Interpersonal Violence Exposure, Social Cognition, and Aggression in Adolescence

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Abstract

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Adolescents who are victims of interpersonal violence are at markedly elevated risk of perpetrating violence not only in childhood and adolescence, but also in adulthood. This is concerning, given that almost a third of American youth have been exposed to at least one form of violence by the time they reach adolescence. Although deficits in empathic ability have long been proposed as a determinant of aggressive behavior, scant research has examined the social cognitive processes underlying empathy (e.g. moral reasoning) as potential mechanisms in the cycle of violence. To that end this study aimed to examine the impact of interpersonal violence exposure on the development of social cognitive processes involved in empathy, and their neural bases. Specifically, I examined the role of disruptions in processes that underlie empathy including emotion perception, cognitive and affective theory of mind, and experience-sharing, as a mechanism linking interpersonal violence exposure and aggressive behavior. This conceptual model was tested by acquiring self-report, behavioral, and functional MRI data in a community-

based sample of 70 14-19 year old adolescents with a high concentration of exposure to interpersonal violence. Interpersonal violence exposure was associated with slower processing of faces expressing negative emotions and delayed identification of others' emotions across a variety of contexts, as well as difficulty discriminating unintentional from intentional behavior. These disruptions in social cognition, in turn, were associated with aggressive behavior, but did not significantly explain the indirect effect of interpersonal violence on aggression. These findings build on existing research on the cycle of violence by identifying a specific pattern of atypical social cognitive processes influenced by childhood experiences of interpersonal violence. Findings not only enhance knowledge of how adverse environments alter development in ways that might increase risk for aggression, but also indicate possible targets for preventive interventions aimed at reducing aggressive behavior in adolescents who are victims of violence.

Interpersonal violence exposure in childhood is a powerful determinant of psychopathology across the lifespan (Keyes et al., 2012; Klitzman & Freudenberg, 2003; Molnar, Buka, & Kessler, 2001; Ward, Flisher, Zissis, Muller, & Lombard, 2001). Critically, childhood violence exposure is a robust predictor of aggressive behavior in childhood, adolescence, and adulthood (Bingenheimer, 2005; Dodge, Bates, & Pettit, 1990; McCloskey & Lichter, 2003; Widom, 1989). Current estimations indicate that more than a quarter of all US adolescents have been exposed to violence in their lifetime, highlighting the critical need to identify mechanisms underlying the cycle of violence (McLaughlin et al., 2013).

Social information processing deficits have frequently been studied as a key mechanism linking interpersonal violence exposure and violence perpetration (e.g., Dodge et al., 1990). Since then, scant research has examined other social cognition abilities that may be disrupted as a result of interpersonal violence exposure. This is surprising given theoretical speculation that deficits in empathy, comprised of several core social cognitive abilities, may play a critical role in antisocial behavior (Blair, 2005; Eisenberg, Cumberland, Guthrie, Murphy, & Shepard, 2005; Herpertz & Sass, 2000; Hoffman, 2001; Raine, Venables, & Mednick, 1997; Zahn-Waxler, Cole, Welsh, & Fox, 1995). The current research addresses this gap in knowledge by examining whether social cognitive abilities involved in empathy, and the neural networks that support these abilities, are disrupted by interpersonal violence exposure. Identification of social processes disrupted by interpersonal violence exposure has the potential to distinguish novel mechanisms in the cycle of violence and provide targets for interventions aimed at reducing aggression (Smith, 2006).

Violence exposure and social cognitive abilities that underlie empathy

The primary objective of this study is to examine how interpersonal violence exposure

influences social cognitive abilities that underlie empathy—the understanding and sharing of emotional states of others. Empathy has been consistently linked with prosocial behavior across development (Eisenberg & Miller, 1987, 1987) and with less aggressive behavior among adolescents (Lovett & Sheffield, 2007) but not children (de Wied, Goudena, & Matthys, 2005; Gill & Calkins, 2003; Marcus, Roke, & Bruner, 1985; Strayer & Roberts, 2004). I propose that this developmental shift occurs because of maturation in the brain regions that support social-cognitive functions underlying empathy, and that greater understanding of these processes, their neural underpinnings, and disruptions that occur following interpersonal violence exposure will yield critical information regarding mechanisms in the cycle of violence. Empathy requires both automatic and effortful socio-cognitive abilities in three core areas: a) emotion perception, b) mentalizing, and c) experience sharing (Zaki, 2014). While prior research has established some links between these domains of social cognition and adverse experiences in childhood, our understanding of these relations remains incomplete due to issues inherent to the heterogeneous nature of these experiences.

Childhood adversity is defined as "exposure during childhood or adolescence to environmental circumstances that are likely to require significant psychological, social, or neurobiological adaptation by an average child and that represent a deviation from the expectable environment" (McLaughlin, 2016). These adverse experiences, characterized by a broad range of acute and chronic negative experiences ranging from abuse and neglect to institutionalization to poverty and parental mental illness, have been linked to an equally broad range of deleterious long-term mental and physical health consequences (e.g., Felitti et al., 1998). Despite evidence that child maltreatment and other forms of adversity influence social-cognitive processes, the pattern of results is highly variable across types of adversity. For example, although both

neglected and physically abused children show deficits in emotion perception, evidence suggests that neglected children show discrimination difficulty across emotions whereas abused children tend to over-identify anger (Pollak, Cicchetti, Hornung, & Reed, 2000). As such, a critical next step in this area of research is to identify how specific aspects of social-cognitive processing are disrupted as a result of specific forms of adversity. Recent conceptual models (McLaughlin, Sheridan, & Lambert, 2014; McLaughlin & Sheridan, 2016) argue for the importance of distinguishing between experiences of threat that involve harm or threat of harm (i.e., exposure to violence, physical abuse) and experiences of deprivation that involve an absence of expected social and cognitive inputs from the environment (i.e., neglect, institutional rearing, poverty) and their downstream consequences on developmental outcomes. Building on that framework, this study will specifically examine the association of interpersonal violence, a clear form of threat to a child's physical integrity, with emotion perception, mentalizing, and experience-sharing and the role that these social-cognitive processes play in increasing risk for aggression.

Collectively, a small number of studies indicate that children exposed to interpersonal violence may develop impairments in social cognition, characterized by high sensitivity to hostility in others yet insensitivity to other types of emotions and cognitions, that may be specific to this form of childhood adversity (Barahal, Waterman, & Martin, 1981; Bowen & Nowicki, 2007; Cicchetti, Rogosch, Maughan, Toth, & Bruce, 2003; Elbedour, Baker, & Charlesworth, 1997; Pollak et al., 2000; Pollak & Kistler, 2002; Pollak & Sinha, 2002; Pollak & Tolley-Schell, 2003; Shackman & Pollak, 2005; Smetana, Kelly, & Twentyman, 1984). If a child is sensitive to early warning signs of violence, for example a menacing expression from a caregiver or an unprompted remark from a stranger, he will be poised to evade the situation and quickly find safety. Detection of danger, real or imagined, is likely to be reinforced over time when safety-

seeking behavior is facilitated and anticipated threat is either avoided through escape or defeated through aggression. In children exposed to interpersonal violence, this will result in an over-developed processing of threat cues paired with underdeveloped processing of socio-emotional communication not directly relevant to safety. Although this pattern represents an adaptation in dangerous settings, a proclivity to perceive threat of violence in safe social contexts may ultimately predispose children to act aggressively in an unnecessary bid for self-protection.

Emotion perception, the ability to identify cues of another's emotional state, follows a prolonged developmental course such that adolescents demonstrate markedly less sensitivity to affective cues than adults (Thomas, De Bellis, Graham, & LaBar, 2007). Consistent evidence suggests that while neglected children demonstrate diffuse problems with positive and negative emotion recognition (Pollak et al., 2000), children exposed to interpersonal violence more readily identify facial and vocal cues of anger (Pollak & Kistler, 2002; Pollak & Sinha, 2002; Pollak & Tolley-Schell, 2003; Shackman & Pollak, 2005) and misidentify negative emotions (Bowen & Nowicki, 2007). However no studies have examined how interpersonal violence exposure disrupts processing of multiple cues of negative and positive emotions during adolescence while controlling for other forms of adversity. A cognitive style that has favored detection of threat over processing of other relevant information across development is likely to produce inaccurate recognition of negative, but not positive, emotions, whereby interpersonal violence-exposed adolescents will interpret sad and fearful expressions as angry. For children reared around dangerous people, they have learned that it may be safer to assume any negative emotional display poses a threat to wellbeing. This study provides novel information on how violence exposure specifically influences perception of a wide range of cues of negative emotions.

Mentalizing, or theory of mind, is the ability to infer another person's thoughts, beliefs, intentions, and feelings. Recent evidence suggests that theory of mind involves a cognitive component (understanding another's thoughts, intentions, beliefs) and an affective component (understanding another's *feelings*) (Sebastian et al., 2011). Importantly, adolescents exhibit worse performance on tasks of affective TOM than adults, suggesting that this ability follows a protracted developmental course (Sebastian et al., 2011). Initial evidence suggests that children exposed to physical abuse demonstrate difficulty with affective theory of mind (Barahal, 1981), and worse performance on tasks of cognitive theory of mind compared to children reared in poverty (Cicchetti, 2003). However, no studies to date have examined and compared these abilities in adolescents exposed to interpersonal violence. Violence-exposed children who have been forced to focus on salient concerns regarding threat and safety may have fewer opportunities to consider the internal experiences of others, hindering the development of cognitive theory of mind. Underdeveloped perspective-taking paired with difficulty understanding negative emotional cues will likely render these adolescents particularly deficient at the later-developing affective theory of mind. This study will reveal nuanced information regarding the influence of interpersonal violence on affective and cognitive theory of mind in adolescents.

The third component of empathy is experience-sharing in which an individual experiences a congruous emotional state with another person. Unlike theory of mind which requires understanding another's thoughts and feelings as separate from one's own, experience sharing requires "catching" the same affective state as another (e.g. distress at another's pain) (Lamm, Decety, & Singer, 2011). Recent evidence suggests that in tasks of moral reasoning, personal discomfort caused by another's pain provides a cue to the moral salience of a situation,

and triggers moral judgments (e.g. whether to punish the wrongdoer) (Decety, Michalska, & Kinzler, 2012). Moral reasoning develops across the lifespan (Decety et al., 2012; Decety & Michalska, 2010). Evidence that physically abused children are more sensitive to personal distress caused by transgressions than neglected children (Smetana, 1984), and that moral reasoning is disrupted among children in war-affected countries (Elbedour et al., 1997), suggests that experience-sharing may be disrupted by exposure to threat. Children exposed to interpersonal violence have by nature been witnesses to or victims of malicious intent from others, creating a foundation for the development of moral reasoning that is offset by suspicion and associated with personal distress. By adolescence, interpersonal violence-exposed youth will be more likely to attribute malicious intent to individuals accidentally causing harm to others as well as to experience more distress viewing accidental injury in tasks of moral reasoning. Importantly, this study provides novel data on the association of interpersonal violence exposure and experience-sharing in adolescents.

Violence Exposure And Neural Networks Involved In Social Cognition

It is possible that interpersonal violence in childhood may introduce disruptions in socio-cognitive processing via atypical recruitment of the brain regions that support social cognition across development, however research examining this question empirically remains in its infancy. Consistent evidence has identified a network of brain regions associated with empathy: the amygdala, ventromedial PFC (vmPFC), anterior insula, anterior cingulate cortex (ACC), temporal poles, and tempoparietal junction (TPJ) (Leigh et al., 2013). The amygdala is centrally involved in the detection of salient cues in the environment and underlies multiple forms of emotional learning (Davis & Whalen, 2001), particularly the detection of threats (Öhman, 2005). The vmPFC supports the shaping of affective responses, modulating amygdala activity by

incorporating relevant semantic information in the environment (Hartley & Phelps, 2013; Roy et al., 2013). The amygdala is consistently activated in tasks of emotion perception, affective theory of mind, and moral reasoning, in which negative emotional or painful stimuli are presented (Adolphs, 2009; Ferstl, Rinck, & Cramon, 2005; Völlm et al., 2006). When individuals must label affective stimuli or determine moral salience of behavior, the vmPFC is additionally recruited and modulates amygdala reactivity. Studies contrasting affective and cognitive theory of mind document the vmPFC as central and specific to conceptualizing another's emotional experience (Bird, Castelli, Malik, Frith, & Husain, 2004; Ferstl et al., 2005; Shamay-Tsoory & Aharon-Peretz, 2007).

Children exposed to violence demonstrate atypical structure and function in brain regions involved in emotional processing (McLaughlin, Alves, & Sheridan, 2014). It is hypothesized that these developmental differences arise from over-recruitment of regions involved in threat detection following exposure to violence (e.g., amygdala), and under-recruitment of regions involved in the modulation of threat responses (e.g., vmPFC; McCrory et al., 2011, 2013; McLaughlin, 2014). Reduced cortical thickness of the vmPFC among adolescents exposed to interpersonal violence likely reflects chronic under-recruitment and, potentially, accelerated synaptic pruning in this region across development (De Brito et al., 2013; Hanson et al., 2010; Kelly et al., 2013). These neuroanatomical changes are adaptive for children raised in dangerous environments, where rapid detection of threat and mobilization of response is necessary for survival (Teicher et al., 2003). If adolescents exposed to violence exposure are predisposed to detection of anger, they may demonstrate a reduced ability to differentiate anger from other forms of negative emotions including sadness or fear; this will influence a cascade of assumptions and decisions that are unlikely to support empathic behavior.

An additional network of social brain regions involved in mentalizing and experience-sharing are centrally involved in empathy, including the anterior insula, temporal poles, TPJ and ACC (Fan, Duncan, de Greck, & Northoff, 2011; Lamm, Batson, & Decety, 2007; Leigh et al., 2013). The anterior insula and temporal poles are involved in self and other awareness and processing of physical and emotional interoception (Craig, 2009; Olson, Plotzker, & Ezzyat, 2007); the ACC supports behavior motivated by distress in self and others, often coactivating with the anterior insula and downregulating amygdala reactivity (Etkin, Egner, & Kalisch, 2011; Vassena, Krebs, Silvetti, Fias, & Verguts, 2014); and the TPJ supports semantic representations of others' mental states (Lamm et al., 2007; Lawrence et al., 2006; Sebastian et al., 2012; Young, Camprodon, Hauser, Pascual-Leone, & Saxe, 2010). For children in dangerous environments, awareness of physical cues of pain and negative emotion in others triggers mobilization of resources favoring self-preservation over consideration of alternate emotional states in others. Across development, consistent recruitment of regions supporting interoception (e.g. anterior insula and temporal poles) could lead to their heightened responses to physical pain and personal distress in others, culminating in higher levels of experience-sharing, yet greater risk of interpreting moral transgressions where there are none. On the other hand, infrequent opportunities to develop accurate conceptual representations of others' emotional states likely result in chronic under-recruitment of regions supporting mentalizing processes (e.g. TPJ and ACC).

The Current Study

The present study examines behavioral performance and neural activation during tasks of social cognition as mechanisms linking exposure to interpersonal violence and aggression in violence-exposed adolescents and healthy controls. The dissertation project and remainder of

this report will focus on behavioral measures only. I measure performance during tasks of emotion recognition, cognitive and affective theory of mind, and moral reasoning in adolescents with and without interpersonal violence exposure and aggressive behavior to examine whether violence-related differences in these social cognition processes may underlie the cycle of violence in adolescence. The following three hypotheses will be examined while controlling for neglect exposure, in order to isolate the specific influence of violence. First, I expect that interpersonal violence exposure will be associated with slower reaction time and lower accuracy in responding to negative emotional faces on emotion perception tasks. Second, I predict that interpersonal violence exposure will be associated with slower reaction times and lower accuracy during both cognitive and affective conditions of a mentalizing task. Given the later development of affective theory of mind and the neural regions that support this ability, I expect that violence exposure will be associated with greater differences on the affective than cognitive conditions of this task. Third, I expect that interpersonal violence exposure will be associated with lower accuracy and higher distress during unintentional relative to intentional injury trials on a moral reasoning task. I expect that these differences in performance on social cognition tasks will be associated with greater engagement in aggressive behavior in adolescence, and will explain the association between interpersonal violence exposure and aggression.

Methods

Participants

A community-based sample of 70 adolescents aged 14-19 years old were recruited for participation from after-school programs, general medical clinics, and the general community in Seattle, WA. This sample size was selected based on power calculations (see Statistical Analysis Section) and financial constraints regarding collection of neuroimaging data in this sample.

Recruitment efforts were targeted at recruiting a sample with variability in exposure to interpersonal violence, specifically physical abuse, domestic violence between caregivers; or violent victimization by a non-family member resulting in an injury requiring medical attention. A total of 70 adolescents participated in the first session of the study. Of these, 52 were eligible for the MRI portion of the study (e.g. did not have braces). Adolescents were excluded from study participation if they did not speak English, had an intellectual quotient (IQ) below 75, were diagnosed with a pervasive developmental disorder; or used long-acting psychiatric medication as it may alter study performance. Consistent with prior research suggesting that exposure to sexual abuse alone has different associations with adolescent problem behaviors than exposure to physical abuse (Riggs, Alario, & McHorney, 1990), adolescents who were exposed to sexual violence without exposure to other interpersonal violence were also excluded.

The sample consisted of 62.9% males (n = 44), and had a mean age of 17.3 years (*SD* = 1.68). Racial/ethnic composition of the sample was as follows: 38.6% White (n=27), 4.3% Black (n=3), 8.6% Hispanic (n=6), 25.7% Asian (n=18), 1.4% Native American (n=1) and 21.4% multiracial (n=15).

Measures

Demographic information. Demographic information and socio-economic status (SES) were assessed using a parent-report measure developed by the MacArthur Network on SES and health (Bernstein, Ahluvalia, Pogge, & Handelsman, 1997) that assesses parent educational attainment, income, occupation, wealth/assets, and subjective social status.

Interpersonal Violence Exposure

Exposure to interpersonal violence was assessed using the Caregiver and Youth Lifetime Forms of the Juvenile Victimization Questionnaire – Revised, Screener Sum Version (JVQ-R2;

Hamby & Finkelhor, 2000). The JVQ-R2 is a 34-item self-report measure that assesses child maltreatment, peer victimization, sibling victimization, sexual assault, witnessing of domestic violence, crime victimization, and indirect victimization. The original screen has been revised so that participants may indicate frequency of exposure to this variety of victimization experiences from 0 (never) to 3 (a lot of times) rather than indicate yes/no responses. The JVQ-R2 has demonstrated excellent convergent validity and reliability among population-based samples of adolescents (Finkelhor, Ormrod, Turner, & Hamby, 2005; Finkelhor et al., 2013). Total victimization scores, created by summing all JVQ-R2 items, demonstrated good reliability for the parent-report (α =.87) and excellent reliability for the youth-report (α =.90) in this sample. Given current consensus that combining adolescent and parent report represents best practice for assessment of youth (Cantwell, Lewinsohn, Rohde, & Seeley, 1997), all of the independent and dependent continuous measures were created by including the highest parent or youth-reported total scores. Adolescents aged 18-19 years (n=38) did not attend the session with parents, and thus only adolescent reports are used for these participants. The total interpersonal violence composite is comprised of the highest total JVQ-R2 score reported by the parent or adolescent.

Aggressive Behavior

Symptoms of aggressive behavior were assessed using the Youth Self Report (YSR) and Parent Report forms of the Child Behavior Checklist (CBCL) (Achenbach & Rescorla, 2001; Achenbach, 1991). The CBCL scales are among the most widely used measures of youth emotional and behavioral problems and use extensive normative data to generate age-standardized estimates of the severity of internalizing and externalizing psychopathology. The aggressive behavior subscale is comprised of items such as “I destroy things belonging to other people”. The aggression subscale has demonstrated validity in identifying youths with

psychiatric disorders characterized by aggressive behavior (Achenbach, 1991; Chen, Faraone, Biederman, & Tsuang, 1994; Kazdin & Heidish, 1984). The total aggression score is comprised of the highest parent or youth-reported aggression subscale.

Potential Covariates

IQ. The two-subtest form of The Wechsler Abbreviated Intelligence Scale – Second Edition was used to estimate IQ (WASI-II; Wechsler & Hsiao-pin, 2011). The WASI-II is a widely used measure of cognitive ability designed for use with individuals aged 6-90. Full scale IQ is estimated from participants' performance on the vocabulary and matrix reasoning subtests.

Neglect. History of childhood neglect was assessed using adolescent report on the Childhood Experiences of Care and Abuse (CECA) interview (Bifulco, Brown, & Harris, 1994; Brown, Craig, Harris, Handley, & Harvey, 2007). The CECA is an interview that assesses multiple aspects of caregiving experiences, including neglect and physical and sexual abuse. The neglect self-report scale asks participants to rate 8 items assessing each parent or guardian's physical (food, clothing, health) and emotional (schoolwork, friendships) neglect on a five point Likert scale from 1 (yes definitely) to 5 (no, not at all). These items are summed to create a total neglect score. Inter-rater reliability for maltreatment reports is excellent, and multiple validation studies suggest high agreement between siblings on reports of maltreatment (Bifulco, Brown, & Harris, 1994; Bifulco, Brown, Lillie, & Jarvis, 1997).

Internalizing symptoms. Symptoms of internalizing psychopathology were assessed using the Youth Self Report (YSR) and Parent Report forms of the Child Behavior Checklist (CBCL) (Achenbach & Rescorla, 2001; Achenbach, 1991). The broad-band internalizing scale is comprised of withdrawn/depressed (e.g., "I would rather be alone than with others"), somatic complains (e.g., "I feel overtired without good reason") and anxious/depressed (e.g., "I am

nervous or tense") subscales. The internalizing scale has demonstrated validity in discriminating between youths with and without psychiatric disorders (Achenbach, 1991; Seligman, Ollendick, Langley, & Baldacci, 2004). The total internalizing score includes the highest parent or youth-reported internalizing total scale.

Proactive and Reactive Physical and Relational Aggression. Distinct forms of aggressive behavior were assessed using the Parent Report and Youth Self-Report versions of the Peer Conflict Scale (PCS; Marsee, Kimonis, & Frick, 2004). The PCS is a 40-item scale designed to assess distinct forms of aggressive behavior in youth. Respondents indicate whether the items, assessing physical proactive aggression (e.g. "Hurts others to feel powerful and respected") and physical reactive aggression (e.g. "When teased, will hurt someone or break something"), describe themselves using a 4-point Likert scale from 0 (not at all true) to 3 (definitely true). The parent-report subscales demonstrated adequate to good reliability (α=.79-.87), and the youth-report subscales all demonstrated adequate reliability (α =.69-.76) in this sample. Total proactive and reactive aggression scales were calculated by including the highest score from the parent- or youth-report subscale.

The majority of the final sample (n=52) endorsed some symptoms of proactive aggression, and more than half of these adolescents (n=28) reported only proactive, not reactive, aggression. However a smaller proportion (n=23) endorsed any behavior on the total reactive aggression scale, and only one adolescent engaged in reactive aggression alone. It was therefore not possible to determine whether there are differences between aggression subtypes in this sample. As a result, analyses focused on overall aggression scores and did not examine proactive and reactive aggression separately.

Procedure

The study took place in two sessions. For adolescents aged 14-17 years, Session 1 required participation by both the adolescent and a parent/guardian. For adolescents aged 18-19 years, parental consent and participation was invited but not required. First, older adolescents consented themselves into the study and younger adolescents were consented into the study by a parent/guardian and also provided their assent for study participation. Session 1 took place at the University of Washington, and involved structured interviews and surveys with the adolescent and the parent/guardian to assess demographic variables, interpersonal violence exposure, and psychopathology. The adolescent also completed one emotion perception task during this session (Reading the Mind in the Eyes, described below). During Session 2, participants completed three social cognition tasks in the context of an MRI scan, and one behavioral task outside of the scanner. This session took place at the Diagnostic Imaging Center of University of Washington. All participants completed a training session prior to the MRI, where for each task they received detailed instructions about how to respond to each cue, observed examples completed out loud by a research assistant, then practiced each task with sample images not included in the tasks.

Emotion Perception.

Reading the Mind in the Eyes Test. This task, adapted from Baron-Cohen, Wheelwright, Hill, Raste, & Plumb (2001), is

designed to assess the ability to evaluate another person's emotional state based on limited facial information. The task has been shown to accurately discriminate among individuals with social-cognitive difficulties (e.g., autism) and controls. Participants are presented with 36 photographs of the eyes of different actors and actresses, and are asked which among four given words best describes what the person in the photograph is thinking or feeling. For example, if the correct

word for a picture stimulus is “suspicious” the other three word choices could be “curious,” “excited,” and “terrified.” Prior to participating, participants were provided with a glossary of all mental state terms used in the task. They were instructed to read all four words for each picture before selecting only one choice. The task was self-paced, such that participants could take as much time as needed to make their choice before proceeding to the next photograph. Mean accuracy and reaction time scores to images of eyes displaying negative emotion were created by averaging participants’ responses on these specific trials.

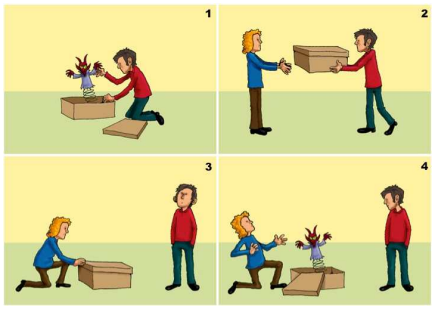
Affect labeling task. Emotion perception was also measured during the MRI scan using a task adapted from Lieberman et al., (2007) designed to measure accuracy and neural function during identification of negative and positive emotional stimuli. This task has accurately differentiated between samples exposed to childhood adversity and controls (Taylor, Eisenberger, Saxbe, Lehman, & Lieberman, 2006).

For each block of the task, participants viewed an instruction screen for 2s followed by 10 5s trials presented sequentially, followed by one 10s control fixation cross. Each trial consisted of a single image of a person expressing affect. Participants were trained to follow one of three instructions for each block of 10 trials. For the *observe* instruction, participants viewed a single picture of an emotional face without providing a response. Following the *emotion label* instruction, participants selected the appropriate emotion label from two response options presented at the bottom of each image. For the *gender label* instruction, participants were asked to identify the gender of the individual from two names presented at the bottom of each image. Six blocks were presented in counterbalanced order for each of the two conditions: negative

emotion and positive emotion. In the negative emotion condition each block consisted of three target faces depicting angry, scared, and sad expressions respectively and one target face depicting a neutral expression. In the positive emotion condition each block consisted of three target faces depicting excited, happy, and calm expressions respectively as well as one target face depicting a neutral expression. Sixty unique images were randomized across each condition, for a total of 120 trials. Half of the target faces in each condition were female, half male. Stimuli were selected from the IASLab Face Set[1] (Barret & Bliss-Moreau, 2009). Negative emotion mean accuracy and reaction time scores were calculated by averaging participants' responses to the photographs with negative emotional content presented during the affect labeling and gender labeling trials of the negative emotion condition.

Mentalizing.

Theory of mind task. Cognitive and affective theory of mind were assessed during the fMRI with a task adapted from stimuli designed to be sensitive to differences in performance among healthy populations (Schlaffke et al., 2015). Participants viewed four-frame single-image cartoon stories and were asked to answer questions about the situations depicted in the cartoons. Three kinds of stories were shown in twelve cartoons. Four cartoons depicted two characters cooperating with one another, four cartoons depicted one character deceiving another, and four cartoons depicted two characters cooperating with each other in order to deceive a third character. All characters were drawn to be of ambiguous race and gender, and without clear



[1]Development of the Interdisciplinary Affective Science Laboratory (IASLab) Face Set was supported by the National Institutes of Health Director's Pioneer Award (DP1OD003312) to Lisa Feldman Barrett. More information is available online at www.affective-science.org

facial expressions.

In the beginning of each block of the task, participants were presented with instructions corresponding to one of three task conditions. In the affective theory of mind condition, participants were given the instruction *feelings*, and told to focus on the feelings of the characters in each frame of the cartoon. In the cognitive theory of mind condition, participants were given the instruction *thoughts*, and told to focus on the characters' intentions or beliefs as they developed throughout the story. Finally, for the physical control condition, participants were given the instruction *objects*, and told to focus on the physical attributes of the cartoon rather than the characters' feelings or intentions in the story. In these control cartoons, the order of the four frames in the cartoon image was scrambled to prevent participants from focusing on the story. Following the 1s instruction screen, the cartoon image was presented alone for 6s. Next, a question about a specific frame in the cartoon appeared for 4s at the bottom of the cartoon along with two response options below the question. Each block consisted of one condition instruction followed by three cartoons and questions presented sequentially, ending with a 10s control fixation cross. The task proceeded in a counterbalanced order across twelve blocks: four blocks per condition, three different story types per block. Each of the twelve cartoons was randomized to be presented once per condition, to ensure differences across conditions were not attributable to inconsistent stimulus difficulty and visual complexity. For example, one cartoon might be accompanied by the question "What is he intending to do here?" when presented in the cognitive condition, "What is the boy feeling here?" in the affective condition and "What color are the flowers?" in the physical condition.

Cognitive theory of mind mean accuracy and reaction time scores were calculated by averaging participants' responses to the twelve questions presented during the cognitive blocks

of the task. Affective theory of mind mean accuracy and reaction time scores were calculated by averaging participants' responses to the twelve questions presented during the affective blocks of the task.

Experience-sharing.

Moral reasoning task. Participants completed a moral reasoning task designed to assess empathy and neural response to pain in others. Participants viewed video clips depicting intentional or accidental harm to either a person or object, then rated the degree to which harm was committed intentionally, in the task adapted from Decety et al. (2012). The video clips show only people's bodies from the waist down (i.e., no facial expressions, see figure below) and thus do not depict people actually expressing pain or distress. This task has been used with children as young as age 4 in previous studies (Decety et al, 2011).

The task consisted of sixteen blocks, eight depicting harm to people and eight harm to objects, with three unintentional and three intentional trials presented in random order within each block. In each of the 96 trials, participants first watched a brief 2.2s video then were given 2.8s to determine whether the clips depicted accidental or purposeful harm on a 4-point Likert scale from 0 (not at all on purpose) to 3 (very much on purpose). Each block was followed by a control fixation cross jittered for 1s, 3s, or 5s. After the scanning session was completed, participants completed the task again on a laptop computer. This time, participants answered additional questions after viewing each of the video clips, including indicating how distressed they were by the images on a Likert scale from 1 (not at all) to 100 (very much).

Participants' responses on the unintentional and intentional ratings during the MRI scan

were dichotomized (0 or 1= unintentional, 2 or 3=intentional) and scored for accuracy. The unintentional injury mean accuracy score was calculated by averaging participant accuracy scores during the 24 unintentional trials within the person blocks of the task. The intentional injury mean accuracy score was calculated by averaging participant accuracy scores during the 24 intentional trials within the person blocks of the task. An accuracy difference score was calculated by subtracting each participant's unintentional injury mean accuracy score from their intentional injury mean accuracy score. Larger difference scores reflect greater difficulty discriminating unintentional from intentional injuries.

Unintentional injury mean distress scores were calculated by averaging participants' distress ratings following unintentional trials of the person blocks during the post-scan moral reasoning task. Intentional injury mean distress scores were calculated by averaging participants' distress ratings following intentional trials of the person blocks during the post-scan moral reasoning task. A distress difference score was calculated by subtracting each participant's unintentional injury mean distress score from their intentional injury mean distress score. Smaller difference scores indicate distress levels during unintentional injury trials that are more similar to distress levels during intentional injury trials.

Statistical Analysis

To examine study hypotheses, I tested three models. In each model, performance on socio-cognitive tasks (emotion perception; mentalizing; experience sharing) was examined as a mediator of the association between interpersonal violence exposure and aggression. For each social cognition construct, I performed a statistical mediation that simultaneously estimated the following paths: the direct effect of interpersonal violence on social cognition (path a); the direct effect of social cognition on aggression (path b); the direct effect of violence on aggression (path

c'); and the indirect effect of violence on aggression through the proposed mediators, while controlling for age, sex, and neglect using the PROCESS test (Hayes, 2013), thereby reducing the need for multiple comparisons. The PROCESS test of multiple mediation is particularly advantageous as it employs a bootstrapping method to address non-normal data distributions and is particularly suited to small sample sizes (Preacher & Hayes, 2008). When zero is not included in the lower and upper endpoints of the bias-corrected bootstrap confidence interval for the regression parameter provided by PROCESS, the indirect effect is interpreted as statistically significant.

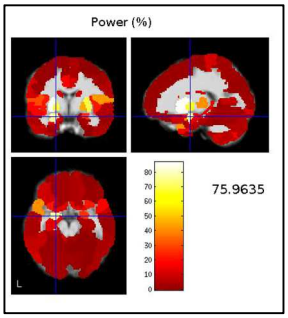
In each of these models, the continuous score reflecting exposure to interpersonal violence based on the highest total report from either the adolescent or parent on the JVQ-R2 was entered as the independent variable and the continuous score reflecting aggressive behavior based on the highest total aggression subscale from either the adolescent report on the YSR or parent report on the CBCL as the dependent variable. In the emotion perception model, I examined mean accuracy and mean reaction time during negative emotion trials of the Reading the Mind in the Eyes and affect labeling tasks as mediators. As these two tasks were conducted at different sessions, 18 fewer participants completed the affect labeling task. The emotion perception model was therefore run separately for each task, so as not to limit the Reading the Mind in the Eyes analyses to the smaller sample who completed the affect labeling task. In the mentalizing model, four mediators entered simultaneously included mean accuracy and mean reaction time during cognitive and affective conditions of the theory of mind task. For the experience-sharing model, the two mediators included the difference score calculated by subtracting the mean level of distress reported following unintentional injury trials from the mean level of distress reported following intentional injury trials, and the difference score

calculated by subtracting mean accuracy during unintentional injury trials from mean accuracy during intentional injury trials of the moral reasoning task.

Following analysis of my three main mediation models, I tested supplementary hypothesis-driven analyses. Specifically, I examined whether my main findings were robust to controlling for internalizing psychopathology. As demonstrated in Table 1 and in line with a large body of literature, internalizing symptoms were highly correlated with symptoms of aggressive behavior among adolescents in this study. Consequently, I ran a regression model for the continuous score reflecting internalizing symptoms based on the highest total internalizing scale from either the adolescent report on the YSR or parent report on the CBCL entered as the dependent variable as predicted by the continuous score reflecting aggressive behavior based on the highest total aggression subscale from either the adolescent report on the YSR or parent report on the CBCL entered as the independent variable, and saved the unstandardized residual for use in my analyses. This adjusted covariate thus represents the unique variance contributed by internalizing symptoms that is not shared by aggressive behavior.

Age and sex were controlled for in all models, given established age and sex-related differences in both violence exposure and aggressive behavior. In addition, I examined Pearson correlations between interpersonal violence exposure and aggression variables and plausible confounding variables, specifically the continuous Full Scale IQ score on the two-subtest form of the WASI-II and the continuous score reflecting total exposure to neglect on the CECA. In my sample, IQ was not statistically significantly related to either interpersonal violence exposure or aggression, and thus was not considered to be a plausible confounder. A statistically significant association was found between interpersonal violence exposure and neglect ($r = 0.32$, $p = .007$), but not between neglect and aggression. Therefore, neglect was included as a covariate in all

multiple-mediation models. Paths a, c' and indirect effects derived from each multiple-mediator model, controlling for age sex and neglect, will be described in the results section. Associations between social cognition to aggression (path b) are reported without adjustment for neglect. All analyses were conducted using SPSS software Version 19.



Power Analysis. The study was powered based on my neuroimaging aims. To ensure that I would be adequately powered to detect group differences in neural activation, I used fMRI-based power analysis implemented in the fMRIpower software package (Mumford, 2012), to calculate power for detecting group differences in amygdala activation using a previous study conducted in my lab in which participants viewed pictures of negative relative to neutral situations (McLaughlin, 2014). The analysis indicates that with n=25 per group I achieve 75% power to detect group differences in the amygdala of the magnitude observed in this previous study. This task activates the amygdala less than facial viewing of emotion, making this estimate conservative. With this sample size, analyses will also be adequately powered to detect large differences (d = 0.8) on all behavioral tasks.

Results

Descriptive Statistics

Table 1 provides the means and standard deviations of all measures. Table 2 provides the zero-order correlations among all measures of interpersonal violence exposure, covariates, social cognition, and aggressive behavior.

Emotion Perception

Detailed results for both the Reading The Mind In The Eyes and affect labeling task

analyses are presented in Table 3.

Path a. Interpersonal violence exposure was not associated with accuracy during negative emotion trials of the Reading The Mind In The Eyes or affect labeling tasks. However, greater interpersonal violence exposure was significantly associated with longer reaction times on trials involving negative emotions during both the Reading The Mind In The Eyes (β = .25, *p* = .044) and the affect labeling tasks (β = .29, *p* = .046).

Path b. Aggression was significantly associated with longer reaction times (β =.30, *p* = .047) and associated at trend-level with lower accuracy (β = -.24, *p* = .094) during negative emotion trials of the affect labeling task. Accuracy and reaction time during negative emotion trials of the Reading the Mind in the Eyes task were not associated with aggression.

Path c'. Interpersonal violence exposure was significantly associated with aggression, such that higher violence exposure was associated with greater engagement in aggressive behavior (β = .43, *p* = .001).

Indirect effects. The indirect effect of interpersonal violence exposure on aggression through lower accuracy and longer reaction times during negative emotions trials on the Reading the Mind in the Eyes task was not statistically significant, 95% CI: (-0.0203 to 0.0428). The indirect effect of interpersonal violence exposure on aggression through lower accuracy and longer reaction times during negative emotion trials on the affect labeling task was also not statistically significant, 95% CI: (-0.0486 to 0.0590).

Controlling for Internalizing Symptoms.

Path a. Interpersonal violence exposure was associated at trend-level with longer reaction times during the negative emotion trials of the affect labeling task (β=.27, p=.062), but not with accuracy during the affect labeling task. Interpersonal violence exposure was not significantly

associated with accuracy or reaction time during negative emotion trials of the Reading the Mind in the Eyes task.

Path b. Aggression was associated with both lower accuracy (β=-.34, p=.049), and longer reaction time (β=.36, p=.039) during the affect labeling task. Accuracy and reaction time during negative emotion trials of the Reading the Mind in the Eyes task were not significantly associated with aggression.

Path c'. Interpersonal violence exposure was significantly associated with aggression (β=.42, p=.002).

Indirect effects. The indirect effect of interpersonal violence exposure on aggression through lower accuracy and longer reaction times during negative emotions trials on the Reading the Mind in the Eyes task was not statistically significant,,95% CI: (-0.0223 to 0.0573). The indirect effect of interpersonal violence exposure on aggression through lower accuracy and longer reaction times during negative emotions trials on the affect labeling task was also not statistically significant, 95% CI: (-0.0597 to 0.0508).

Mentalizing

Detailed results for the theory of mind task analyses are presented in Table 4.

Path a. Interpersonal violence exposure was associated with longer reaction times during the affective condition of the theory of mind task (β = .28, *p* = .048), but not significantly associated with reaction time during the cognitive condition or accuracy during affective or cognitive conditions of the task.

Path b. Aggressive behavior was significantly associated with lower accuracy during the affective, but not cognitive, condition of the theory of mind task (β = -.36, *p* = .023), and significantly associated with longer reaction times during both the affective condition (β = .34, *p*

= .027) and cognitive condition of the task (β = .30, *p* = .050).

Path c'. Interpersonal violence exposure was significantly associated with aggression (β = .43, *p* = .001).

Indirect effect. The indirect effect of interpersonal violence exposure on aggression through lower accuracy and longer reaction times during affective and cognitive conditions of the theory of mind task was not statistically significant, 95% CI: (-0.0487 to 0.0716).

Controlling for Internalizing Symptoms.

Path a. Interpersonal violence exposure was associated with longer reaction time during the affective condition of the theory of mind task at trend-level (β = .27, *p* = .062) but not significantly associated with reaction time during the cognitive condition or accuracy during affective or cognitive conditions of the task.

Path b. Aggressive behavior was significantly associated with lower accuracy (β = -.38, *p* = .035) and longer reaction times (β = .37, *p* = .031) during the affective condition of the theory of mind task. Aggressive behavior was also significantly associated with longer reaction times, though not lower accuracy, during the cognitive condition of the theory of mind task (β = .34 *p* = .050).

Path c'. Interpersonal violence exposure was significantly associated with aggression (β=.42, p=.002).

Indirect effect. The indirect effect of interpersonal violence exposure on aggression through lower accuracy and longer reaction times during affective and cognitive conditions of the theory of mind task was not statistically significant, 95% CI: (-0.0534 to 0.0698).

Moral Reasoning

Detailed results for the moral reasoning task analyses are presented in Table 5.

Path a. Interpersonal violence exposure was associated with a larger accuracy difference score at trend-level, reflecting lower accuracy during the unintentional relative to intentional injury trials (β = .24, *p* = .092). However, interpersonal violence exposure was not significantly related to a smaller distress difference score, representing more similar distress during the unintentional relative to intentional injury trials.

Path b. Aggressive behavior was significantly associated with a greater difference in accuracy (β = .32, *p* = .028), but not significantly associated with distress, during unintentional relative to intentional injury trials of the moral reasoning task.

Path c'. Interpersonal violence exposure was significantly associated with aggression (β = .43, *p* = .001).

Indirect effect. The indirect effect of interpersonal violence exposure on aggression through greater differences in accuracy and smaller differences in distress during unintentional relative to intentional injury trials during the moral reasoning task was not statistically significant, 95% CI: (-0.0195 to 0.0768).

Controlling for Internalizing Symptoms.

Path a. Interpersonal violence exposure was not significantly associated with differences in accuracy and distress during unintentional relative to intentional injury trials.

Path b. Aggression was not significantly associated with differences in accuracy and distress during unintentional relative to intentional injury trials.

Path c'. Interpersonal violence exposure was significantly associated with aggression (β=.42, p=.002).

Indirect effect. The indirect effect of interpersonal violence exposure on aggression through greater differences in accuracy and smaller differences in distress during unintentional

relative to intentional injury trials during the moral reasoning task was not statistically significant, 95% CI: (-0.0336 to 0.0482).

Discussion

Prior research has documented that interpersonal violence exposure in childhood is a powerful determinant of aggression across the lifespan (Bingenheimer, 2005; Dodge et al., 1990; McCloskey & Lichter, 2003; Widom, 1989). Although deficits in empathy have been implicated in this association (e.g., Lovett & Sheffield, 2007), no studies have simultaneously investigated the associations between violence exposure, aggression and the specific forms of social cognition that underlie empathy: emotion perception, cognitive and affective theory of mind, and moral reasoning. Furthermore, the research concerned with disrupted social cognitive abilities following adversity has often failed to isolate effects of violence from disruptions attributable to other forms of adversity, such as neglect. As a result, a considerable gap exists in the literature between prevailing theory and existing evidence of whether interpersonal violence specifically disrupts distinct forms of social cognition in ways that may encourage aggressive behavior. The current study applied a novel conceptual model for explaining patterns of social cognition developed in an environment characterized by threat in a community-based sample of adolescents with a high concentration of exposure to interpersonal violence. First, I found that exposure to interpersonal violence was associated with disruptions across multiple domains of social cognition, including delayed processing of negative emotional cues, hesitancy predicting emotional states of others in a variety of social situations, and greater difficulty differentiating between unintentional and intentional acts of aggression. Second, difficulty across these domains, in turn, was associated with aggressive behavior. Finally, this pattern of results remained similar even when controlling for internalizing symptoms. Taken together, these

findings suggest that atypical socio-cognitive development warrants further consideration as a vulnerability factor for aggression shaped by interpersonal violence exposure. Although I did not find evidence that the indirect effects of interpersonal violence on aggression were explained by atypical patterns of emotion perception, mentalizing, or experience-sharing, examination of the individual pathways in my model extends the literature in several important ways.

Consistent with my hypotheses and a great deal of research, I found a strong association between interpersonal violence and aggressive behavior in adolescence, a finding that remained significant after controlling for the influence of internalizing symptoms. Higher engagement in aggressive behavior likely reflects a developmental adaptation to a dangerous environment. Under threat, self-defense may be critical to safety, however a tendency to behave aggressively is problematic for a number of reasons. First, and most obvious, adolescent aggressive behavior is associated with a wide range of negative interpersonal, educational, legal, and health outcomes (Huesmann, Dubow, & Boxer, 2009; Kokko & Pulkkinen, 2000). Second, a tendency to behave aggressively is likely to provoke a similar response in others. As a result, these violence-exposed youth create more opportunities for re-exposure. This is particularly concerning because the risk for virtually all forms of psychopathology, including externalizing psychopathology, increases with each traumatic experience (Copeland, Keeler, Angold, & Costello, 2007; McLaughlin et al., 2012). It is therefore critical that we identify the ways in which adapting to interpersonal violence may alter how children interact with their social environment in ways that increase risk for aggression. Here, I examine three core dimensions of social cognition.

Across two tasks of emotion perception, I found that adolescents exposed to greater levels of interpersonal violence were likely to respond more slowly when identifying an emotion in another person's face when that face was exhibiting a negative emotion. If adolescents

exposed to violence have a learning history in which early identification of threat has been reinforced over time, they may become more primed to detect cues of anger. As a result, violence-exposed youth can identify a single expression of anger in a degraded image faster and using less perceptual information than non-exposed youth (Pollak & Sinha, 2002). However findings suggest that a focus on perceptual cues of anger may lead to slower identification of perceptually similar emotions. Previous research has established that anger is most reliably detected by focusing on certain features of the face, specifically the eye and brow region (Ellison & Massaro, 1997). Although detection of happiness and disgust relies on other facial features, detection of sadness and fear appears to rely on the same eye region as detection of anger (Calder, Young, Keane, & Dean, 2000; Sullivan, Ruffman, & Hutton, 2007). As a result, it may take these adolescents longer to recognize expressions as fearful or sad rather than angry. This finding is consistent with past studies that have found that physically abused children have difficulty discriminating between sad, neutral, and angry faces (Pollak et al., 2000). If it is difficult to discriminate other negative emotions from anger, any negative emotion may initially be perceived as threatening. Indeed, prior evidence shows that violence-exposed adolescents experience greater amygdala reactivity to negative stimuli (McCrory et al., 2011). To cope, these adolescents may be avoiding looking at the images they find threatening, causing them to take longer to identify the correct emotion. This theory has support from earlier research in which physically abused children were slower to detect a visual probe when it followed a picture of an angry face, indicating an association between interpersonal violence exposure and attention bias away from threat (Pine et al., 2005). It is worth noting that, unlike some studies of maltreatment and emotion recognition (e.g., Bowen & Nowicki, 2007; Leist & Dadds, 2009; Pajer, Leininger, & Gardner, 2010), I did not find differences in accuracy at identifying negative emotions.

However these studies were conducted with samples of young children or with a greater proportion of adolescents exposed to neglect than to violence. In general, the adolescents in this study performed very well across emotion perception tasks, consistent with evidence that emotion recognition accuracy improves with age (Herba, Landau, Russell, Ecker, & Phillips, 2006). Had this study been conducted with younger children, I may have seen greater variability in task performance and therefore been more likely to detect violence-associated differences in accuracy in addition to the slower reaction times to negative emotions. Slower reaction time, but not lower accuracy, suggests that violence-exposed adolescents may take longer to identify expressions when they are interpreted as potentially threatening but ultimately are just as able as non-violence exposed teens to be accurate. Although the associations became weaker, the fact that this pattern of results remained similar after internalizing symptoms were controlled for highlights the role of interpersonal violence in shaping negative emotion perception. Sensitivity to threatening perceptual information at the expense of timely detection of other emotions represents a positive adaptation for adolescents living in a violent environment. However, failure to expediently recognize others' emotions may impair these adolescents' ability to be interpersonally responsive, costing them close social connections with peers during the developmental period in which these relationships are most important.

Consistent with my hypotheses, adolescents who had experienced more severe interpersonal violence demonstrated greater difficulty with the affective than the cognitive component of mentalizing. Specifically, interpersonal violence was associated with slower reaction times but not lower accuracy when predicting how another person might feel in a specific context. This pattern remained consistent at trend-level even after accounting for internalizing symptoms. This finding is unsurprising, given that violent behavior is essentially a

demonstration of an emotional reaction that is inappropriate to the situation at hand. Over time, repeated encounters with others' atypical emotional outbursts are likely to alter the way children exposed to chronic violence think about the kinds of experiences that may trigger a variety of emotions and whether the strength of these emotions are commensurate with the context in which they occur. As a result, we might expect to see lower affective theory of mind accuracy in adolescents exposed to more severe and chronic violence as children. However most adolescents in this study were exposed a few discrete instances of violence. These experiences might introduce hesitation when predicting how different contexts influence the emotions of other people. Although ultimately able to get it right, these adolescents need more time to overcome their uncertainty as they contemplate a wider range of potential emotional triggers. Hesitation during affective perspective taking can be problematic in an immediately dangerous environment, when quick decision-making is needed. However for adolescents who have experienced violence in the past but are no longer in danger, this may actually be a positive adaptation. Consideration of a wider range of emotions and motivations in others may promote resilience and safety as these adolescents are better able to anticipate and avoid volatile individuals.

In contrast, I found no significant association between violence exposure and the accurate or swift identification of other peoples' thoughts and intentions across different contexts. Although a body of research supports an association between maltreatment and lower accuracy during tasks of cognitive theory of mind in childhood (Burack et al., 2006; Cicchetti et al., 2003; O'Reilly & Peterson, 2015; Pears & Fisher, 2005; Tarullo, Bruce, & Gunnar, 2007; Yagmurlu, Berument, & Celimli, 2005), this is the first study to my knowledge to examine this relationship in adolescence. Available evidence suggests that the cognitive component of mentalizing has

largely developed by middle childhood while the affective component continues to develop across adolescence (Baron-Cohen, O'Riordan, Stone, Jones, & Plaisted, 1999; Perner & Wimmer, 1985; Sebastian et al., 2011), with recent models suggesting that cognitive theory of mind is in fact a necessary prerequisite to the development of affective theory of mind (Kalbe et al., 2010; Perner & Wimmer, 1985). It is therefore possible that deviations from typical cognitive theory of mind development catalyzed by violence exposure emerge earlier in childhood and largely resolve by adolescence. This is promising news. The ability to predict the plans and intentions of other people across a variety of social contexts is particularly critical during adolescence, a developmental period when youth are navigating the world more independently. This is particularly the case for the violence-exposed adolescents who continue to live in a dangerous environment. Predicting another person's plans may be critical to evading violent behavior, especially when these adolescents have learned that another person's emotions are inconsistently linked to behavior.

Interpersonal violence exposure was also associated at trend-level with greater difficulty discriminating unintentional from intentional injuries. This finding is consistent with prior evidence that children reared in households with harsh parental discipline or physical abuse are more likely to assume hostile intentions during ambiguous provocations, a social cognitive pattern commonly referred to as hostile attribution bias (Dodge et al., 1990; Shahinfar, Kupersmidt, & Matza, 2001; Teisl & Cicchetti, 2008). Violence-exposed adolescents may be more likely to assume physical injuries are intentionally caused because they themselves have been the victims of hostile intentions from others in the past. When one individual harms another person, it is safer for a witness to assume the act was purposeful in order to safely evade the potentially dangerous individual. This pattern is highly adaptive in violent homes and

communities. However, over time children who over rely on hostile attribution biases lose opportunities to process important contextual information indicating when they are in fact safe, for example that the perpetrator was walking backwards, and hadn't seen the victim when he bumped into him. Although I predicted that interpersonal violence exposure would also lead to greater distress when viewing unintentional than intentional injury, cueing adolescents to potentially threatening intentions in others, I did not find this to be the case. Unlike the intentionality ratings that took place inside the scanner, the distress ratings were collected outside of the scanner following participants' second viewing of the moral reasoning task videos. It is therefore possible that violence-related differences in distress were attenuated by the second viewing, as adolescents had habituated to the distressing nature of the images. Another explanation is that interpersonal-violence exposed adolescents actually were experiencing greater distress but the difference could only be detected at a more subtle, biological level. Indeed, prior studies have found that amygdala reactivity to negative stimuli is not associated with self-reported negative affect in adults (Prather, Bogdan, & Ahmad R. Hariri, 2013), and that violence exposure is associated with higher reactivity in the amygdala but not in self reports among adolescents (McLaughlin, Peverill, Gold, Alves, & Sheridan, 2015). I will be able to examine differences in distress during the moral reasoning task using more sensitive neural activation measures, although neuroimaging data are currently being processed and I do not yet have those results. Finally, it is worth noting that the generalization of threat cues, failure to process relevant safety cues, and heightened emotional reactivity which hypothetically drive disruptions to moral reasoning are also typical features of post-traumatic stress disorder (PTSD). Higher PTSD symptoms among violence-exposed adolescents may explain why the association between interpersonal violence and lower accuracy on unintentional than intentional injury trials was no

longer significant once I controlled for internalizing symptoms. It will be important for future research studies to compare violence-exposed adolescents with and without PTSD on tasks of moral reasoning in order to elucidate whether this pattern is solely attributable to PTSD.

My second aim was to examine whether disruptions across negative emotion perception, cognitive and affective theory of mind, and moral reasoning accounted for greater levels of aggressive behavior in adolescents. As expected, I found that lower accuracy and slower responding when identifying negative emotions during emotion perception were associated with aggression. This finding was even stronger once internalizing symptoms were controlled for. Prior research on emotion perception in aggressive children has produced somewhat mixed results, with two studies finding no association (Pajer et al., 2010; Woods, Wolke, Nowicki, & Hall, 2009) and two others identifying a nuanced pattern in which aggression was associated with impaired fear recognition but superior anger recognition (Carr & Lutjemeier, 2005; Munoz, 2009). However by adulthood, violent behavior is consistently associated with persistent difficulty in the recognition of all negative emotions, particularly sadness and fear (Marsh & Blair, 2008). Our finding may reflect a developmental shift that occurs in adolescence. During this time period, outright aggression is less common than it is in early and middle childhood (Loeber & Hay, 1997). It may be the case that severity of social cognitive impairment is what differentiates the subset of children who continue to behave aggressively as adolescents and are more phenotypically similar to aggressive adults than to aggressive children. Indeed, only poor performance on the simpler task of emotion perception, the affect labeling task, was predictive of aggression. Adolescents generally performed near ceiling on this task. Why might poor perception of negative emotions, likely driven by particular difficulty with sadness and fear, predict aggressive behavior? If children have deficits in the ability to accurately discriminate and

identify negative emotions, it is possible that all negative emotions are interpreted broadly as a reflection of threat. The finding that adolescents are slower to identify negative emotions is particularly interesting given the large body of research devoted to the association between impaired executive function, especially impulsivity, and aggression (Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001; Oosterlaan & Sergeant, 1996). Although I did not directly examine inhibitory ability, slower processing speed suggests that the association between negative emotion perception and aggression is unlikely to be attributed solely to the fast responding characteristic of impulsivity. Instead, it may reflect greater uncertainty as aggressive adolescents try to distinguish between different negative emotions, and despite taking more time to identify the expression, they are still less likely to arrive at the correct answer. Adolescents who respond aggressively after mistaking a peer's sadness, fear, or even neutral emotions for anger are likely to provoke an angry response. Over time, these kinds of interactions are apt to produce a kind of confirmation bias, in which all negative emotions eventually *do* serve as precursors to anger. As a result, aggressive adolescents lose opportunities for corrective learning.

Aggressive behavior was also associated with slower reaction times during both cognitive and affective dimensions of mentalizing. Although aggressive adolescents were ultimately able to correctly identify characters' intentions and plans as well as less aggressive adolescents, they could not accurately predict characters' feelings across a variety of complex social situations. These findings remained significant while controlling for internalizing symptoms, underscoring the role of deficits in mentalizing as a risk factor for adolescent aggressive behavior. In particular, findings extend the literature by highlighting the importance of the later-developing affective dimension of theory of mind, a topic that has largely been ignored in aggression research. Although I am unaware of previous studies that have directly measured aggression as it

relates to affective perspective taking in adolescents, our finding is consistent with limited evidence that affective theory of mind is more impaired than cognitive theory of mind among clinical populations of children and adolescents diagnosed with conduct disorder (Hughes, Dunn, & White, 1998). Anticipation of negative interpersonal consequences provides a strong rationale for inhibiting aggression. Failure to anticipate these consequences may account for aggression in adolescents with diffuse mentalizing deficits. However, not all youth with impairments in perspective taking behave aggressively. A sizable proportion of children and adolescents with ASD are not aggressive (Kanne & Mazurek, 2011). The specific pattern of mentalizing deficits characterized by frequent prediction of hostile emotions and intentions (e.g. hostile attribution bias; Dodge et al., 1990; Molano, Jones, Brown, & Aber, 2013; Pornari & Wood, 2010) may differentiate the adolescents who are aggressive. As a result, these adolescents need more time to consider why people are behaving or feeling contrary to their expectations in any given situation. By adolescence, they are able to perform tasks of cognitive theory of mind as well as their non-aggressive counterparts. However, they continue to exhibit impairments in affective theory of mind.

Finally, I found that aggressive behavior was associated with lower accuracy at differentiating injuries caused accidentally from those that were intentionally inflicted. As with other domains of social cognition, this pattern extends prior research linking aggression with a tendency to assume hostile intent in ambiguous situations (Dodge, Laird, Lochman, & Zelli, 2002). Evidence suggests that the tendency to attribute antagonism where there is none is modeled early on by aggressive adults in the environment. Parents of aggressive toddlers and children are more likely to have inappropriate developmental expectations for their children, leading to the belief that challenging behavior is vindictive when it is normative (e.g. an infant

"refusing" to stop crying or toddler not independently dressing himself) (Dix & Lochman, 1990). Parents who engage in these cognitive processes are at higher risk of harsh parenting and physically abusing their children (Larrance & Twentyman, 1983; Nix et al., 1999). It is perhaps unsurprising that children reared in this kind of environment go on to exhibit hostile attribution biases themselves. They also tend to generate a more limited array of prosocial responses to interpersonal challenges (Guerra & Slaby, 1989), probably because they have had fewer opportunities to observe a range of prosocial resolution strategies at home. When more effective responses are not easily accessed, these youth will respond aggressively.

Interestingly and in contrast with my predictions, I did not find that aggression was associated with similar distress levels when viewing unintentional and intentional injuries. Moral reasoning, our judgment of the acceptability of others actions, theoretically is cued by personal discomfort experienced when viewing injustice befalling another person. However, this distress may be processed outside of the observer's awareness. Indeed, prior neuroimaging studies have demonstrated that, although imperceptible to the adolescents, viewing unintentional injury in similar tasks of moral reasoning produces greater reactivity in brain regions that process emotion and interoception among aggressive than non-aggressive adolescents (Decety, Michalska, Akitsuki, & Lahey, 2009). Alternatively, a growing body of evidence suggests that adolescents with externalizing problems tend to display a blunted, rather than heightened, pattern of reactivity to distressing situations (Hastings, Zahn-Waxler, Robinson, Usher, & Bridges, 2000; Sterzer, Stadler, Krebs, Kleinschmidt, & Poustka, 2005). In particular, this pattern has differentiated the trauma-exposed adolescents who develop externalizing problems from those who develop internalizing problems (Heleniak, McLaughlin, Ormel, & Riese, 2016; McLaughlin, Sheridan, Alves, & Mendes, 2014). I hope to examine whether aggression is

associated with blunted or heightened activation in the amygdala and anterior insula when this data is processed. A pattern of attenuated neural reactivity during this task may explain why the association between aggression and lower accuracy during unintentional injury is no longer significant once internalizing symptoms are controlled.

Findings from this study suggest that the similar pattern of associations between both interpersonal violence exposure and aggression and a constellation of disruptions across three core dimensions of social cognition, emotion perception, mentalizing, and moral reasoning, represents a plausible mechanism underlying the cycle of violence. However, in overall multiple mediation models, I failed to find evidence that these three pathways significantly explain the indirect effects of interpersonal violence exposure on aggression. A central tenet of my model is that neural function in brain regions that support social cognition evolves atypically over time as a result of children's heightened threat sensitivity reinforced over repeated social interactions. Among adolescents exposed to violence more recently, not enough time may have passed for disrupted social cognition to emerge, diminishing the strength of the indirect effects models. Limited by the small neuroimaging sample, I was unable to investigate the role of timing of interpersonal violence exposure. A second possibility is that these domains of social cognition are far less critical in the cycle of violence than other proposed mechanisms including poor executive function (Mezzacappa, Kindlon, & Earls, 2001), emotion dysregulation (Teisl & Cicchetti, 2008), and genetic influences (Caspi et al., 2002). However, the individual pathways of the mediation models revealed a specific pattern of social cognitive disruptions shared among violence-exposed and aggressive adolescents, specifically slower processing speeds when tasked with identifying facial cues of negative emotions and predicting the feelings of characters across a variety of social situations, as well as impaired ability to identify when injuries are accidentally

caused. As the final sample was quite small, it is likely that I was simply underpowered to detect the indirect effects implicated by the individual pathways. It is also worth noting that while both constructs were associated with difficulties across these domains, the adolescents exposed to more violence were eventually able to overcome their uncertainty to perform just as accurately as those with less exposure to interpersonal violence in tasks of negative emotion perception and affective theory of mind. Findings from this study suggest that, in contrast, the more aggressive adolescents could not ultimately compensate for their difficulty in the same domains. A larger sample would grant us more power to examine whether the inability to compensate for uncertainty during negative emotion perception, affective theory of mind, and moral reasoning might distinguish the violence-exposed adolescents who are at risk for aggression across the lifespan.

This study had many notable strengths, including separating the effects of interpersonal violence exposure from variation contributed by neglect experiences and examination of behavioral indices of several domains of social cognition. However, study findings should be interpreted with caution given the following limitations. First, data for this study were collected cross-sectionally, precluding us from examining deficits in social cognition and changes in aggression over time. For this reason, I interpret the results of the indirect effects models with caution. An important goal for future research will be the replication of these findings in longitudinal studies. Second, adolescents may have been motivated to under-report their own aggressive behavior (e.g., Cantwell et al., 1997). This limitation was addressed by including parent report of aggression for adolescents aged 14-17, however I was unable to include parental assessments for the participants who were over 18. Finally, limited variability in the reactive aggression scale precluded us from examining the differential effects of violence exposure and

social cognition on proactive and reactive aggression. It will be important for future research to examine these differences in larger samples recruited for greater variation in reactive and proactive aggression, for example juvenile-justice involved youth.

Study findings suggest that preventive interventions incorporating treatments developed to target social skills deficits may be useful for preventing the development of aggressive behavior for the large number of violence-exposed youth in our country. Cognitive-behavioral therapy is the most well-established treatment for symptoms associated with trauma exposure in youth (Dorsey et al., 2017). This form of therapy focuses on teaching children how to recognize, think about, and regulate their own emotions. Findings from this study suggest that it may also be important that interventions incorporate skills for recognizing and thinking about *other* people's emotions. Healthy adults are superior at recognizing emotions in faces when taught to use a feature-based rather than holistic approach (Martin, Slessor, Allen, Phillips, & Darling, 2012). A similar skill could be taught to violence-exposed children to enhance emotion discrimination and perception. To ameliorate difficulties with mentalizing and moral reasoning, it may be useful to appropriate components from evidence-based social skills interventions for children and adolescents with social impairments associated with ADHD or ASD. The PEERS program, in particular, teaches adolescents how to predict other teens' emotional and behavioral responses and how to identify whether a peer has antagonistic intentions by incorporating relevant contextual information in social interactions (Laugeson, Frankel, Gantman, Dillon, & Mogil, 2012). Future research is needed to identify whether early introduction of skills to address these specific disruptions in social cognition may buffer violence-exposed children from later aggressive behavior.

The current study provides novel evidence for the roles of under-studied dimensions of social cognition in the cycle of violence – negative emotion perception, affective theory of mind, and moral reasoning. Both interpersonal violence-exposed and aggressive adolescents demonstrated slower processing of faces expressing negative emotions and slower identification of others' emotions across a variety of contexts, as well as difficulty discriminating unintentional from intentional behavior. This specific pattern of atypical social cognition likely represents adaptation to an environment characterized by danger, yet may underlie later aggressive behavior. Future longitudinal research in larger samples is needed to further disentangle the ways in which violence disrupts aspects of emotion perception, mentalizing, and experience-sharing in ways that increase risk of aggression.

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Table 1. Means and standard deviations of interpersonal violence exposure, covariate, social cognition, and aggression variables

Measure	Mean	(*SD*)
1. JVQ-R2 Highest Total	54.10	13.13
2. CECA Neglect	30.26	10.79
3. CBCL/YSR Internalizing	15.31	9.71
4. RME Neg Acc %	72.33	17.71
5. RME Neg RT	5111.24	1648.08
6. AL Neg Acc %	97.76	3.07
7. AL Neg RT	1627.99	307.21
8. TOM Aff Acc %	83.69	8.87
9. TOM Cog Acc %	85.19	12.22
10. TOM Aff RT	2396.78	364.69
11. TOM Cog RT	2589.00	360.98
12. MR INT>UNINT ACC %	21.80	15.81
13. MR INT>UNINT DIS	31.14	14.23
14. CBCL/YSR Aggression	7.66	4.59

Note. JVQ-R2 Highest Total = highest parent- or youth-reported total victimization score on the Juvenile Victimization Questionnaire – Revised Screener Sum Version; CECA Neglect = Childhood Experiences of Care and Abuse – Neglect subscale; CBCL/YSR Internalizing = highest internalizing broad band scale total score from the Child Behavior Checklist or the Youth Self Report; RME, and AL Neg Acc % = percentage accurate across negative emotional stimuli on the Reading the Mind in the Eyes and Affect labeling tasks, respectively; RME Neg RT and AL Neg RT = time (in ms) between presentation of negative emotion stimuli and response for the Reading the Mind in the Eyes and Affect Labeling tasks, respectively; TOM Aff Acc % and TOM Cog Acc % = percentage accuracy during the affective and cognitive components of the theory of mind task, respectively; TOM Aff RT and TOM Cog RT = time (in ms) between presentation of the appearance of the perspective taking question under each cartoon and the participant response to the affective and cognitive questions, respectively; MR INT>UNINT ACC % = accuracy during unintentional personal injury trials subtracted from mean accuracy during intentional personal injury trials of the moral reasoning task. MR INT>UNINT DIS = level of distress, out of 100, reported during unintentional personal injury trials subtracted from the mean level of distress during intentional personal injury trials of the moral reasoning task; CBCL/YSR Aggression = highest aggression subscale score from the Child Behavior Checklist or the Youth Self Report.

Table 2. Correlations of interpersonal violence exposure, covariate, social cognition, and aggression variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. JVQ-R2 Highest Total	—													
2. CECA Neglect	.32**	—												
3. CBCL/YSR Internalizing	.36**	.18	—											
4. RME Neg Acc %	-.17	-.15	-.05	—										
5. RME Neg RT	.24*	-.12	.02	.09	—									
6. AL Neg Acc %	0.06	-0.06	-0.04	0.00	0.05	—								
7. AL Neg RT	0.29*	-0.05	0.13	0.09	0.16	-0.18	—							
8. TOM Aff Acc %	-0.22	-0.10	-0.20	0.01	-0.04	0.30*	-0.40**	—						
9. TOM Cog Acc %	0.12	0.12	0.05	-0.09	0.11	0.11	-0.36**	0.21	—					
10. TOM Aff RT	0.27	-0.04	0.14	0.20	0.15	-0.15	0.67**	-0.58**	-0.24	—				
11. TOM Cog RT	0.09	-0.12	0.10	0.19	0.21	-0.07	0.61**	-0.32*	-0.19	0.67**	—			
12. MR INT>UNINT ACC %	0.17	0.02	0.34*	0.03	-0.25	-0.14	0.29*	-0.20	-0.12	0.28*	0.05	—		
13. MR INT>UNINT DIS	0.10	0.24	0.08	0.04	0.05	-0.05	-0.13	0.09	-0.06	-0.09	-0.08	-0.12	—	
14. CBCL/YSR Aggression	.44**	.04	.40**	-.08	.15	-0.34*	0.35*	-0.34*	-0.07	0.28*	0.31*	0.18	-0.04	—

Note. JVQ-R2 Highest Total = highest parent- or youth-reported total victimization score on the Juvenile Victimization Questionnaire – Revised Screener Sum Version; CECA Neglect = Childhood Experiences of Care and Abuse – Neglect subscale; CBCL/YSR Internalizing = highest internalizing broad band scale total score from the Child Behavior Checklist or the Youth Self Report; RME and AL Neg Acc % = percentage accurate

across negative emotional stimuli on the Reading the Mind in the Eyes and Affect labeling tasks, respectively; RME Neg RT and AL Neg RT = time (in ms) between presentation of negative emotion stimuli and response for the Reading the Mind in the Eyes and Affect Labeling tasks, respectively; TOM Aff Acc % and TOM Cog Acc % = percentage accuracy during the affective and cognitive components of the theory of mind task, respectively; TOM Aff RT and TOM Cog RT = time (in ms) between presentation of the appearance of the perspective taking question under each cartoon and the participant response to the affective and cognitive questions, respectively; MR INT>UNINT ACC % = accuracy during unintentional personal injury trials subtracted from mean accuracy during intentional personal injury trials of the moral reasoning task. MR INT>UNINT DIS = level of distress, out of 100, reported during unintentional personal injury trials subtracted from the mean level of distress during intentional personal injury trials of the moral reasoning task; CBCL/YSR Aggression = highest aggression subscale score from the Child Behavior Checklist or the Youth Self Report.

Table 3. Violence Exposure, Emotion Perception, and Aggression[a]

	Reading the Mind in the Eyes Negative Emotion		Affect Labeling Negative Emotion	
	Accuracy	Reaction Time	Accuracy	Reaction Time
1. Primary Model	*β*	*β*	*β*	*β*
Interpersonal Violence Exposure	-0.14	0.25*	0.14	0.29*
Aggression[b]	-0.10	0.14	-0.24[t]	0.30*
2. Secondary Model A: Controlling for internalizing symptoms				
Interpersonal Violence Exposure	-0.14	0.21	0.13	0.27[t]
Aggression[b]	0.05	0.15	-0.34*	0.36*

Note. Interpersonal Violence Exposure was measured as the highest parent- or youth-reported total victimization score on the Juvenile Victimization Questionnaire. Aggression was measured as the highest aggression subscale score from the Child Behavior Checklist or the Youth Self Report. RME, and AL Negative Emotion Perception Accuracy was calculated as the mean accuracy during all negative emotional stimuli on the Reading the Mind in the Eyes and Affect labeling tasks, respectively. RME and AL Negative Emotion Perception Reaction Time reflects the mean time, in milliseconds between presentation of negative emotion stimuli and response for the Reading the Mind in the Eyes and Affect Labeling tasks, respectively. Internalizing symptoms were calculated as the highest internalizing broad-band scale from the Child Behavior Checklist or the Youth Self Report.

[a]Multiple mediator models run separately for the RME and AL tasks, controlling for sex, age, and neglect

[b]Linear regressions controlling for sex and age

*p ≤ 0.05

**p ≤ 0.01

[t] ≤ 0.10

Table 4. Violence exposure, mentalizing, and aggression[a]

	TOM Affective		TOM Cognitive	
	Accuracy	Reaction Time	Accuracy	Reaction Time
1. Primary Model	β	β	β	β
Interpersonal Violence Exposure	-0.19	0.28*	0.12	0.10
Aggression[b]	-0.36*	0.34*	-0.05	0.30*
2. Secondary Model A: Controlling for internalizing symptoms				
Interpersonal Violence Exposure	-0.18	0.27 [t]	0.12	0.09
Aggression[b]	-0.38*	0.37*	-0.09	0.34*

Note. Interpersonal Violence Exposure was measured as the highest parent- or youth-reported total victimization score on the Juvenile Victimization Questionnaire. Aggression was measured as the highest aggression subscale score from the Child Behavior Checklist or the Youth Self Report. Affective and Cognitive TOM accuracy were calculated as the mean accuracy during the affective and cognitive components of the theory of mind task, respectively. Affective and Cognitive TOM reaction time reflects the mean time, in milliseconds, between presentation of the appearance of the perspective taking question under each cartoon and the participant response across all the affective and cognitive questions, respectively. Internalizing symptoms refers to the highest internalizing broad-band scale from the Child Behavior Checklist or the Youth Self Report.

[a]Multiple mediator models controlling for sex, age, and neglect

[b]Linear regressions controlling for sex and age

*$p \leq 0.05$

**$p \leq 0.01$

[t] ≤ 0.10

Table 5. Violence exposure, experience sharing, and aggression[a]

	Intentional > unintentional personal injury	
	Accuracy	Distress
1. Primary Model	β	β
Interpersonal Violence Exposure	0.24[t]	0.01
Aggression[b]	0.32*	-0.09
2. Secondary Model A: Controlling for internalizing symptoms		
Interpersonal Violence Exposure	0.20	-0.01
Aggression[b]	0.15	-0.10

Note. Interpersonal Violence Exposure was measured as the highest parent- or youth-reported total victimization score on the Juvenile Victimization Questionnaire. Aggression was measured as the highest aggression subscale score from the Child Behavior Checklist or the Youth Self Report. Intentional > unintentional personal injury accuracy was calculated as the mean accuracy during unintentional personal injury trials subtracted from mean accuracy during intentional personal injury trials of the moral reasoning task. Intentional > unintentional personal injury distress reflects the mean level of distress reported during unintentional personal injury trials subtracted from the mean level of distress during intentional personal injury trials of the moral reasoning task. Internalizing symptoms refers to the highest internalizing broad band scale from the Child Behavior Checklist or the Youth Self Report.

[a]Multiple mediator models controlling for sex, age, and neglect

[b]Linear regressions controlling for sex and age

*$p \leq 0.05$

**$p \leq 0.01$

[t] ≤ 0.10