THESIS

ATTENTION BIAS AS A MEDIATOR OF THE ASSOCIATION BETWEEN INTERPARENTAL CONFLICT AND CORTISOL REACTIVITY

Submitted by

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ABSTRACT

ATTENTION BIAS AS A MEDIATOR OF THE ASSOCIATION BETWEEN INTERPARENTAL CONFLICT AND CORTISOL REACTIVITY

The current study aimed to explore whether attention bias mediated the relationship between adolescents' appraisals of interparental conflict (IPC) and cortisol reactivity (CR). There is a robust literature on the relationship between attention bias and anxiety in children and adults (Bar-Haim et al., 2007; Cisler & Koster, 2011), and an emerging literature on how interparental conflict is associated with an attention bias toward angry interactions (Lucas-Thompson et al., 2020). While there is a robust association in the literature between interparental conflict and cortisol reactivity (Davies et al., 2007; Lucas-Thompson, 2012; Koss et al., 2012), the results of this study found no association between the two variables. Similarly, the results of this study indicated no associations between attention bias and any other variables. The results of this study suggest that attention bias may be a moderator, or risk factor in the relationship between IPC and CR. Additionally, further research is needed to determine whether a conflict specific stressor should be used to elicit more variability in cortisol reactivity. Further research should continue to aim to link neurobiological processes to clinically relevant topics, as it is essential to bridge the gap between the medical field and the psychotherapy process.

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LITERATURE REVIEW

A recent American Psychological Association survey shows that teen stress levels are on the rise: adolescent stress levels have reached that of adults and, during the school year, exceed those of adults (American Psychological Association [APA], 2019). Many teens also reported other adverse mental health outcomes as a result of stressful experiences, including depression, fatigue, and anxiety (APA, 2019). There are a multitude of physiological reactions in the body that are initiated by stressors, and these reactions are an essential mechanism tying stressors to mental and physical health outcomes (Danese & McEwen, 2012). One of the physiological reactions of the body in response to stress is a release of cortisol by the hypothalamic-pituitary-adrenocortical (HPA) axis. Because adolescents are particularly vulnerable to the degrading effects of stress on the brain (Anderson, 2003), it is essential to understand the mechanisms linking stressful events and stress reactions in adolescents.

One important stressor that predicts dysregulated stress physiology in children and adolescents is interparental conflict (Lucas-Thompson, 2012). High levels of destructive interparental conflict were found to be linked with dampened physiological stress responses and heightened emotional responses in adolescents (Lucas-Thompson, 2012). Although several studies document an association between interparental conflict and dysregulated cortisol reactivity, it is important to establish what mechanisms link the relationship (Davies et al., 2007) so that interventions can tailor to specific processes. Further, using a process-oriented approach to understand the impact of interparental conflict on adolescent's physiological reactivity can help identify the explanatory pathways that lead to children's and adolescents mental and physical health problems (Cummings & Davies, 2010). Attention bias has been given significant consideration as a factor in the relationship between broader family stress/trauma and mental health problems, with specific attention to anxiety (Cisler & Koster, 2010; Connell et al., 2013). Anxiety is involved in the same regions of the brain and can initiate a similar stimulation of the HPA axis (Cisler & Koster, 2010). There is evidence that attention bias, particularly increased attention towards negative stimuli, is also connected with dysregulated cortisol production (Ursache & Blair, 2013). Until now, however, there has been no research directed towards attention bias as a mediator of interparental conflict and physiological stress reactivity. The goal of this study was to fill this gap in the literature and investigate the extent to which attention bias mediated the relationship between interparental conflict and cortisol reactivity.

Interparental Conflict

Destructive interparental conflict is one significant predictor of children's externalizing and internalizing symptoms (Cummings & Davies, 2002; Kouros et al., 2010). Although witnessing frequent, hostile, or intense conflict between parents is stressful for children, interparental conflict is not always negative and in fact is relatively common and unavoidable in couples (Cummings & Davies, 2002). The type of conflict parents engage in is multidimensional, and different forms of conflict can have constructive or destructive effects on children, couples, and families (Cummings & Davies, 2002). For example, parents who solve conflict consistently and quickly after a fight by using effective problem solving and conflict resolution skills serve as positive role models for their children (Grych & Fincham, 1990). Conversely, arguments between parents that are threatening to family security and/or engender self-blame in the child are most stressful for children (Grych & finch man, 1990). Frequent, intense, and/or hostile conflict between parents can drain emotional resources, decrease the emotional availability of parents, and increase their anger towards children (Cummings & Davies, 2002). Additionally, exposure to frequent, intense, or hostile conflict can increase a wide range of psychological issues such as anxiety and depression, as well as negatively influence behavior and social skills (Grych & Fincham, 2001).

Two major models, the emotional security theory (EST; Davies, & Cummings, 1994) and the cognitive contextual framework (Grych & Fincham, 1990), help explain the effects that interparental conflict has on children by emphasizing the importance of their appraisals and perceptions of the conflict affect. The EST emphasizes that family relationships undergird and affect children's functioning through diminishing or increasing children's security (Davies, Winter, & Cicchetti, 2006). Overtime, preserving emotional security may compound to impact a child's future response to their parent's conflict (Grych & Fincham, 2001). Additionally, the EST model has been reformulated (EST-R) to include how children's reactions are based around an evolutionary framework that utilizes a web of neurobiological, psychological, and processing systems in order to preserve security and survival (Davies & Martin, 2013). Distress from interparental conflict in this mode, might engender a wide array of behaviors that are often elicited in response to fear such as vigilance towards threat (Davies & Martin, 2013).

Though the emotional security theory helps guides the overarching theoretical model of this study the cognitive contextual framework provides a clear operationalization of interparental conflict as it relates to children's appraisals. The cognitive contextual framework hypothesizes that children's cognitions about the conflict are an essential mediator of the effects of interparental conflict on children's coping behaviors and other outcomes (Grych & Fincham, 1990). In this model, children's perception of their parents' conflict is multidimensional and can be influenced by temperament, perceived emotional climate, and their encounters with previous conflict (Grych & Fincham, 1990). Factor analyses show that there are three main dimensions of interparental conflict: conflict properties, threat, and self-blame (Grych et al., 1992). Conflict properties include the frequency, intensity, and resolution of the interparental conflict. Threat, particularly anxiety inducing in adolescents (Grych, Harold, & Miles, 2003), refers to the risk of the conflict to the child's or family's safety and their subsequent coping efficacy. When conflict is seen as hostile or aggressive, children may assume or fear that their parents may be angry at them as well or even that their parents may divorce (Grych et al., 2000). Self-blame refers to the degree to which the content of the fight is child-centered, and how the child attributes blame to themselves for the fight. In intense interparental conflict, children may not be able to distinguish the initiator of the fight (e.g. parenting style disagreements) and the overall larger issues in the marriage (e.g. communication) resulting in them feeling their presence or actions are the reason for the fight (Grych et al., 2000).

Children appraisals of their parent's conflict, then, often serve to help children determine causes of conflict, attribute blame for it, and then attempt to cope with the conflict. Children who experience intense interparental conflict and aggression also have higher perceived threat and therefore lower coping abilities (Grych, 1998). In addition, threat and self-blame appraisals mediate the association between interparental conflict and internalizing problems, suggesting that these two appraisals of interparental conflict may lead to persistent feelings of anxiety or sadness (Grych et al., 2000). Thus, it is not only interparental conflict itself that affects children's outcomes, it is also the child's perceptions and appraisals of the conflict, specifically when they elicit anxious or threatening responses. Though many studies focus on conflict purely from parent's report, there are several acknowledged issues with their reports of conflict (Holt et al., 2020). When parents report conflict, they may be unable to see the impact of their fights on their children because of their own emotional investment. Additionally, children often do their best to hide their true emotions and reactions from their parents, so parents may not even be aware of their impact on their children (Cummings, et al.,1981). Thus, this study will use children's appraisals to represent interparental conflict, primarily examining how threat and self-blame appraisals may activate regions of the brain associated with anxiety and fear.

Physiological Stress Response

The EST-R framework describes children's responses to their parents' conflict as organized by a social defense system that stems from fear and threat detection (Davies & Martin, 2013). In this model, a child's emotional responses to their parents' conflict, or any stressor, initiates the hypothalamic-pituitary-adrenocortical (HPA) axis (Davies & Martin, 2013). The HPA axis is one of two primary branches of the human stress response and works in conjunction with the limbic system, and most associated with the production of cortisol, a hormone that is both naturally secreted throughout the day and also produced to jumpstart the body into protection against stressors. The prefrontal cortex, one part of the brain that is activated, helps regulate "flight or fight" fear mechanisms by activating in congruence with the hippocampus, central to memory processes (Danese & McEwen, 2012). Together they exert inhibitory control over the amygdala (Danese & McEwen, 2012) These parts of the limbic system help control top-down emotional regulation and attention facilitation and form a cranial network known as the threat detection system, designed to detect threats in an individual's environment (Danese & McEwen, 2012). When the threat detection system is activated, the HPA system is also activated and begins producing additional cortisol, which operates to shut down non-essential functions like digestion and instead fuel the fight, flight, or freeze response.

In typically functioning individuals, cortisol is produced in a circadian diurnal pattern across the day and in a relatively stable pattern in non-ill people (Stone et al., 2001). In addition, cortisol is released and regulated after stressful stimulation such as fear, worry, anxiety, and threat of any kind (Foley & Kirschbaum, 2010). Cortisol is released gradually and immediately (less than 10 minutes) after such stimulation and immediately systemically circulated allowing it to be measured in either blood or saliva samples (Foley & Kirschbaum, 2010). Changes in cortisol levels have been found to be the best biological marker of HPA axis stimulation in response to acute stressors (Foley & Kirschbaum, 2010). Though cortisol response to stressors is normative, the magnitude of the cortisol response is dependent on biological psychological and demographic characteristics of individuals (Foley & Kirschbaum, 2010). As cortisol production can not only flexibly shift throughout the day, but also be different from person to person, area under the curve with respect to increase is used to calculate the reactive increases from baseline (Prussner et al., 2003). Similarly, to capture total output, area under the curve with respect to ground was used to represent total systemic production during a stressor (Prussner et al., 2003).

Although the HPA axis is designed to flexibly adapt to stress, chronic amounts of stress can degrade the structural functioning of various essential brain regions involved in the threat detection system such as the prefrontal cortex, the amygdala, and the hippocampus (Danese & McEwen, 2012). This degradation leaves adolescents, whose brains are not fully developed, uniquely vulnerable to damage from stressors that continually activate the HPA axis. Chronic stress damages the prefrontal cortex by shortening dendrites (Danese & McEwen, 2012). Chronic stress can also degrade behavior indices, such as facilitated attention, which leads to increased abnormalities in stress responses (Danese & McEwen, 2012). A meta-analysis of HPA axis activity in response to chronic stress demonstrated that both elevated and dampened cortisol reactions can result from chronic stress exposure; differences in outcomes may result from different timepoints in stress process, features of the stress, and appraisals of the stress at the time (Miller et al., 2007). One speculation might be that the threat detection system process that occurs in the brain in reaction to stress might be playing a role in the degree to which the HPA axis is activated. Additionally, an individual's emotional reaction to the stressor may also factor into the impact on their body. Understanding the relationship, then, between how adolescents appraise their parents' conflict (i.e. feeling threatened or attributing self-blame to it) may be important for understanding cortisol reactivity.

Interparental Conflict and Cortisol Reactivity

There are two proposed hypotheses about the effects of interparental conflict on cortisol reactivity: hypercortisolism, and hypocortisolism (Davies et al., 2007). The hypercortisolism hypothesis postulates that because of chronic exposure to stressful events, the HPA axis over functions and then becomes increasingly sensitized to threat detection in future conflict (Davies et al., 2007). Frequent conflict between parents repeatedly stimulates the threat detection system and subsequently the HPA axis; as a result, according to the hypercortisolism hypothesis, over time interparental conflict elicits larger amounts of cortisol reactivity to direct resources to cope with the threat. In contrast, the hypocortisolism hypothesis posits that cortisol reactivity is dampened with repeated exposure to stress. In this model, interparental conflict that continually activates the HPA axis, degrades the ability of the HPA axis to respond flexibly and up- and down- regulate as it normally should in response to new stressors. Subsequently, the HPA axis and cortisol response lowers its set point and resumes a homeostasis at a lower cortisol output (Davies et al., 2007; Susman, 2006). Not only does continual HPA activation lead to lower production of cortisol overall, but continual HPA activation leaves the system vulnerable to HPA attenuation, where it fails to nimbly up- and down- regulate in response to stressors (Susman, 2006). Thus, according to the hypocortisolism and HPA attenuation hypothesis, chronic exposure to stress will both suppress overall HPA responses and weaken the response and, over time, down regulate the system (Fries et al., 2005). This serves an adaptive purpose of displacing the negative impact that might come from extended cortisol elevation to the brain, cardiovascular health, and immune system (Susman, 2006).

Citing the hypocortisolism hypothesis, Davies and colleagues (2007) completed a longitudinal study that found high levels of interparental conflict predicted diminished cortisol reactivity in children. Early stressors in a child's life, including neglect and abusive care, also reduce cortisol reactivity in the early periods of life (Gunnar & Donzell, 2002), suggesting that hostile parent-child relationships may dysregulate and overwhelm the HPA axis. In a study of late adolescents, interparental conflict was also associated with diminished cortisol reactivity (Lucas-Thompson, 2012; Lucas-Thompson & Granger, 2014). Further explicating the link between interparental conflict and cortisol reactivity was a study that found the ways in which youth appraise their parents' conflict is associated with their subsequent stress physiology (Lucas-Thompson et al., 2016), such that exposure to destructive interparental conflict predicted dampened cortisol reactivity particularly for adolescents who appraised that conflict as threatening. Such intense levels of stress may be overloading the HPA system and degrading the function of the stress response, therefore resulting in HPA attenuation and diminished cortisol reactivity to stressful experiences. Lastly, Koss et al. (2012) found that children from high conflict homes had flat and muted cortisol reactivity patterns, which the authors suggested may have been reflective of HPA axis attenuation. This study also demonstrated that high perceived threat and child-centered interparental conflict was particularly distressing for children and resulted in increased cortisol reactivity, suggesting that appraisals of marital conflict may result in differing physiological responses from children. Though the association between threat and self-blame appraisals of interparental conflict and cortisol reactivity is robust in the literature, less is known about what mechanisms might mediate the relationship.

Attention Bias

Attention bias toward threat may help explain the dampened cortisol patterns that interparental conflict predicts. Attention bias refers to a repeated subconscious preference toward neutral, positive, or negative stimuli (Danese & McEwen, 2012). In situations where threat or the insinuation of threat is constant, attentional biases towards threat result in a processing bias toward negative stimuli in an individual's environment (Bar-Haim et al., 2007). Though threat-related attention bias has been associated with a number of clinical disorders, a meta-analysis demonstrated that the majority of studies examine anxiety; there is a significant threat-related bias found in anxious participants and not in non-anxious individuals across studies (Bar-Haim et al., 2007).

The Bar-Haim et al. model (2007) incorporates multiple other models to explain the mechanisms these biases, and is developed based on the findings of the meta-analysis; according to this model, there are four processing stages in which an anxious individual can abnormally process threat from stimuli. The first stage determines whether stimuli are high or low threat. If a stimulus is tagged as high threat, a resource allocation system will elicit a physiological alarm (i.e. HPA axis) which moves resources to address the threat (the second stage). The third and fourth stage are aimed at assessing threat amongst current coping mechanisms and resources within the current context, and then orienting the individual appropriately towards or away from the initial threat. This model further proposes that various anxiety related disorders may cause a bias in different stages of the model and may be different based on context. Importantly, however, though anxiety and depression are often comorbid disorders, anxiety is uniquely associated with threat related attention bias, while individuals with depression do not show attentional biases (Bar-Haim et al., 2007). Anxiety provoking stimuli such as high threat and self-blame appraisals of interparental conflict, then, may leave adolescents particularly susceptible to attention biases.

Interparental Conflict and Attention Bias

Conflict between caregivers can be especially harmful and threatening to children's conscious and subconscious sense of safety and security in the family system (Cummings & Davies, 2002). Among youth up to 19 years old, a meta-analysis demonstrated there is a significant, positive, association between interparental conflict and anxiety (Ran et al., 2021). Insofar as interparental conflict is anxiety provoking, different youth appraisals of the conflict may be differentially impactful. In a sample of adolescents, those who blamed themselves for interparental conflict displayed an attention to anger after they were exposed to interparental conflict (Lucas-Thompson, Dumitrache, et al., 2017). Because feeling responsible for interparental conflict and interpreting it as threatening can be so damaging to children (Lucas-Thompson et al., 2016), I infer that threatening interparental conflict likely activates regions of the brain, like the amygdala, already commonly associated with fear and anxiety detection (Davis & Whalen, 2000). Similarly, appraisals of interparental conflict associated with self-blame activate anxiety (Jouriles et al., 2000), which could also stimulate the amygdala and other regions in the limbic system. As the brain detects anxiety, or as I propose, threat or self-blame from interparental conflict, it processes the stimuli according to its salience to the safety of the individual, subsequently triggering the necessary systems to allocate resources appropriately (Bar-Haim et al., 2007; Cisler & Koster, 2011). Repeated attention toward the threatening stimuli, then, could potentially lead to an information processing bias, wherein the individual is conditioned to focus on the most threatening stimuli first, and only disengages after a longer period of time than they would with neutral stimuli (Cisler & Koster, 2011).

Although very few studies have linked interparental conflict directly to attention bias, there are a couple studies that demonstrate the association between interparental conflict and attention bias. First, one study found that participants with exposure to greater interparental conflict demonstrate greater attention toward angry couple interactions than happy couple interactions, suggesting an attention bias toward anger in participants whose parents' conflict was negative (Lucas-Thompson et al., 2020). Additionally, children who have been maltreated have displayed increased attention towards angry stimuli, suggesting that maltreated children tailor the release of cognitive resources to meet the danger presented by their environment (Pollak et al., 1997; Pollak et al., 2001).

Attention Bias and Cortisol Dysfunction

While adolescents' self-blame and threat appraisals of interparental conflict may elicit coping strategies (or not) that are visible behaviorally, the subconscious process of attention bias operate without conscious knowledge. Similarly, several neural and autonomic processes are associated with the body's threat detection system and can help explain the mechanisms of the subconscious process of attention bias in the stress process (Cisler and Koster, 2011). A wealth of data has emerged suggesting that the amygdala (e.g. Davis & Whalen, 2000) and the prefrontal cortex (e.g. Miller & Cohen, 2001) are primary systems involved in facilitating attention to emotion. The amygdala complex is one of the main brain structures involved in processing fear-related information and expression/management of that behavior (Susman, 2006; Ledoux, 200; Davison & Irwin, 1999). There are several studies demonstrating amygdala stimulation in response to fearful faces using neuroimaging such as functional magnetic resonance imaging (fMRI) and positron-emission tomography (PET) (Schneider et al., 1997; LaBar et al., 1998; Davidson & Irwin, 1999). Morris et al. (1996) used PET to measure neural activity in the amygdala and found the amygdala was directly engaged in the processing of emotions in response to fearful and happy faces, which is consistent with other research in the field (Lane et al., 1997; Schneider et al., 1995). Additionally, the presence of cortisol modulates attentional processing in the amygdala, demonstrating a hypervigilance effect, which emphasize the importance of cortisol in attentional processes (Henckens et al., 2012) Attention bias toward threat, then, has been understood as an important evolutionary neural process in which increased attention to negative stimuli results in a hyper vigilance toward negative events to boost chances of survival (Henckens et al., 2012).

Once the amygdala is stimulated by fear, the HPA axis is activated through neural pathways such as the lateral hypothalamus and medulla (McGaugh et al., 1993). If danger or the prospect of danger continually elicits anxiety and thus stimulates activation of the amygdala even when no threat is present, the HPA axis may become constantly in overdrive, working to protect the body from the threat. Continual activation, however, will cause the HPA axis and threat detection system to continuously produce cortisol and other hormones disrupting the natural processes of returning to equilibrium and the pre-fear state (Susman, 2006). Any continual and chronic stress also results in a failure of flexibility in a system specifically meant to adapt to changing threat levels throughout the day (Danese & McEwen, 2012). This process of HPA axis overdrive is known as allostatic load and can cause significant and dangerous wear on the body, leading to negative cardiovascular health outcomes and issues in the endocrine system (Danese & McEwen, 2012). In order to not overload the cardiovascular and endocrine system, an adaptive strategy of down regulation (i.e. lower cortisol output) has been observed in both humans and animals (Gunnar & Donzell, 2002). When allostatic load ensues, the HPA system cannot properly regulate cortisol appropriately in response to stressful situations, leading to a 'domino effect' where stress hormones and other biological processes shift their operating ranges (Juster et al., 2010). Repeated attention towards threatening stimuli such as interparental conflict then, may decrease the functional range of the HPA axis, leading to hypocortisolism, HPA axis attenuation and dysregulated cortisol production, making it harder for the HPA axis to be triggered by similarly stressful stimuli in the future (Susman, 2006). The Adaptive Calibration Model (ACM) further explicates that differential responses to stress are part of a continual process of adaptive adjustment to an organism's ability to adapt to its environment (Del Giudice, 2011). In the context of this study, the ability of the HPA axis to down-regulate via the hypocortisolism hypothesis, even after chronic stress exposure, is an evolutionarily adaptive strategy in the long term.

There are several studies linking attention bias and cortisol (e.g. Mchugh et al., 2010; Putman et al., 2006). One of the most significant studies in the literature linking attention bias to cortisol reactivity was a large-scale study of more than 300 kindergarten children who were administered the dot probe task, frequently used in attention bias research (Ursache & Blair, 2015). Though not used in this study, the dot probe task (Macleod, Matthews & Tata, 1986) is one of two frequently used methods to assess attention bias. It is measured using side by side negative or neutral stimuli and directing participants to quickly indicate the location of a dot appearing where the pictures once were. When participants respond faster to dots that were on threat-related stimuli, attention bias toward threat is exposed (Macleod et al., 1986). The authors found that children's cortisol and salivary alpha amylase, a measure of stress from the autonomic nervous system, interacted to predict greater attention biases to threat, such that children with coordinated (i.e. both high or both low) levels of both cortisol and salivary alpha amylase had the greatest levels of attention bias to threat. This suggests that attention bias is linked to both low and high cortisol reactivity. These findings are in line with what I am proposing, given that some children may have consistent and healthy engagement with attention facilitation and subsequently demonstrate high cortisol reactivity to stressors but others may have developed hypocortisolism as a result of allostatic load and would demonstrate low cortisol output.

THE CURRENT STUDY

The current study aimed to explore the association between adolescents' appraisals of interparental conflict, attention bias, and cortisol reactivity. There is a robust literature on the relationship between attention bias and anxiety in children and adults (Bar-Haim et al., 2007; Cisler & Koster, 2011), and an emerging literature on how interparental conflict is associated with an attention bias toward angry interactions (Lucas-Thompson et al., 2020). The reformulated emotional security theory posits that an children's reactions to interparental conflict (or any interpersonal relationship) is based on an evolutionarily protective design to largely informed by the social defense system which is organized by the fear/threat system (Davies & Martin, 2013). In a healthy functioning adolescent, this threat detection system activates the HPA axis via the limbic system and ultimately produces cortisol to jumpstart the system into action and towards safety (Foley & Kirschbaum, 2010). When a child or adolescent is repeatedly exposed to threatening or self-blame inducing interparental conflict, this study proposed that an attention bias toward threat may increase stress, and over time, create an overburdening of the HPA system leading it to less flexibility up and down regulate cortisol responses and ultimately produce less cortisol overall via hypocortisolism. Given this theoretical proposal this study suggested four hypotheses in order to suggest mediation. The first hypothesis was that greater threat and self-blame appraisals in adolescents are related to lower cortisol reactivity. The second hypothesis was that threat and self-blame appraisals are associated with increased attention bias towards angry faces. The third hypothesis was that increased attention toward angry faces is associated with decreased cortisol reactivity. Finally, the fourth hypothesis is that attention bias mediates the association between interparental conflict and dampened cortisol reactivity (e.g. Figure 1).

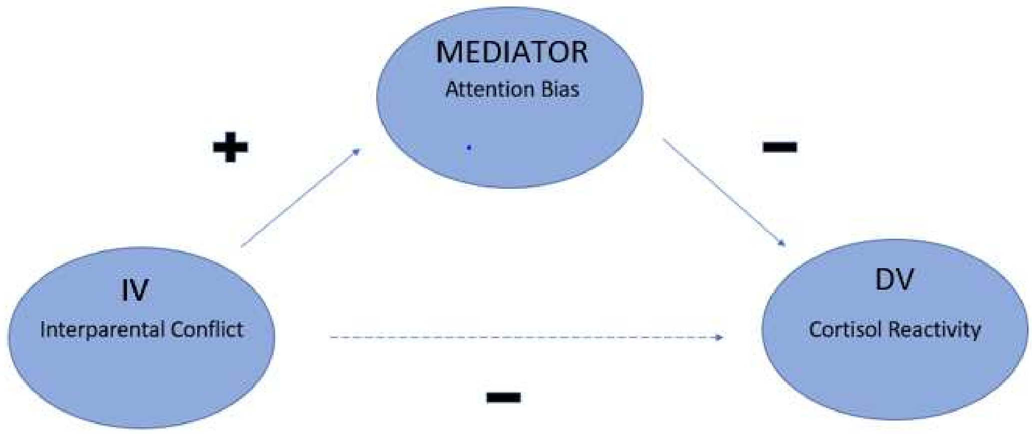

Figure 1

Conceptual Model of Mediation Pathways

METHOD

Participants

Participants in this study were recruited from Colorado State University (CSU) and the Larimer County community using a variety of methods. Only participants whose household consisted of two caregivers living in the home and were also between the ages of 14-21 years were recruited for this study. Adolescents with stepparents were included if they had been cohabitating or married for more than two years. Community recruitment ranged from advertisements in local school papers and on social media platforms (i.e., Facebook), to using in person community fair booths. CSU students participated through their undergraduate psychology and human development classes. After recruitment, the sample was made of both CSU students and adolescents in the community (n = 74)[1]. Less than 20% of the sample was aged 17 or below.

The final sample of participants identified as 70% female and 30% male. A majority of the same identified as non-Hispanic Caucasian (69%), while 7% identified as Hispanic, 4% as Asian or Pacific Islander, 3% as African American, and 1% as American Indian; 16% reported other or multiple ethnicities. Family income ranged from $35,000 and less to $150,000 and greater (*Median* = $124,999, *SD* $36,480.93).

Procedure

Participants were part of a larger cross-sectional study of family relations and stress responses (Lucas-Thompson et al., 2020) though I will only review procedures relevant to the

[1] The original sample for this study consisted of 150 participants. Due to a computer failure, the attention bias data was lost for all but 74 of the participants.

current study. Participants each attended two sessions at the CSU lab, one week apart. After reviewing informed consent/assent, adolescents began attention bias tracking tasks. The eye-tracking procedure used in this study is one way to measure of attention bias (Isaacowitz et al., 2006; Lucas-Thompson et al., 2020; for benefits of eye-tracking procedure see Hadwin & Field, 2010). The procedure involved viewing a series of fifteen happy and fifteen angry images side by side neutral images of adults on a computer screen in a randomized order. Photos depicted angry, happy, or neutral stills of racially and ethnically diverse adult men and women interacting. As the photos were presented to participants, a high-speed camera tracked the gaze of the participants. The participants were told to look at whatever was naturally interesting to them and were directed in-between trials to stare at the crosshairs in the middle of the screen to reduce viewing bias between each trial. After the attention task, participants completed questionnaires using Audio Computer Assisted Self Interview software.

The procedure for saliva collection was then explained and participants were asked to produce a practice sample to start. Participants were told to place the swab in their mouths for three minutes, leaving it anywhere except between their gums and lips. Participants were asked to sit quietly for ten minutes, and then baseline cortisol was collected before the instructions were given for the next task.

In order to test cortisol reactivity, this study used the Trier Social Stress Test (TSST) to induce a stress activating response, and collected salivary samples at three time points, one before and two after the test. The TSST is a robust stressor that is widely used to demonstrate changes in cortisol levels in a laboratory setting (Dickerson & Kemeny, 2004; Kirschbaum et al., 1993). During the second visit to the lab, participants were walked through the TSST, which involved a fifteen-minute public performance task in front of an evaluator. Participants then were asked to give a fifteen-minute public speech in front of a trained female evaluator who remained neutral during the entire process. Participants were told that they were evaluated on their speech, posture, and tone of voice, and that it would be videotaped and evaluated by experts. The task involved five minutes of preparation, a five-minute speech on personal strengths and weaknesses and five minutes of mental math spoken out loud. The evaluators were trained to keep a neutral expression during the speech with no verbal or non-verbal feedback cues given to the participant. Cortisol reactivity was measured after the TSST using the same description provided for baseline cortisol collection. Salivary samples were then collected again immediately after the test was complete. To assess reactivity and recovery, two other samples were taken fifteen and thirty minutes after the test. Overall, then, four cortisol salivary samples were collected.

Measures

Interparental Conflict

The Children's Perceptions of Interparental Conflict (CPIC) Scale was used to assess interparental conflict appraisals (Grych et al., 1992). The CPIC uses 49 questions to assess nine different dimensions of interparental conflict: frequency, intensity, threat, coping efficacy, content, stability, self-blame, resolution, and triangulation between parents and their adolescent. The nine dimensions were then divided into three dimensions: conflict properties (28 items; Cronbach's $\alpha = .94$), threat (12 items; Chronbach's $\alpha = .78$), and self-blame (9 items; Chronbach's $\alpha = .89$). Answer choices range from one to three where 1 = *true*, 2 = *sort of true* and 3 = *false*. An example of a questionnaire item is: "When my parents have an argument, they usually work it out." Some items are reverse scored so that higher scores are reflective of higher negative appraisals of adolescent's parents' conflict. The CPIC is a reliable and valid measure for use with late adolescents (Bickham & Fiese, 1997).

Attention Bias

Attention bias refers to an allocation of attention towards threatening stimuli as opposed to neutral stimuli (Cisler & Koster, 2009). Two distinct variables were calculated to represent attention bias (Lucas-Thompson et al., 2020). One of these variables measured the average time a participant spent looking at emotional as opposed to neutral stimuli. In order to calculate this value, the following equation was used: (emotional - neutral) / (emotional + neutral) (e.g. Isaacowitz et al., 2006). The other variable was calculated based on the proportion of first fixations, meaning a proportion how many times the participant looked first at the emotional photo compared to the neutral photo (e.g. Knight et al., 2007).

Cortisol Reactivity

Though the HPA axis is associated with the release of many hormones, cortisol is a common salivary indicator of HPA activity (Schwartz et al., 1998). Saliva was collected via Salivettes (Salimetrics, Carlsbad, CA) that were placed below the tongue for 3 minutes. Saliva was collected using this method at baseline, promptly pre-TSST, directly post-TSST and 15 minutes after the TSST. Saliva was stored at -20 degrees Celsius until assayed at the University of Trier. Saliva samples were put in a centrifuge for 10 minutes at 2000g and assayed in duplicate for cortisol concentrations. Intra- and inter-assays coefficients of variation were calculated at 4-6.7% and 7.1-9%. To calculate cortisol reactivity increases from baseline, area under the curve with respect to increase (AUCi) as well as area under the curve with respect to ground (AUCg) were calculated. The process as described by Pruessner and colleagues (2003) was utilized.

Covariates

This study included several control variables because of their association with changes in stress reactivity. Age was included to account for differences in pubertal development and timing that may change an adolescent's baseline cortisol productions (Kirschbaum et al., 1999). Family income was added as a control because of the known association between income and blunted cortisol reactivity patterns (Raffington et al., 2018). Race/ethnicity (White/non-White) was also added as a control because people from marginalized race and ethnicities are known to experience multiple everyday stressors as a result of racism (Burton et al., 2010) and because of the association between race/ethnicity in adolescents and dysregulated cortisol levels (DeSantis et al., 2007). In addition to the previously mentioned controls, participants were screened and assessed for food consumption, exercise, caffeine intake, last menstrual period and time of collection, all which may have had an impact on cortisol reactivity (Lucas-Thompson et al., 2016).

Data Analytic Plan

All variables were examined for normality, and the following variables were log transformed to adjust for significant skew: conflict properties, self-blame, threat, dwell time on happy images, AUCg, and AUCi. Bivariate correlations were then conducted for all the variables. I then used multiple regression to test the relationship between the independent, mediator and dependent variables. Using the product of coefficients approach, statistical significance of the indirect effect can be tested by multiplying *a* (association between interparental conflict and attention bias) and *b* (association between attention bias and cortisol reactivity) and then dividing by its standard error (MacKinnon & Dwyer, 1993). The resulting score can be compared to a standard normal distribution to test for statistical significance. In congruence with that method, a regression model was used to demonstrate the overall association between the independent variable (IV; interparental conflict) and the dependent variable (DV; cortisol reactivity). Second, another regression was run to show if the interparental conflict (IV) predicts attention bias (DV in this model). Third, a regression as run to show the association between attention bias (mediator) and cortisol reactivity (DV). Although the produce of coefficients approach was intended for this study (MacKinnon & Dwyer, 1993), there were not significant pathways in the regressions and thus no mediation was tested. Covariates were included at every step in the regression models to rule out confounds. Semi-partial correlations from the regression analyses reflect the unique association between that predictor variable and the dependent variable, controlling for all other variables in the model, and were requested to provide an index of effect size.

Table 1

Bivariate Correlations and Descriptive Statistics

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1. Conflict Properties [a]	—												
2. Self-blame [a]	0.33***	—											
3. Threat [a]	0.44***	0.41***	—										
4. Dwell Time: Angry	0.00	0.27*	.15	—									
5. Dwell Time: Happy [a]	-0.08	0.06	-.07	-0.02	—								
6. First Fixation: Angry	-0.20	-0.06	.00	0.08	-0.20	—							
7. First Fixation: Happy	-0.15	-0.14	.01	0.06	-0.23	0.23	—						
8. AUCg [a]	0.00	0.04	-.09	-0.06	0.12	-0.07	0.05	—					
9. AUCi [a]	0.00	0.00	-0.04	-0.04	0.00	0.17	0.06	-0.12	—				
10. Sex [b]	0.06	-0.02	0.10	-0.29*	0.04	-0.08	-0.12	-0.04	0.06	—			
11. Age	0.07	-0.03	0.00	-0.16	-0.11	-0.07	0.02	0.35***	-0.12	-0.05	—		
12. Income	-0.13	-0.09	-0.15	0.09	-0.18	0.00	0.07	0.05	-0.06	0.00	0.17	—	
13. White [c]	-.10	-.11	-.14	-.02	0.05	-0.02	-0.06	-0.05	0.12	-0.11	-0.03	0.26**	—
M	.17	.07	.14	-.21	-0.06	0.45	0.40	2.29	2.54	0.59	17.86	6.30 [d]	0.71
SD	.11	.11	.09	.25	0.19	0.13	0.14	0.30	0.24	0.49	2.17	2.35	0.45

* $p < .05$ ** $p < .01$ *** $p < .001$ *Note.* [a] Variable log-transformed [b] 1=male, 2=female [c] 1=White, 0=other [d] Corresponds to $95-$109,000 per year

Table 1 describes the means, standard deviations, and bivariate correlations for all variables. Conflict appraisal variables (i.e., conflict properties, self-blame, threat) were found to be significant and positively correlated with each other. Additionally, self-blame was significantly, positively correlated with attention toward angry stimuli. Age was significantly, and positively correlated with AUCg for cortisol reactivity but not with any other variables. Female adolescents had significantly greater dwell time on angry stimuli than male adolescents. None of the other control variables were significantly correlated with any other key variables. In addition, a repeated measure ANOVA was used to examine whether there were significant changes in cortisol production over the different collection points; this analyses suggests that there was significant change, $F(1,147) = 19.55$, $p < .01$., though the overall levels of change between times are relatively small (Figure 1).

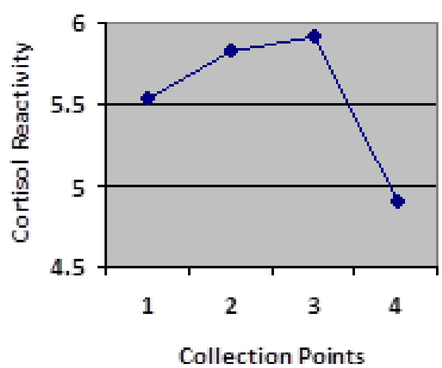

Figure 2

Cortisol Production in Response to the TSST

Next, I examined the associations between interparental conflict and cortisol reactivity (see Tables 2 and 3). There are no significant associations between interparental conflict and AUCg or AUCi. Semi-partial correlations revealed trivial associations between interparental conflict and cortisol reactivity (i.e., all were < .10). As a result, there was no direct effect of interparental conflict on cortisol reactivity.

Table 2

Overall Association between Interparental Conflict and AUCg

Variable	*B*	*SE*	*β*	*t*	*p*	r_{sp}
Conflict Property	0.01	0.26	<.01	0.05	0.96	0.00
Self-blame	0.16	0.26	0.06	0.64	0.52	0.06
Threat	-0.36	0.33	-0.11	-1.08	0.28	-0.09
Sex	-0.05	0.05	-0.08	-0.90	0.37	-0.08
Age	0.04	0.01	0.30	3.32	<.01*	0.29
Income	<.01	0.01	-0.01	-0.13	0.90	-0.01
White	<.01	0.06	0.00	-0.03	0.98	-0.00

$R^2 = .11$

Table 3

Overall Association between Interparental Conflict and AUCi

Variable	*B*	*SE*	*β*	*t*	*p*	r_{sp}
Conflict Property	0.03	0.24	0.01	0.12	0.90	0.01
Self-blame	0.03	0.24	0.01	0.11	0.91	0.01
Threat	-0.14	0.31	-0.05	-0.44	0.66	-0.04
Sex	0.03	0.05	0.06	0.65	0.52	0.06
Age	<.01	0.01	-0.07	-0.79	0.43	-0.07
Income	<.01	<.01	-0.09	-0.96	0.34	-0.09
White	0.10	0.05	0.17	1.75	0.08	0.16

$R^2 = .04$

Next, I examined the association between interparental conflict variables and the four attention bias variables, each an outcome in a separate regression (see Tables 4, 5, 6, and 7). There were no significant associations found between any of the variables and the effect sizes were trivial (i.e., all were < .10).

Table 4

Associations for Attention to Angry Stimuli and Interparental Conflict Variables

Variable	B	SE	β	t	p	r_{sp}
Conflict Property	-0.20	0.29	-0.10	-0.07	0.49	-0.08
Self-blame	0.38	0.29	0.18	1.32	0.19	0.15
Threat	0.37	0.37	0.14	1.00	0.32	0.11
Sex	-0.19	0.07	-0.35	-2.87	<.01*	-0.33
Age	-0.03	0.02	-0.21	-1.72	0.09+	-0.20
Income	0.01	0.01	0.10	0.81	0.42	0.09
White	-0.03	0.07	-0.06	-0.45	0.65	-0.05

Note: + = *Trend level significance;* $R^2 = .21$

Table 5

Associations for Attention to Happy Stimuli and Interparental Conflict Variables

Variable	B	SE	β	t	p	r_{sp}
Conflict Property	-0.09	0.24	-0.06	-0.39	0.70	-0.05
Self-blame	0.09	0.23	0.05	0.38	0.71	0.05
Threat	-0.31	0.30	-0.16	-1.01	0.31	-0.12
Sex	<.01	0.05	-0.02	-0.17	0.86	-0.02
Age	<.01	0.01	0.02	0.18	0.86	0.02
Income	-0.02	0.01	-0.26	-1.89	0.06+	-0.23
White	0.06	0.05	0.15	1.12	0.27	0.14

Note: + = *Trend level significance;* $R^2 = .08$

Table 6

Associations for First Fixation toward Angry Stimuli and Interparental Conflict Variables

Variable	B	SE	β	t	p	r_{sp}
Conflict Property	-0.16	0.16	-0.15	-1.03	0.31	-0.13
Self-blame	-0.24	0.16	-0.22	-1.52	0.13	-0.18
Threat	0.08	0.20	0.06	0.39	0.70	0.05
Sex	-0.05	0.04	-0.17	-1.26	0.21	-0.15
Age	<.01	<.01	-0.08	-0.61	0.55	-0.07
Income	<.01	<.01	-0.06	-0.46	0.65	-0.06
White	0.01	0.04	0.04	0.30	0.77	0.04

$R^2 = .09$

Table 7

Associations for First Fixation toward Happy Stimuli and Interparental Conflict Variables

Variable	B	SE	β	t	p	r_{sp}
Conflict Property	-0.22	0.18	-0.19	-1.26	-1.26	0.21
Self-blame	-0.19	0.17	-0.16	-1.07	-1.07	0.29
Threat	0.38	0.23	0.26	1.66	1.66	0.10
Sex	-0.05	0.04	-0.17	-1.26	-1.26	0.21
Age	<.01	0.01	0.02	0.17	0.17	0.86
Income	<.01	<.01	0.05	0.34	0.34	0.73
White	-0.02	0.04	-0.06	-0.43	-0.43	0.67

$R^2 = .09$

Based on the two sets of regression, mediation is not possible because interparental conflict does not significantly predict attention bias or cortisol reactivity. The third set of regressions was still conducted to examine the link between attention and cortisol reactivity. The multivariate associations demonstrated in Table 8 and 9 also revealed no significant associations between interparental conflict, attention bias and cortisol reactivity (AUCi and AUCg). The control variables included in this model similarly revealed no significant associations. However, in these models, self-blame and threat was related to cortisol (AUCg) at trend levels of significance, such that greater self-blame was related to increased AUCg production and threat was related to less cortisol production. Examination of the semi-partial correlations indicated that these trends represented small to moderate effect sizes.

Table 8

Multivariate Associations between AUCg and All Variables

Variable	B	SE	β	t	p	r_{sp}
Conflict Property	-0.12	0.35	-0.05	-0.34	0.73	-0.04
Self-blame	0.60	0.35	0.23	1.74	0.09+	0.19
Threat	-0.86	0.45	-0.28	-1.93	0.06+	-0.21
Dwell Time: Angry	-0.12	0.15	-0.10	-0.80	0.43	-0.09
Dwell Time: Happy	0.18	0.20	0.11	0.91	0.37	0.10

Variable	B	SE	β	t	p	r_{sp}
Fixation: Angry	-0.15	0.29	-0.06	-0.50	0.62	-0.06
Fixation: Happy	0.24	0.27	0.11	0.91	0.37	0.10
Sex	-0.10	0.09	-0.16	-1.20	0.23	-0.13
Age	0.06	0.02	0.34	2.79	<.01*	0.31
Income	<.01	0.02	-0.08	-0.58	0.56	-0.06
White	-0.08	0.08	-0.13	-1.05	0.30	-0.12

Note: + = Trend level significance; $R^2 = .32$

Table 9

Multivariate Associations between AUCi and All Variables

Variable	B	SE	β	t	p	r_{sp}
Conflict Property	0.19	0.44	0.07	0.43	0.67	0.05
Self-blame	0.31	0.44	0.11	0.71	0.48	0.09
Threat	-0.23	0.57	-0.07	-0.40	0.69	-0.05
Dwell Time: Angry	-0.05	0.19	-0.04	-0.27	0.79	-0.03
Dwell Time: Happy	0.06	0.25	0.03	0.23	0.82	0.03
Fixation: Angry	0.53	0.38	0.20	1.41	0.16	0.18
Fixation: Happy	0.17	0.34	0.07	0.51	0.61	0.07
Sex	0.14	0.11	0.19	1.27	0.21	0.16
Age	<.01	0.03	-0.04	-0.29	0.78	-0.04
Income	<.01	0.02	<.01	-0.05	0.96	-0.01
White	0.09	0.10	0.13	0.95	0.35	0.12

$R^2 = .10$

DISCUSSION

The goal of this study was to examine attention bias as a mediator of the association between adolescents' appraisals of interparental conflict and cortisol reactivity. Specifically, this study was interested in how threat and self-blame could be particularly damaging appraisals of interparental conflict as they may incite emotional insecurity and anxiety in ways that more objective features of parents' fights (i.e. conflict properties) do not. Although previous research demonstrated that interparental conflict is related to dampened cortisol reactivity in children (Davies et al., 2007), this study did not observe any such pattern. Additionally, past research has found that greater interparental conflict is associated with greater attention bias toward anger (Lucas-Thompson et al., 2020) and that attention bias is robustly associated with cortisol reactivity (Putnam et al., 2006; McHugh et al., 2010); however, this study had no significant findings in either of these relationships.

Though past research has a robust history documenting the connection between interparental conflict and cortisol reactivity (e.g. Davies et al., 2007; Lucas-Thompson et al., 2012; Lucas-Thompson & Granger, 2014), in this study no significant associations were found. One supposition for the differences found in these results may be based on the demographics of this sample. Seventy percent of this sample was 18 years or older, suggesting that many in the sample likely did not live at home. This characteristic might suggest that interparental conflict is less salient in their daily lives than for children still living at home, perhaps allowing their physiological states to recalibrate to their new environment. This speculation is supported by the adaptive calibration model which emphasizes that individuals have evolved to continually adapt their physiological responses to their environment (Del Giudice et al., 2011). Further, leaving home is a significant life stage for adolescents and can be marked by hormonal and genetic changes in individuals (Del Giudice et al., 2011). During these transitions, "remarkable plasticity" allows the body to be more attuned to environmental changes (Del Giudice et al., 2011, p. 1569), suggesting that for adolescents who are no longer in their parents' home there might be adaptive recalibration of the HPA axis to their new home.

Another possible explanation is more methodological. Overall, there were not very large changes in cortisol in response to the stressor. The TSST, however, is a robust stressor in eliciting cortisol reactivity and arousal across age groups (Yim et al., 2015), suggesting that it was not the measure used but perhaps due to the characteristics of this study's specific sample. For instance, this sample was 70% female, and although women and men both show a robust response to the TSST, women display smaller responses than men (Reschke-Hernández et al., 2017). Another possible explanation could be found in that there may be different cortisol responses to different types of stressors. Both interparental conflict appraisals and attention bias are issues both related to conflict; however, the TSST is a general social-evaluative stressor based on anxiety, not conflict. Many studies that link interparental conflict and cortisol reactivity use stressors that are related to conflict. For example, Davies et al. (2007) collected cortisol samples from children after a live simulated phone argument between their parents. Though the TSST is a robust stressor in eliciting cortisol reactivity (Dickerson & Kemeny, 2004; Kirschbaum et al., 1993) a conflict-specific stressor may have been more appropriate for this study, to elicit the specific anxiety and emotional insecurity that is produced from self-blaming and threatening appraisals of children's conflict. Further explicating the differentiation of stressors on the HPA axis, one meta-analysis found that the nature of stress differentially impacts the timing and amount of cortisol reactivity (Miller et al., 2007), suggesting that the TSST may not have elicited a conflict-specific stress reactivity that we were hoping for.

Interestingly, when all variables are included in the model, self-blame and threat were associated with AUCg at trend levels of significance, with effect sizes in the small to moderate range. This pattern suggests that there may be a small effect that was missed because of low power. Specifically, self-blame was associated with increased overall cortisol production while threat was associated with decreased overall cortisol production. These results are in line with findings that chronic stress is both linked to dampened and heightened cortisol reactivity (Miller et al., 2007).

Though this study was cross-sectional and thus cannot be causal in nature, the statistical and theoretical model in this study proposed but did not find evidence to support that increased attention toward angry faces would be associated with subsequent dampened cortisol reactivity. One explanation for the null findings could be that the pathway order is wrong, such that an increase in cortisol may lead to selective attention towards threat. In congruence with that temporal ordering, one study suggested that increased cortisol levels function as a signal to activate the limbic system, primarily the amygdala, in increased attention toward the stressful stimuli (McHugh et al., 2010). Similarly, another study found that injecting cortisol into male participants increased biased toward angry faces (Putman et al., 2006). These results demonstrate that though responding selectively to angry expressions is directly tied to neuroendocrine mechanisms such as HPA axis functioning, the temporal order may be extremely important in understanding how the body may react to threat. In addition, one study found that interparental conflict and attention biases towards anger interact to predict anxiety, such that it's when both are present in adolescents that individuals have greater anxiety symptoms (Lucas-Thompson et al. 2021). This finding suggests that attention bias may not be a mediator but instead a risk factor, or moderator, that in combination with interparental conflict contributes to dampened cortisol reactivity in adolescents. Future research should examine how interparental conflict and attention bias toward angry faces might interact to contribute to cortisol reactivity patterns.

Another limitation of this sample was that it was not diverse in race/ethnicity. First, this is problematic because this sample is not representative or generalizable which may be the result of sampling bias. Second, race and ethnicity are known stressors that contribute to cortisol reactivity (Zeiders et al., 2012) and may be moderating any impact of interparental conflict The minority stress model (Meyer, 2003) and critical race theory (Burton et al., 2010) explain the ways in which marginalized people face significantly higher levels of stress as a result of prejudice, structural and institutional discrimination, negative internalized messages and stigma. A major limitation of the current literature is the lack of acknowledgement of the amassed stress from these factors in minority families. To truly understand the impact of interparental conflict on all families, the field must acknowledge how stress may compound differently in marginalized families than in majority white samples. In the context of this study, does stress from racism increase the overall burden of interparental conflict on adolescents' cortisol reactivity? Future research should longitudinally examine the mechanisms that are associated with of the impact of interparental conflict on cortisol reactivity in adolescents from a racially and ethnically representative sample.

A last possible explanation for these nonsignificant findings can be sample size and representativity of the sample. The sample size (n = 74) may not have been large enough to capture associations. Despite this, however, examination of effect sizes indicates that we are not missing moderate to large effects, as most were very small in size. Additionally, the conflict appraisals in this sample were all skewed and on average conflict appraisals were more neutral to positive than negative, suggesting that there may have not been the possible range within the appraisal data needed to find significance. Further studies should also aim to better establish temporal precedence between attention bias toward threat and cortisol reactivity. Last suggestions for future research include not only establishing the link between interparental conflict and attention bias, but also further exploring the mechanisms linking interparental conflict and cortisol reactivity in children and adolescents

Conclusion

This study aimed to establish attention bias as a mediator between youth appraisals of interparental conflict and cortisol reactivity but found no significant associations between the variables. Though a connection between attention bias and cortisol reactivity had been established in previous research (e.g. Applehans & Luecken, 2006; McHugh et al., 2010; Ursache & Blair, 2015), only one study had established the association between interparental conflict and adolescent attention bias (Lucas-Thompson et al., 2020). Because attention bias, cortisol reactivity and interparental conflict all independently have significant clinical implications for youth, it is important that future research continues to examine these connections. Clinically, understanding both the neurobiological and the psychosocial implications of interparental conflict is essential to provide systemic and holistic mental healthcare to youth. While the medical family therapy field (McDaniel et al., 1992) is relatively new, studies that aim to link clinically relevant everyday issues to neurobiological processes are essential to further both the medical and clinical field and to provide research to back integrated interventions for youth.

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