, Fairchild, Snoek, & Harold, 2007). Of note, a previous study using the participants from this treatment sample found that higher cortisol reactivity predicted poor treatment adherence on the part of the therapist at midtreatment (Brennan, Foster, Cunningham, Whitmore, & Wold, unpublished). Taken together, these findings suggest that further research concerning the treatment difficulties posed by youth with higher cortisol levels may be useful in improving treatment outcomes associated with MST.

Importantly, the main effects of daily hassles and cortisol levels on MST treatment response were qualified by an interaction. Specifically, it was noted that adolescent males with an increased amount of daily hassles as well as higher levels of morning cortisol showed the poorest response to treatment. This interaction remained even when comorbid internalizing behaviors were taken into account. Interestingly, once internalizing behaviors were accounted for, negative recent life events also interacted with cortisol to predict externalizing behaviors at post treatment. Thus, youth who had reported experiencing more negative events 60 days prior to the commencement of treatment had worse treatment outcome if they also had higher basal cortisol levels.

These findings add to the paucity of literature regarding the potential moderating effects of stress and cortisol on externalizing behavior in males. Murray-Close et al. (2008) found that the relationship between cortisol and aggression in adolescent boys was strongest for nonmaltreated youth compared with youth with a history of maltreatment. Cicchetti and Rogosch (2001) also found that lower levels of morning cortisol were related to increased antisocial behavior for nonmaltreated youth. In addition, Hawes et al. (2009) suggest that stress may not impact aggression in subgroups of particularly callous-unemotional (low cortisol) males. Our findings provide initial support for this contention,

and suggest that future examinations of these moderating influences on externalizing problems are warranted.

Surprisingly, this study did not find that lifetime stress was associated with any of the recent stress measures, cortisol, or externalizing behaviors. Post hoc analyses controlling for recent negative life events did not change these results. Much literature indicates that events occurring throughout the lifetime, particularly early in life, impact the stress response system (Susman, 2006) and the development of psychopathology (Benjet, Borges, & Medina-Mora, 2010; Lubit, Rovine, DeFrancisci, & Eth, 2003; Stouthamer-Loeber, Loeber, Homish, & Wei, 2001; Weber et al., 2008). Some findings have indicated that stress occurring during specific developmental windows may lead to delinquency during adolescence. For example, Thornberry et al. (2001) found that maltreatment that was childhood limited did not predict adolescent delinquency, but maltreatment occurring across the lifetime and only during adolescence was correlated with increased adolescent delinquency.

In the current study, results regarding lifetime stress may not have been significant for multiple reasons. First, our lifetime stress measure did not delineate when the stress occurred. This lack of specificity with regards to the timing of the stressor prevented me from distinguishing whether stress occurred during a specific developmental window. In addition, all items on the measure were equalized. Thus, an event that may have more of an impact on the HPA axis dysregulation was given the same weight as an item that may have had less of an effect. Despite these limitations and unexpected findings, these results still add to the literature regarding stress and

externalizing behaviors. Specifically they suggest that the impact of recent stressors on treatment response depends upon the regulation of the HPA axis system.

Overall, findings from this study revealed stronger associations of stress and hormonal factors with post treatment externalizing problems, rather than concurrent externalizing problems at pretreatment. These results are similar to those noted in a recent study of testosterone and externalizing behavior using the same dataset (Ryan, unpublished). Testosterone is the end product of the hypothalamus-pituitary-gonadal (HPG) axis and is involved in the reproductive and immune systems (Terburg, Morgan, & Honk, 2009). Similar to the present study, testosterone was not related to antisocial behavior at pretreatment, but was significantly associated with aggressive behavior at post treatment. Specifically, results revealed that adolescent males with higher levels of testosterone were less responsive to MST treatment.

Literature suggests that a relationship exists between cortisol and testosterone (Terburg, Morgan, & Honk, 2009) and testosterone has been found to inhibit HPA functioning (Viau, 2002). Popma et al. (2007b) found that cortisol moderated the relationship between testosterone and aggression, such that there was a positive relationship between testosterone and overt aggression for adolescent males with low cortisol. Scerbo and Kolko (1994) and Ryan (unpublished) also investigated the interaction between testosterone and cortisol but did not find this relationship. Overall findings from the Ryan study and the current study indicate that biological factors may play a significant role in treatment outcome, but further exploration is needed to determine how these biological systems can be incorporated into prevention programs.

Neurological functioning is another biological factor that appears to be associated with aggressive behavior. Reduced amygdala in response to fearful faces has been linked to youth with Oppositional Defiant Disorder (ODD) and Conduct Disorder (CD) and callous-unemotional traits (Marsh et al., 2008) and adult psychopathy (Kiehl, et al., 2001). Also of note, the prefrontal cortex, an area implicated in planning and executive functioning, is still developing during adolescence (Gogtay et al., 2004). The HPA axis and cortisol secretion has also been linked to changes in brain functioning in animals: hypo-amygdala responsiveness due to cortisol dysfunction has been associated with reduced recognition and avoidance of negative stimuli (Moriceau & Sullivan, 2005). Future studies might investigate whether an underactive amygdala or an underdeveloped prefrontal cortex, as well as the role of cortisol, may be associated with changes in aggressive behavior overtime and how this might affect treatment outcome.

The findings from the present study have several implications for therapists working to reduce externalizing behaviors during adolescence. While previous studies suggest that therapists should be aware of episodic stressors that have occurred recently as well as throughout their clients' lifetime (Mathijssen, Koot, & Verhulst, 1999; Willemen, Koot, Ferdinand, Goossens, & Schuengel, 2008), this study indicates that it may be the daily stressors and hassles encountered by the youths themselves that are the greatest obstacle for treatment. In addition, results indicate that the negative effect of daily hassles is compounded by biological mechanisms. If these findings are replicated in future studies, it might be reasonable to use cortisol measures as indicators for selecting appropriate candidates for MST treatment, or for selectively focusing the intervention on coping strategies related to daily stress.

*Potential Limitations and Future Directions*

The study suffered from some notable limitations. First, the sample did not include a non-treated control or comparison group, thus weakening our ability to state that change in externalizing behavior was due solely to MST treatment. Other factors, such as maturation, could have played a role in any changes in observable externalizing behaviors. Second, the lifetime stress measure did not allow for responders to specify when the stressor occurred, thus limiting the ability of the researchers to determine whether the developmental timing of stress was related to cortisol levels or behavior. In addition, the internal consistency of the lifetime stress measure ( $\alpha = .60$ ) was low, and this lower reliability may have impacted our ability to find the hypothesized stress and behavior associations. Third, this study only examined basal morning cortisol levels rather than diurnal patterns or reactivity. While Brennan et al. (unpublished) also found that increased stress reactivity (in response to a cognitive stressor) was associated with worse treatment adherence, including a diurnal pattern would provide a more comprehensive idea of the relationship between daily cortisol levels and treatment outcome. Furthermore, it would allow for researchers to compare results across studies using other measures of cortisol. Fourth, this study did not parse out the types of aggressive acts (e.g. physical versus relational) or the type of aggressor (e.g. callous-unemotional versus non-callous-unemotional or early-onset versus late-onset). As studies have indicated that these distinctions may be related to different patterns in cortisol levels (Murray-Close, Han, Cicchetti, Crick, & Rogosch, 2008; Loney, Butler, Lima, Counts, & Eckel, 2006; Lopez-Duran, Olson, Hajal, Felt, & Vazquez, 2009) this could have limited the current findings.

In the future, researchers should investigate how stress and cortisol relate to the development of internalizing problems and treatment outcome. The present study only examined internalizing behaviors as a statistical control; stress and cortisol in relation to internalizing disorders are not explored. This should be the focus of future studies looking at treatment predictors for internalizing disorders. As internalizing disorders and externalizing disorders have been shown to be highly comorbid (Hewitt et al., 1997; Hinshaw, 1987), a better understanding of the factors that are related to internalizing disorders will also enhance our understanding of externalizing disorders. In addition, research has shown that the presence of comorbid externalizing and internalizing behaviors is related to treatment response (Beauchaine, Webster-Stratton, & Reid, 2005; Lavigne et al., 2008). Understanding the factors that predict treatment response for youth with internalizing disorders would allow for improved, comprehensive treatment for youth suffering from a wide range of behavior problems. In that same vein, studies such as the current one should also examine females, as it is essential to better understand the factors that affect externalizing behavior in both genders. Gender has been shown to be a moderator in treatment outcome (Lavigne et al., 2008). Thus, further exploration of the role of gender is imperative to better meet the needs of all adolescents seeking treatment for behavior problems. Lastly, the current study only examined pretreatment. Past studies have noted that changes in the number of stressors experienced during treatment can be associated with treatment results (Willems, Koot, Ferdinand, Goossens, & Schuengel, 2008). In particular, the duration of the present study varied for each participant. Future analyses may want to explore the relationship between the number of completed treatment sessions, stress, and treatment outcome. In addition, future studies will want to



investigate whether any stressors that occur during treatment help to explain the complex interplay between cortisol, stress, and externalizing behavior problems.

### *Conclusions*

This study explored the relationship between stress, cortisol, and externalizing behavior in adolescent males in the context of an intervention. Daily hassles were significantly associated with worse treatment outcome for adolescent males with higher levels of basal cortisol. Negative recent life events were also associated with worse treatment response for youth with higher cortisol when comorbid internalizing behaviors were statistically controlled. These results add to the burgeoning literature exploring the complicated relationship between cortisol levels and externalizing behavior. These findings should be considered as future treatment and prevention programs for externalizing behaviors are designed and implemented.

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Table 1.					
<i>Descriptive Statistics</i>					
	M	SD	Minimum	Maximum	$\alpha$
Cortisol	0.59	0.29	0.10	1.43	----
Lifetime Stress	3.74	2.23	0	9.00	.60
Negative Recent Events	1.50	2.11	0	11.00	.72
Urban Hassles	8.90	8.76	0	55.00	.88
Externalizing Scores at Pretreatment	21.21	13.35	1.00	51.00	.94
Externalizing Scores at Post Treatment	15.07	12.25	0	58.00	.96



Table 2.				
<i>Pearson Product Moment Inter-correlations Between Cortisol and Stress Measures</i>				
Measure	1	2	3	4
1. Basal Cortisol	----			
2. Lifetime Stress	.09	----		
3. Negative Recent Events	.15	.16	----	
4. Urban Hassles	.25*	.16	.39***	----

\* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .

Analyses looking at cortisol statistically controlled for time of cortisol collection.

Table 3.		
<i>Pearson Product Moment Inter-correlations Between Cortisol, Stress Measures, and Externalizing Behaviors</i>		
Measure	Externalizing Pretreatment	Externalizing Post Treatment
Basal Cortisol	.15	.22*
Lifetime	.12	.04
Negative Recent Events	.07	.11
Daily Hassles	.16	.30**

\* $p < .05$ . \*\* $p < .01$ .

Analyses looking at cortisol statistically controlled for time of cortisol collection.

Table 4.				
<i>Moderator Analyses</i>				
	R <sup>2</sup> Change	F Change	P value	β
<b>Externalizing Pretreatment</b>				
Lifetime/Cortisol Interactions	.02	2.60	.11	.16
Negative Recent Events/Cortisol Interactions	.003	.40	.55	-.06
Urban Hassles/Cortisol Interactions	.0002	.03	.87	.02
<b>Externalizing Post Treatment</b>				
Lifetime/Cortisol Interactions	.006	1.23	.27	.09
Negative Recent/Cortisol Interactions	.007	1.36	.25	.09
Urban Hassles/Cortisol Interactions	.02	4.73	.03*	.15

\* $p < .05$ .

Table 5.				
<i>Zero-order Correlations not Controlling for Ethnicity</i>				
Measure	1	2	3	4
1. Basal Cortisol	----			
2. Lifetime Stress	.05	----		
3. Negative Recent Events	.13	.17	----	
4. Urban Hassles	.25*	.17	.39***	----
5. Externalizing Pretreatment	.21*	.17	.07	.18

\* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .

Analyses looking at cortisol statistically controlled for time of cortisol collection.