Differentiating Between Us & Them: Reduced In-Group Bias as a Novel Mechanism Linking Childhood Violence Exposure with Internalizing Psychopathology

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Abstract

Strong in-group bonds, facilitated by implicit favoritism for in-group members (i.e., in-group bias), promote mental health across development. Yet, we know little about how the development of in-group bias is shaped by early-life experiences. Childhood violence exposure is known to alter social information processing biases. Violence exposure may also influence social categorization processes, including in-group biases, in ways that influence risk for psychopathology. We examined associations of childhood violence exposure with psychopathology and behavioral and neural indices of implicit and explicit bias for novel groups in children followed longitudinally across three time points from age 5 to 10 years old ($n = 101$ at baseline; $n = 58$ at wave 3). To instantiate in-group and out-group affiliations, youths underwent a minimal group assignment induction procedure, in which they were randomly assigned to one of two groups. Youth were told that members of their assigned group shared common interests (in-group) and members of the other group did not (out-group). In pre-registered analyses, violence exposure was associated with lower implicit in-group bias, which in turn was associated prospectively with higher internalizing symptoms and mediated the longitudinal association between violence exposure and internalizing symptoms. During an fMRI task examining neural responses while classifying in-group and out-group members, violence-exposed children did not exhibit the negative functional coupling between vmPFC and amygdala to in-group vs. out-group members that was observed in children without violence exposure. Reduced implicit in-group bias may represent a novel mechanism linking violence exposure with the development of internalizing symptoms.

Keywords Intergroup Dynamics · Social Information Processing · Developmental Psychopathology · Implicit Bias · Childhood Maltreatment · Violence Exposure

Introduction

Membership in social in-groups confers myriad benefits, including fostering a sense of belonging and opportunities to explore identity, sharing information and resources, and collaborating on shared goals, which together support well-being (Boyd et al., 2011; Skinner & Meltzoff, 2019; Tajfel & Turner, 1979; Tomasello et al., 2012). This capacity for forming strong in-group bonds stems from our ability to rapidly and accurately differentiate between those who are similar to us (i.e., "in-group") and different from us (i.e., "out-group") in important ways, a phenomenon known as social categorization. This social categorization mechanism facilitates feelings of closeness, security, and ultimately safety by equipping us with a culturally meaningful and reliable way to predict, explain, and evaluate the behavior of others based on our implicit understanding of intergroup expectations, norms, and dynamics (Allport, 1954; Meltzoff, 2007; Over, 2016; Swann et al., 2009; Tajfel & Turner, 1979; Tomasello et al., 2012; Wilson & Wilson, 2007). To date, however, little is known about how interpersonal experiences

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in childhood influence the development of social categorization processes and concomitant implicit bias -- the tendency to have more positive associations with one group, often a group one belongs to, over others. Moreover, few studies have examined whether individual differences in implicit bias are associated with changes in mental health over time.

In this study, we examine the hypotheses that experiences of violence in early life might shape social categorization processes and the emergence of in-group bias at both behavioral and neural levels, and that individual differences in these biases might influence mental health in children. We are unaware of prior studies examining how early-life experiences influence the social categorization processes that promote in-group bias. As such, we draw on existing evidence linking violence exposure to other forms of social information processing biases to make these predictions. We additionally review findings on the development of in-group bias in children along with recent findings from developmental-affective neuroscience that establish developmental patterns in the behavioral and neural bases of intergroup biases. The current study integrates these previously disparate literatures to evaluate how early-life experiences of violence might influence fundamental social categorization processes involved in distinguishing between "us" and "them," and the relevance that these processes have for the emergence of psychopathology in children.

Violence Exposure and Psychopathology

Childhood violence exposure is common, with as many as one-half of U.S. children experiencing some form of either direct victimization (e.g., experiencing abuse or assault) or witnessing violence (Finkelhor et al., 2009; Lewis et al., 2019; McLaughlin et al., 2013). Childhood violence exposure is a robust predictor of internalizing and externalizing psychopathology across development (Clark et al., 2010; Cohen et al., 2001; Fowler et al., 2009), accounting for a substantial proportion of mental disorder onsets in childhood as well as adolescence and adulthood (Green et al., 2010; McLaughlin et al., 2012). However, many questions remain about the mechanisms underlying this strong association.

Violence Exposure and Social Information Processing

Changes in social information processing constitute one mechanism linking violence exposure with psychopathology. Violence exposure has been associated consistently with social information processing biases that facilitate the rapid identification of potential threats. For example, children exposed to violence are able to identify anger and fear—but not other emotions—in facial expressions more rapidly, with

higher accuracy, and with less perceptual input than children who have not experienced violence (Hepp et al., 2021; Pollak & Sinha, 2002; Pollak et al., 2009), and this bias persists into adulthood (Gibb et al., 2009). Children who experience violence are also more likely to interpret neutral and ambiguous faces as angry compared with youth who have not experienced violence (Ardizzi et al., 2015; Pollak et al., 2000) and more likely to perceive ambiguous acts as intentional and malevolent (hostile attribution bias; Dodge et al., 1995, 2015).

Consistent with these social information processing biases, children exposed to violence exhibit elevated response in the amygdala and other nodes of the salience network (e.g., anterior insula, dorsal anterior cingulate cortex) to social cues that signify the presence of threat (Jenness et al., 2021; McCrory et al., 2013; McLaughlin et al., 2019). Together these behavioral and neural patterns facilitate defensive responses to threat that are likely adaptive in the short term by aiding the rapid identification of danger in contexts where threat of harm is high. At the same time, these tendencies may become maladaptive later on, especially in contexts that are safe. Indeed, these behavioral and neural patterns are associated with increased risk for many forms of psychopathology (Briggs-Gowan et al., 2016; Dodge et al., 1995; Dotterer et al., 2017; Swartz et al., 2015).

In-group Bias as a Mechanism Linking Violence Exposure and Psychopathology

Though violence exposure has clear influences on the development of mechanisms underlying threat and social information processing, it is unknown whether violence exposure may also impact other cognitive biases involved in social categorization, such as in-group biases, that inform perceptions of and responses to other people, and the establishment of group affiliations. Children's social categories and intergroup biases vary as a function of their social experiences (for reviews see Rhodes & Baron, 2019; Skinner & Meltzoff, 2019). Indeed, infants as young as 6 months old prefer to look at individuals who previously spoke their native language relative to a foreign language or their native language spoken with a foreign accent (Kinzler et al., 2007). Further, 10-month-old infants preferentially accept toys from, and children as young as 5 years old preferentially choose as friends individuals who speak their native language (Kinzler et al., 2007). These social preferences and behaviors are informed by an underlying assumption among children that perceived similar others are more likely to abide by accepted social norms than perceived dissimilar others (Liberman et al., 2018), expectations that are likely applied to implicitly understood in-groups and out-group as well. Indeed, children aged 3–9 years expect that members of the same group should not harm one another,

whereas harming members of other groups is deemed more acceptable (Rhodes & Chalik, 2013). Importantly for the present study, children as young as 5 years old are primed to rapidly form implicit and explicit biases for new in-groups relative to out-groups on the basis minimal information (e.g., minimal group induction) (Cvencek et al., 2016; Dunham et al., 2011; Master et al., 2017).

In addition to behavioral phenomena, recent work suggests that distinct neural patterns representing intergroup perceptual processes emerge across development. Guassi Moreira and colleagues (2017) assigned 8–16-year-olds to novel groups and found that youth demonstrate heightened amygdala, fusiform, and ventromedial prefrontal (vmPFC) activation to out-group compared with in-group member faces prior to adolescence. In contrast, they found heightened activation to in-group relative to out-group members in these regions in adolescence. Moreover, neural activation in these regions mediated the association of age with explicit preferences for in-group members. The authors interpret these findings to suggest stronger out-group vigilance among younger children and heightened in-group preference among adolescents. Several prior studies lend additional support for the interpretation of out-group vigilance among young children. Specifically, younger children exhibit better memory for socially threatening stimuli (Baltazar et al., 2012), generalize socially unacceptable and less moral behaviors to out-group members (Baron & Dunham, 2015; Liberman et al., 2018), and more readily support harm toward out-group members who threaten in-group norms (Rhodes & Chalik, 2013). Together, these streams of evidence suggest that greater out-group vigilance in young children may support an important threat-monitoring function.

Together, this evidence from the social and developmental psychology and developmental social-affective neuroscience literatures indicates that intergroup biases emerge early in development and inform social interactions and affiliations throughout development. Given that childhood violence exposure influences other social information processing biases, altering the threshold for perception of anger and attributions of hostile intent among children (Pollak & Sinha, 2002; Pollak et al., 2000; Rhodes & Chalik, 2013), it is possible that violence exposure may also relate to social categorization processes and implicit bias as well. Specifically, children who have been exposed to violence may exhibit stronger vigilance for out-groups, as threat is more readily attributed to out-group members, particularly in young children. If this were true, we might also expect children exposed to violence to exhibit neural responses associated with threat processing when viewing out-group relative to in-group faces, such as elevated amygdala responses. This heightened sensitivity to out-group members may in turn be associated with symptoms of internalizing or externalizing psychopathology.

The Present Study

We investigated these questions in a longitudinal study of children aged 5–6 years old who were followed across three time-points until age 8–10 years using a minimal group assignment paradigm. Random assignment to a novel group is sufficient to activate in-group favoritism towards that group among children and adults, highlighting in-group affiliation as a rapid, implicit process addressing basic needs for belonging and social wellbeing (Cvencek et al., 2016; Dunham et al., 2011; Otten & Wentura, 1999; Van Bavel et al., 2008). We focus on childhood, when out-group vigilance is high and the neural systems underlying social categorization processes are still maturing. Prior work demonstrates the feasibility of assessing behavioral and neural indices of intergroup bias in children of this age (Guassi Moreira et al., 2017). Our hypotheses, methods, and analytic plan were pre-registered on Open Science Framework prior to analyzing the data (https://osf.io/y3cgh).

Method

Participants

Children and a caregiver were recruited to participate in a longitudinal study examining associations of the home environment with cognitive and socioemotional development. Families were recruited via flyers posted in a diverse range of communities in the Seattle area, and via networks of preschools, daycares, and clinics. The race/ethnicity of the children closely matched the demographics of the Seattle area (67.3% White, 14.8% Black, 2.9% American Indian or Alaska Native, 12.8% Asian, 0.9% Native Hawaiian or Pacific Islander, 0.9% Other; 8.9% of the sample identified as Hispanic/Latinx ethnicity). The mean income-to-needs ratio of the sample was 4.65 (SD = 2.81). The Institutional Review Board of the University of Washington approved all procedures. Written informed consent was obtained from legal guardians and youths provided verbal assent for each wave of data collection. Caregivers and youths were compensated for study visits across all waves of data collection. Participants and their families were English-speaking and without developmental delays.

A total of 101 youths aged 60–75 months (M = 66.60 months/5.55 years, SD = 4.44 months, 50% female) and their caregivers completed the first wave of the study between February 2016 and September 2017 (Rosen et al., 2020). Two participants who scored 2 standard deviations below the mean on a test of verbal ability did not meet eligibility criteria and were not included in any analysis. The variables of interest measured during this first wave of data collection include violence exposure history, demographic

variables (i.e., sex and age), and family socioeconomic status.

All participants were contacted to participate in a follow-up approximately 18 months later (M_{age} = 84.12 months/7.01 years, SD = 5.52 months), and 76 of the 99 families (76.8%) participated. During this second wave, the minimal group assignment task and related implicit and explicit bias measures and fMRI task were completed; baseline psychopathology was also assessed. Finally, 58 of the 76 families that participated at the second wave (76.3%) completed a third follow-up in the Spring of 2020 (M_{age} = 106.44/8.87 years, SD = 7.08), during which symptoms of psychopathology were assessed. Participants lost to attrition from the first wave to the third and final wave (n = 41) did not differ from completers (n = 58) on race (χ^2 values = 0–1.57, ps = 0.45 – 1), sex (χ^2 = 0.30, p = 0.58), age (b = -0.45, z = -0.83, p = 0.41), violence exposure (χ^2 = 0.55, p = 0.46), or SES (b = -0.08, z = -0.82, p = 0.41). The Harvard University Institutional Review Board approved the procedures conducted for the third wave of data collection in the Spring of 2020. See Table 1 for details on variables collected.

Materials and Measures

Violence Exposure

During the first wave of data collection, caregivers completed three measures assessing their child's exposure to violence: The Violence Exposure Scale for Children – Revised (VEX-R) Parent Report, the caregiver version of the UCLA PTSD Reaction Index (PTSD-RI; Steinberg et al., 2004), and the Conflict Tactics Scale (CTS; Straus, 1979). Children were coded as violence-exposed if the caregiver endorsed the child's exposure to *any* item among the pre-registered index of items measured using the VEX-R (e.g., "how many times has a person beat up your child?"), CTS (e.g., witnessed "pushing, grabbing, or shoving of another family member"), and UCLA PTSD-RI scales (e.g., "being hit, punched, or kicked very hard at home"), including physical abuse, sexual abuse, community violence, and domestic violence. See Online Resource 2 and https://osf.io/y3cgh for a full list of items included, scoring details, and rationale for this operationalization.

Psychopathology

We measured symptoms of internalizing and externalizing psychopathology at the second and third waves of the study. At the second wave, caregivers reported on psychopathology symptoms using the Child Behavior Checklist (CBCL; Achenbach, 1991), one of the most widely used measures of youth emotional and behavioral problems which uses normative data to generate age- and sex-standardized estimates of symptom severity. The internalizing composite (α = 0.77) includes symptoms of anxiety, depression, and somatic complaints (e.g., "cries a lot", "is nervous or tense"). The externalizing composite (α = 0.85) includes rule-breaking, aggressive behaviors, and symptoms of inattention and hyperactivity (e.g., "breaks rules at home, school, elsewhere", "has trouble sitting still", "physically attacks people"). Symptoms are rated on a 3-point Likert scale (Not True, Somewhat True, Very True) and analyzed using proprietary Aseba software. The composite T-scores comprised our baseline measure of psychopathology.

We assessed internalizing (α = 0.74) and externalizing (α = 0.83) psychopathology again during the third wave of data collection using the 25-item Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997; Goodman et al., 2010). This much shorter, 25-item measure was used to reduce burden during the highly-stressful early phase of the COVID-19 pandemic. Symptoms are rated on a 3-point Likert scale (Not True, Somewhat True, Certainly True), and include items such as "often seems worried," "often fights with other children," and "often unhappy, depressed or tearful." The SDQ discriminates well between low- and high-risk samples of school-aged youth (AUC = 0.95), and the subscales of the SDQ exhibit moderate to strong positive correlations (0.59–0.87) with parallel CBCL subscales (Goodman & Scott, 1999).

Socioeconomic Status (SES)

Violence exposure is more common among families of a lower socioeconomic status (SES). As such, we controlled for SES, defined as the income-to-needs ratio, in all models examining violence exposure (see Online Resource 2 for details on how this variable is calculated). Values less than one indicate income below the poverty line.

Minimal Group Assignment

Before arriving to the lab, each child was randomized to a minimal group—the green or orange group—using an established minimal group assignment procedure for 5-year-olds (Master et al., 2017). Upon arriving to the testing space, each child encountered several items that were of their in-group color (green or orange): a chair for them to sit in, a tablecloth covering a small table, a poster board that matched the in-group color with photos of six children wearing t-shirts of the in-group color, and three folded t-shirts of the in-group color on the surface in front of the poster board. A second poster next to the child's in-group poster was of the out-group color and contained photos of six other children wearing t-shirts of the out-group color; there were three folded t-shirts of the out-group color in front of that poster. The child sat at the table facing the posters and t-shirts throughout the experiment.

Table 1 Descriptive Statistics & Intercorrelations

		Violence Exposed			No Exposure		
		N(%)	*M*	*SD*	*N*	*M*	*SD*
Baseline							
1.	Sex (Female)	48%	0.52	0.51	50%	0.5	0.51
2.	Age	46	7.03	0.46	30	6.97	0.47
3.	Income to Needs (SES)	46	3.91	2.73	30	5.79	2.58
4.	Violence Exposure	46	1	0	30	0	0
Wave 2							
5.	Group Color (Orange)	52%	0.52	0.51	47%	0.47	0.51
6.	IAT D-score	46	0.22	0.35	30	0.37	0.27
7.	Explicit Bias Proportion	46	3.61	1.11	30	3.07	1.01
8.	L Amygdala	32	0.14	0.85	24	0.05	0.93
9.	L Fusiform	32	-0.16	0.98	24	-0.19	1.15
10.	L vmPFC	27	0.29	0.85	24	-0.26	0.94
11.	R Amygdala	32	0.19	0.86	24	0.03	0.75
12.	R Fusiform	32	0.17	0.9	24	-0.10	0.77
13.	L Amygdala – L vmPFC Connectivity	27	0.10	0.39	24	-0.12	0.32
14.	Externalizing (CBCL)	45	51.78	8.84	30	47.13	8.74
15.	Internalizing (CBCL)	45	48.91	8.32	30	48.67	9.38
Wave 3							
16.	Externalizing (SDQ)	31	6.81	3.16	22	6.09	3.29
17.	Internalizing (SDQ)	31	4.81	3.60	22	3.2	2.86

Correlations

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
1.	-																
2.	0.05	-															
3.	-0.05	0.04	-														
4.	0.02	0.06	-0.33**	-													
5.	-0.03	-0.05	-0.21	0.05	-												
6.	-0.25*	0.00	0.03	-.23*	-0.17	-											
7.	0.06	0.03	-0.10	0.24*	-0.1	0.09	-										
8.	-0.05	0.19	-0.10	0.05	0.04	-0.19	-0.22	-									
9.	0.06	0.10	-0.10	0.02	0.01	0.04	-0.16	0.30*	-								
10.	-0.11	0.06	-0.20	0.30*	0.16	-0.08	-0.08	0.11	0.31*	-							
11.	-0.04	0.03	-0.02	0.10	-0.02	-0.09	-0.14	0.50**	0.43**	0.32*	-						
12.	-0.05	-0.16	-0.03	0.16	-0.06	-0.17	-0.18	0.31*	0.16	0.02	0.26	-					
13.	0.07	-0.12	-0.15	0.29*	-0.33*	-0.03	0.24	-0.17	-0.12	-0.14	-0.17	0.22	-				
14.	0.02	-0.12	-0.07	0.25*	0.12	-0.19	0.03	0.12	0.15	0.10	0.03	0.20	0.15	-			
15.	0.04	-0.02	0.00	0.01	-0.14	-0.06	0.04	0.08	-0.02	-0.07	-0.25	0.02	0.02	0.53**	-		
16.	0.28*	0.08	-0.09	0.11	-0.04	-0.25	-0.05	-0.03	0.05	0.00	0.07	0.13	0.19	0.38**	0.26	-	
17.	-0.08	-0.01	-0.07	0.23	-0.24	-0.23	0.11	0.01	-0.12	0.18	0.02	0.22	0.14	0.14	0.34*	0.36*	-

*$p < 0.05$; **$p < 0.01$

Each child took a colorblindness test to ensure they could distinguish between orange and green. All children tested had normal color vision. Next, the experimenter recorded the child's answers to three questions: "What's your favorite toy/animal/food to eat?" (Master et al., 2017). Children were then told that members of their in-group also like those things and therefore that means they are also in that group (e.g., "Kids in the green group also like Lego, bears, and pizza. That means you're also in the green group"). Then, the child's attention was directed toward the poster of the

other group, and they were told that the members of the other group did *not* like the same things that the child's in-group liked. All members of both groups in the photos were the same gender-presentation as the participant and the same age, though the group members on both teams were phenotypically diverse. Next, the child put on a t-shirt of their in-group color or held it in their lap if they did not want to wear it. The child then had their picture taken, printed, and added to their in-group's poster. Finally, the child was given a flag the color of their in-group to put on the table and told they would play games that all their group members had already played. Children first completed unrelated cognitive tasks, after which they completed an Implicit In-Group Bias task and an Explicit In-Group Bias task (counterbalanced across participants).

Implicit In-Group Bias

A child-friendly version of the Implicit Association Test (IAT) was used to assess children's implicit in-group bias. The IAT is a timed, computerized sorting task in which the participant is instructed to sort stimuli as quickly as possible using two response buttons. The fundamental principal of the IAT is that it is easier for a participant to sort stimuli that are paired based on some mental association than when they are not. Thus, the participant will respond faster to the task when it is easier. For example, most child participants would have *ice cream* mentally linked with *good*, and insects with *bad*, and would therefore sort stimuli into those category pairs rather quickly. Conversely participants would find it more difficult to sort stimuli into the pairs that are not mentally associated (i.e., *ice cream* with *bad* and *insects* with *good*) and would therefore respond more slowly. A greater difference in speeds between the two tasks suggests a stronger association between the items in the easier task.

We adapted the Child IAT which has been used to measure implicit attitudes in children of this age (Cvencek et al., 2011). Children respond to the stimuli by pressing one of two large buttons on an adapted keyboard, each with an arrow printed on it pointing to the left or the right. The four categories of items in this Child IAT were good, bad, *in-group*, and *out-group*. The *in-group* items were pictures of four children wearing the same color t-shirts as the child participant him/herself and out-group items were pictures of four children wearing the different color t-shirt. The child pictures in each group in the IAT were distinct from each other and from the children in the photos on the posters previously seen. The *good* and *bad* categories were each represented by four words (e.g., "happy," "mad") presented simultaneously as text and audio recording. For more details on the Child IAT procedure, please see Cvencek and colleagues (2011).

The Child IAT yields a test score (*D;* Greenwald et al., 2003). Positive *D scores* indicated stronger association of the in-group with *good*. Negative *D* scores indicated stronger association of the out-group with *good*. A *D* score of 0 indicated equal association of each group with *good*.

Explicit In-Group Bias

Children were shown a four-page binder in which each page had two photos: one of a child wearing the in-group-colored t-shirt, and one of a child wearing the out-group-colored t-shirt. Both photos on each page were of children presenting the same gender and age, and race/ethnicity varied across pages. The side on which the in-group and other-group children were presented also varied across pages and was counterbalanced across participants. The experimenter asked children to point to the person they liked more on each page and recorded the children's responses. Responses were coded as 1 when the in-group child was selected and 0 when the other-group child was selected. The explicit bias score was computed by summing the number of in-group to out-group selections across the four trials (i.e., scores ranging from 0, reflecting complete out-group preference to 4, reflecting complete in-group preference).

fMRI Task

Before participating in the fMRI task on Day 2, participants were given an explicit memory test to determine whether they remembered which group they were in. All participants remembered their group on Day 2. Participants changed into MRI safe scrubs and a t-shirt that matched the color of their group. Participants completed 2 runs of an in-group/out-group classification task in the scanner in which they viewed pictures of children wearing green or orange t-shirts. These pictures were the same as those they saw on the posters during the minimal group assignment induction and were counterbalanced such that all of the children appeared in each condition (green/in-group, orange/in-group, green/out-group, orange/out-group) for roughly ¼ of participants.

A green rectangle and orange rectangle appeared at the bottom of the screen. Participants pressed a button with the same hand corresponding to the side of the screen of the green rectangle, and a button with the other hand for the side corresponding to the orange rectangle. The side of the green and orange rectangles and whether these corresponded to each child's in-group or out-group was counterbalanced across participants. Pictures of children were presented for 2 s followed by an inter-trial interval (ITI) of 2, 3 or 4 s. Participants saw a total of 6 in-group and 6 out-group faces and saw each face a total of 3 times per run for a total of 36 in-group and 36 out-group trials across the two runs. Five

participants were excluded from MRI analyses due to below chance performance on both runs of the group classification task; 10 participants had one run excluded for below chance performance.

Imaging Procedures & Data Processing

See Online Resource 2 for details on mock scanning and fMRI acquisition and data pre-processing.

fMRI Analysis

FMRI data analysis was performed using FSL FEAT version 6.0.0. Regressors were created by convolving a boxcar function of phase duration with the standard double-gamma hemodynamic response function for each condition of the task (in-group members, out-group members). A general linear model was constructed for each participant. Higher level analysis was carried out using FLAME1. We extracted estimates for the contrast of in-group > out-group in five pre-registered regions of interest (ROIs) defined independently of neural contrasts of interest based on prior work on neural correlates of intergroup bias in children following a similar minimal group induction (Guassi-Moreira et al., 2017): right and left amygdala, left ventromedial prefrontal cortex (vmPFC), and right and left fusiform. We defined the amygdala anatomically using the Harvard–Oxford Subcortical Atlas in FSL (20% threshold). We defined the vmPFC and the fusiform gyrus by creating a 5 mm sphere around coordinates identified in prior developmental work in a similar age group (Guassi Moreira et al., 2017).

Finally, to aid the interpretation of pre-registered findings, we performed a post-hoc exploratory (non-preregistered) task-related functional connectivity analysis to examine connectivity between the left amygdala and left vmPFC. To do so, we implemented a beta series correlation analysis, which is recommended for event-related designs (Rissman et al., 2004). Specifically, because of the relatively short, 2–4 s inter-trial intervals in our task, we implemented a least squares-separate (LSS) regression. In this analysis, we implement a separate general linear model (GLM) for every event (i.e.., a separate GLM for each trial presentation of an in-group or out-group face) with two regressors – one for the event of interest, and another for every other event (Mumford et al., 2012). We conducted this analysis using the left amygdala as a seed region and extracted estimates of functional connectivity with the left vmPFC ROI used in our other analyses. Connectivity estimates between these seeds were computed for each participant for in-group > out-group faces and extracted for analysis.

Analysis Plan

All analyses controlled for age and sex, longitudinal models predicting psychopathology at wave three controlled for psychopathology at wave two, and models examining neural responses and functional connectivity during the group classification task controlled for randomly assigned group (i.e., orange or green). Models examining violence exposure as a predictor additionally controlled for SES, which correlates strongly with violence exposure. Unless otherwise specified below, models utilize linear regression for estimation. We report p-values FDR-corrected for multiple comparisons throughout.

Main Effects

We first examined the association of violence exposure with behavioral implicit and explicit in-group bias ($n = 76$). For models in which explicit bias was the outcome, we used negative binomial regression given a skewed distribution and report unstandardized betas accordingly. Second, we examined the association of violence exposure with activation in pre-specified ROIs during the group classification task for the contrast of in-group > out-group faces ($n = 56$), and amygdala-vmPFC functional connectivity during this contrast ($n = 51$).

Mediations

Next, we conducted a series of mediation analyses. Having already tested the association of violence with neural (a path) and behavioral (c path) indices of implicit bias, we examined the b path for the first mediation model: whether activation in each of the specified ROIs ($n = 56$) or amygdala-vmPFC connectivity ($n = 51$) were associated with behavioral implicit and explicit bias. After testing each of these paths, we used the mediation package in R (Tingley et al., 2014) to estimate the significance of indirect effects using a bootstrapping approach (10,000 iterations) that provides confidence intervals for indirect effects.

Finally, we examined whether behavioral and neural measures of in-group bias mediated the association of childhood violence exposure with longitudinal psychopathology. Having already tested the association of violence with neural and behavioral indices of implicit and explicit bias (a paths), we examined the associations of violence with longitudinal internalizing and externalizing symptoms ($n = 53$; c path), and the associations of implicit and explicit bias with internalizing and externalizing symptoms ($n = 53$; b path). For models in which longitudinal internalizing symptoms was
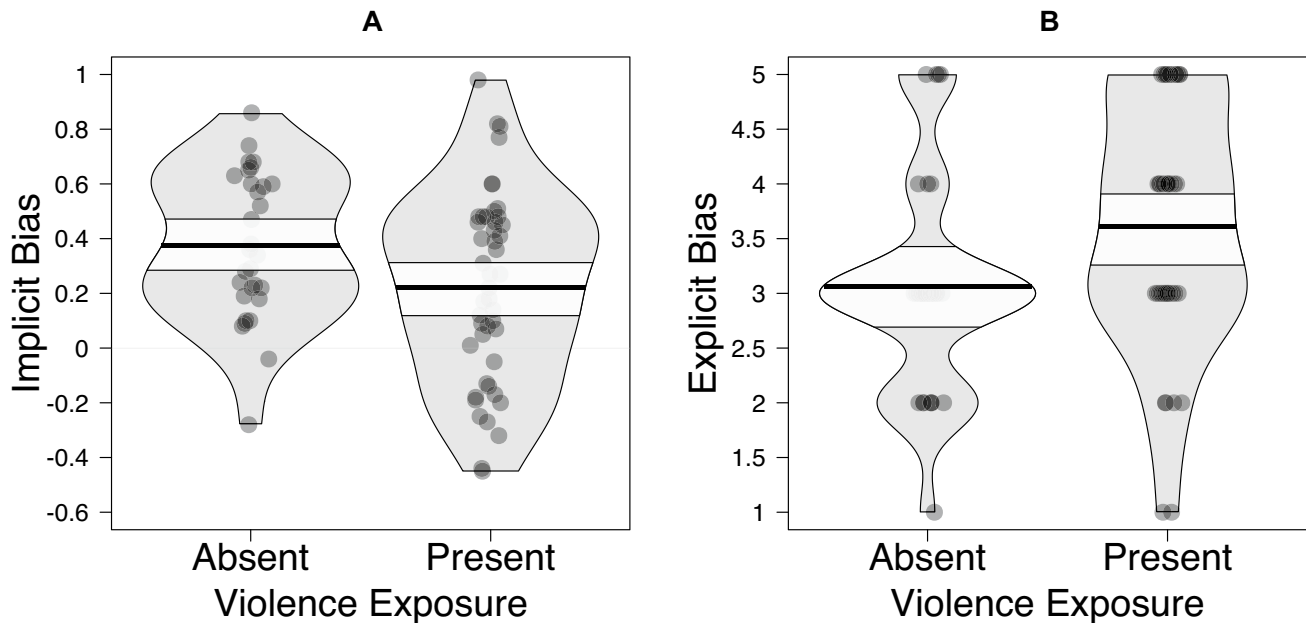
Fig. 1 Association of violence exposure with implicit bias D-score (**A**) and explicit bias score (**B**). In plot A, values above and below 0 on the y-axis reflect in-group and out-group favoritism respectively. In plot B, values above and below 3 on the y-axis reflect in-group liking and out-group liking respectively. Each point in the shaded region represents a single observation. The shaded grey area and the curve along the outer edges represent a smoothed density curve showing the full distribution of the data. The black line in the middle of the shaded region is the mean and the white band above and below the black line signifies the 95% confidence interval

the dependent variable, we used zero-inflated negative binomial regression given a zero-inflated, right-skewed count distribution. For models in which longitudinal externalizing symptoms and explicit bias were the dependent variables, we used negative binomial regression. For analyses utilizing negative binomial regression we report unstandardized betas accordingly. After testing each of these paths, we again estimated indirect effects using the protocol previously described.

We estimated indirect effects for all models, regardless of whether the direct path (i.e., c path) was significant, consistent with recommendations in modern approaches to mediation analysis (Hayes, 2009; MacKinnon et al., 2006; Rucker et al., 2011; Shrout & Bolger, 2002). Although our original pre-registered hypothesis focused on externalizing symptoms, we also examined internalizing symptoms given that associations of violence exposure with intergroup bias were in the opposite direction as predicted, as detailed in Results.

Results

Descriptive Statistics

Means, standard deviations, and intercorrelations for all variables are presented in Table 1. Children exhibited strong implicit bias, D-score $= 0.28$, $t(75) = 7.53$, $p < 0.001$, 95% CI $= [0.21, 0.36]$; Cohen's $d = 0.87$, and moderate explicit bias, $M = 3.39$, $t(75) = 3.14$, $p = 0.002$, 95% CI $= [3.14, 3.65]$; Cohen's $d = 0.36$, favoring their in-group following minimal group assignment.

### Violence Exposure and Implicit and Explicit Bias

Childhood violence exposure was associated with implicit bias for one's randomly assigned group (Fig. 1), but in the opposite direction of our pre-registered hypothesis. Specifically, violence-exposed children exhibited reduced relative implicit favoritism for their in-group compared with children who had not experienced violence ($\beta = -0.25$, $p = 0.04$, 95% CI $= [-0.32, -0.01]$), although both were positive. Violence exposure was not significantly related to explicit bias ($b = 0.16$, $p = 0.26$, 95% CI $= [-0.11, 0.43]$).

Violence Exposure and Neural Response to In-Group > Out-Group

In the whole sample, activation did not differ significantly when classifying in-group relative to out-group faces in any of the five ROIs (See Online Resource 3).

Childhood violence exposure was not significantly related to activation in any of the five ROIs (See Online Resource 3).

Fig. 2 Association of violence exposure with functional connectivity between the left amygdala and left vmPFC when categorizing in-group compared with out-group faces. Values above and below 0 on the y-axis reflect positive and negative correlations respectively between activation in these two regions. Each point in the shaded region represents a single observation. The shaded grey area and the curve along the outer edges represent a smoothed density curve showing the full distribution of the data. The black line in the middle of the shaded region is the mean and the white band above and below the black line signifies the 95% confidence interval
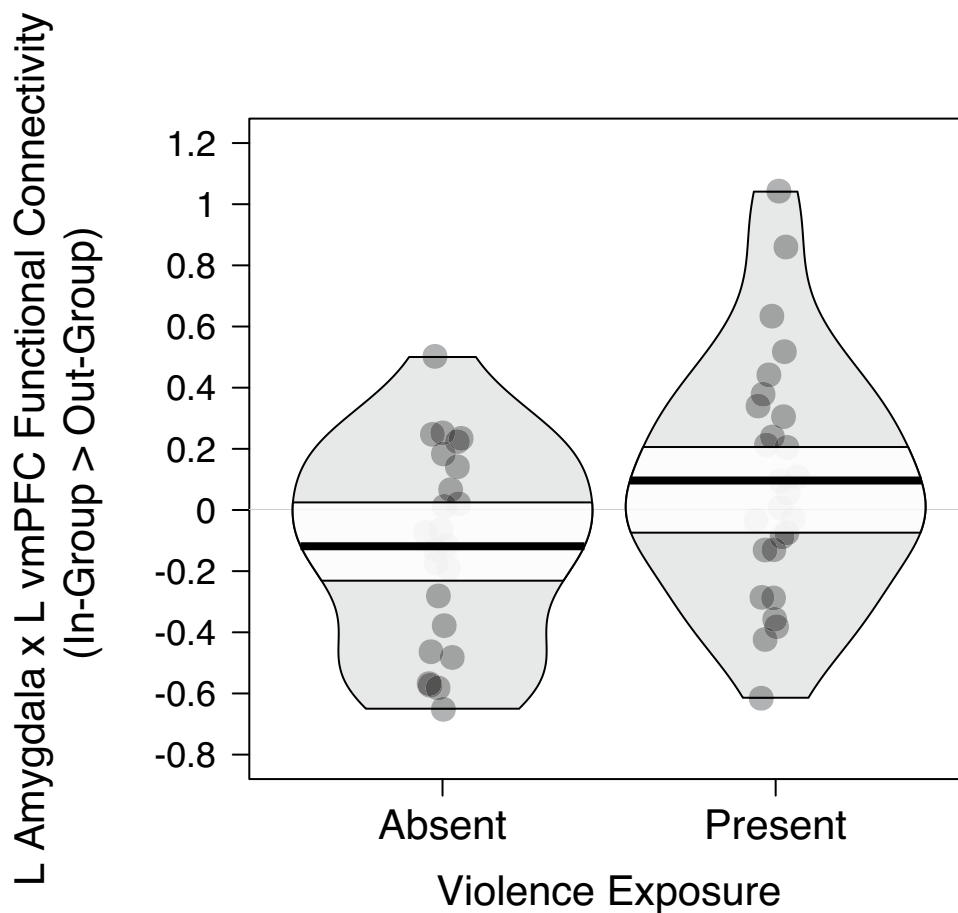
Violence Exposure and Amygdala-vmPFC Functional Connectivity

We observed differences in connectivity of left amygdala and left vmPFC when classifying in-group relative to out-group faces as a function of childhood violence exposure, ß=0.28, p=0.047, 95% CI=[0.003, 2.47] (Fig. 2). Specifically, activation in the left amygdala and left vmPFC were negatively correlated in children who had not experienced violence, such that increased vmPFC activation was associated with decreased activation in the left amygdala. In contrast, violence exposed youth exhibited no significant connectivity between the left amygdala and left vmPFC when classifying in-group relative to out-group members.

Neural Response to In-Group > Out-Group Faces and Implicit and Explicit Bias

ROI activation when classifying in-group relative to out-group member faces was not associated with implicit or explicit bias among any of the five ROIs examined after FDR-correction (See Online Resource 4). Amygdala-vmPFC functional connectivity was also not associated with implicit or explicit bias (See Online Resource 4). There were no

indirect effects of neural activation to in-group compared with out-group faces in the ROIs examined, nor functional connectivity between the left amygdala and left vmPFC, on the associations of violence exposure with implicit and explicit biases (See Online Resource 5).

Violence Exposure and Psychopathology

Violence exposure was associated with increased baseline externalizing symptoms (ß=0.27, p=0.03, 95% CI=[0.48, 9.33]) but not internalizing symptoms at baseline (ß=0.02, p=0.89, 95% CI=[-4.15, 4.75]). Violence exposure did not predict changes in externalizing symptoms (b=0.03, p=0.85, 95% CI=[-0.24, 0.30]), but was associated with changes in internalizing symptoms at the follow-up, controlling for baseline symptoms (b=0.53, p=0.02, 95% CI=[0.08, 0.97]).

Implicit & Explicit Bias and Psychopathology

Higher relative implicit favoritism for one's in-group was associated with lower prospective internalizing symptoms, controlling for baseline symptoms (b=-0.74, p=0.02, 95% CI=[-1.35, -0.14]), but was unrelated to
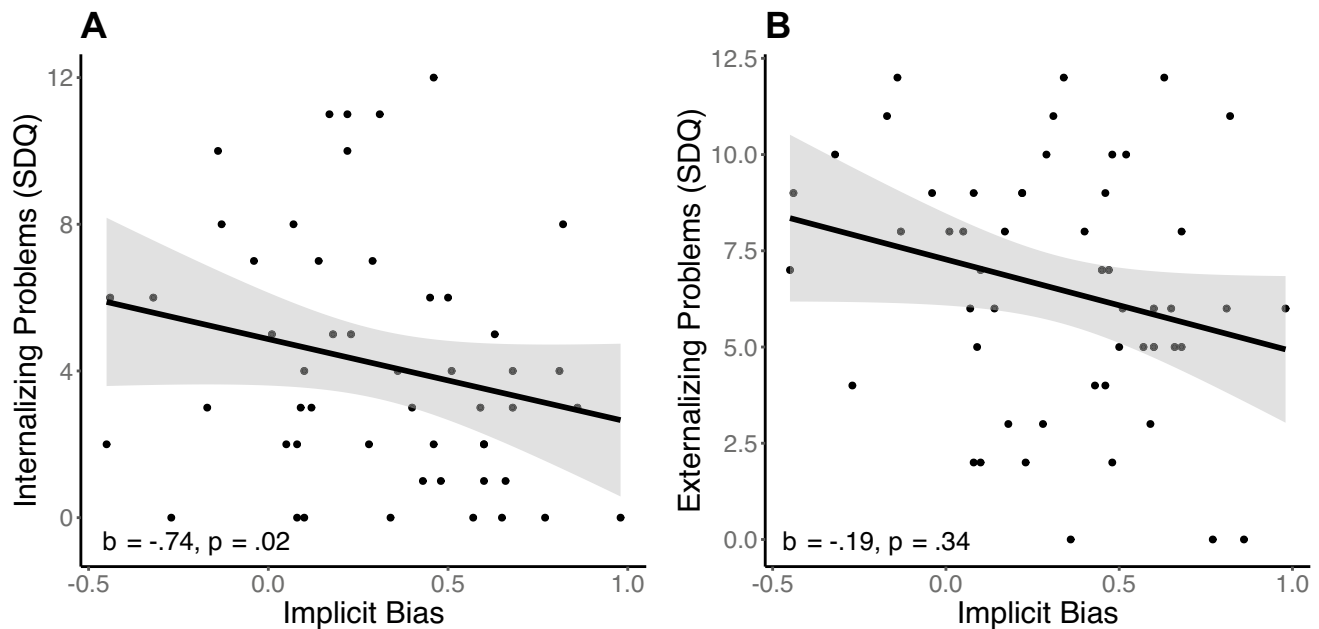
Fig. 3 Association of implicit bias D-score with prospective internalizing (**A**) and externalizing (**B**) symptoms controlling for baseline symptoms. Values above and below 0 on the x-axis represent in-group and out-group favoritism respectively. Each point represents a single observation from the raw data. The solid black line is the line fitted to the data using regression. The grey shaded region encompassing the fitted line signifies the 95% confidence interval

prospective externalizing symptoms ($b = $ -0.19, $p = 0.34$, 95% CI = [-0.57, 0.20]) (Fig. 3). Explicit bias was unrelated to prospective internalizing ($b = 0.03$, $p = 0.74$, 95% CI = [-0.15, 0.20]) or externalizing symptoms ($b = $ -0.05, $p = 0.35$, 95% CI = [-0.16, 0.06]).

Violence Exposure, Implicit Bias, and Psychopathology

Our original pre-registered hypothesis about violence exposure, implicit bias, and externalizing psychopathology was unsupported, and no indirect effect of violence exposure on externalizing symptoms was observed through implicit bias ($b = $ -0.07, 95% CI [-1.11, 0.78]). However, the longitudinal association between violence exposure and internalizing symptoms, controlling for baseline symptoms, was mediated by implicit bias ($b = 0.59$, 95% CI = [0.06, 1.82]).

Discussion

Here we found that childhood violence exposure was associated with reduced implicit in-group favoritism. Specifically, children exposed to violence exhibited lower relative in-group preference than children who have never experienced violence. Children exposed to violence also did not

exhibit the pattern of negative functional coupling between the left vmPFC and left amygdala when classifying in-group compared to out-group members that was observed in children who had never experienced violence. Finally, lower implicit in-group bias was associated with higher internalizing, but not externalizing symptoms, over time, and mediated the association between childhood violence exposure and prospective internalizing symptoms. Together, these findings provide preliminary support for aspects of implicit in-group processing as a novel mechanism linking early violence exposure with the emergence of internalizing psychopathology.

Violence Exposure and Behavioral In-group Bias

Minimal group assignment resulted in increased implicit and explicit in-group favoritism, such that children were more likely to implicitly associate their randomly-assigned group with positive valance relative to the other group and displayed more explicit liking for their in-group. These findings are consistent with prior work (Cvencek et al., 2016; Dunham et al., 2011; Master et al., 2017), suggesting that the minimal group induction was successful.

Childhood violence exposure was associated with reduced implicit in-group favoritism but was not related to explicit in-group liking. The direction of this finding was opposite

our pre-registered hypotheses, such that children exposed to violence exhibited reduced, not enhanced, favoritism for in-group members relative to out-group members. We initially predicted that violence-exposed youth would exhibit greater in-group favoritism due to heightened vigilance about out-group members, who may embody a representation of threat among youth previously exposed to violence. The reduction in implicit in-group favoritism we observed indicates that implicit positive attitudes were more similar for in-group and out-group members among children exposed to violence, most likely reflecting lower implicit positive attitudes about in-group members. Studies of aversive learning demonstrate similar results such that childhood violence exposure is associated with reduced discrimination between threat and safety cues, which may be analogous to out-group and in-group members respectively (McLaughlin et al., 2016). One interpretation is that violence-exposed youth had a difficult time learning which children were members of each group. If that were true, we would expect to see the same reduced discrimination in explicit preferences, which we did not. On the other hand, early experiences of violence may increase the threshold of information required to determine that someone is an in-group member (i.e., safe or trustworthy) relative to an out-group member (i.e., unsafe or untrustworthy). This lack of discrimination between in- and out-group members could give rise to heightened hypervigilance when interacting with new people. This is consistent with evidence that children exposed to violence perceive anger in faces with less perceptual information (Pollak & Sinha, 2002; Pollak et al., 2009), are more likely to interpret neutral expressions as angry (Pollak et al., 2000), and are more likely to attribute hostility to ambiguous actions among people they do not know well (Dodge et al., 1995, 2015) compared with non-exposed youth. Though this hypervigilance may be adaptive in certain contexts, prior work has also shown that worries about danger and threat of harm following experiences of violence are an important mechanism linking interpersonal violence with risk for psychopathology and future revictimization (Jaffe et al., 2019).

The context in which violence has been experienced may play a role in this association. For example, among the young children in our sample, most experiences of violence involved violence between caregivers or violence directed at the child from a caregiver or family member. When the perpetrator of violence is a member of one's in-group (i.e., family), the normative preference for in-group compared with out-group members may be complicated or reduced. Children who have experienced violence within their families may exhibit less trust of in-group members and thus less favoritism for in-group relative to out-group members. We would expect this pattern to be different for victims of violence from out-group members, although future research is needed to evaluate this hypothesis directly.

Violence Exposure, Amygdala-vmPFC Functional Connectivity, and Intergroup Bias

Violence-exposed youth did not exhibit the typical pattern of negative functional connectivity between the left vmPFC and amygdala that non-exposed youth demonstrate. The vmPFC subserves several key functions supporting emotion processing, including subjective affective valuation of thoughts and memories that inform decision-making (Cikara & Van Bavel, 2014; Dixon et al., 2017; Rudebeck & Murray, 2014; Wallis, 2007); higher-order appraisals based on simulated outcomes that supplement sensory encoding and valuations (Dixon et al., 2017); and facilitation of dynamic valuations of external stimuli (Dixon et al., 2017). Our finding that violence-exposed youth did not exhibit the typical pattern of negative functional connectivity between the left vmPFC and amygdala suggests that appraisals of in-group member faces generated in vmPFC did not down-regulate amygdala responses to in-group faces to the same degree as for children who have not experienced violence. This may also reflect meaningful differences in the appraisals generated about in-group members among children exposed to violence, who may be less likely to attribute trustworthiness to in-group members than children not exposed to violence. Indeed, this may partially explain why violence exposed youth in our study exhibited lower in-group favoritism than non-exposed youth. Importantly, the literature reporting normative developmental trends in this circuit is decidedly mixed, with results varying widely as a function of differences in measurement and analytic approaches (Bloom et al., 2022). As such, future work is needed to determine both the stability of this pattern and associations with social categorization processes.

Violence Exposure, In-group Bias, and Psychopathology

Reduced implicit in-group favoritism was associated with increased internalizing symptoms at follow-up, controlling for baseline symptoms, and the association between violence exposure and prospective internalizing symptoms was mediated by implicit in-group bias. It may be that children who demonstrate more in-group favoritism on the basis of minimal information approach new in-group relationships with a greater degree of openness and trust, facilitating greater social connection and closeness with others; conversely, youth who exhibit reduced implicit in-group favoritism may approach these new relationships with relatively less trust, which may lead to difficulty establishing connections with peers, resulting in feelings of loneliness or anxiety. Indeed, some evidence suggests that children use in- and out-group categorizations to inform expectations of who will adhere to or violate moral norms and expect out-group members

to be more likely to violate these norms (Liberman et al., 2018). As such, more similar valuations of in- and out-group members may reflect greater ambiguity regarding trustworthiness, which may partially explain the association of this pattern with increased internalizing symptoms and the mediation of the link between violence exposure and later internalizing psychopathology. It is also important to highlight that the interpersonal nature of violence may contribute to increased risk for developing internalizing problems rather than externalizing problems. Specifically, as the violence reported in the present sample was primarily intrafamilial, likely characterized by higher levels of hostility and lower levels of warmth, the participants' attachment to family members may have been influenced in ways that are known to prospectively increase risk for developing depression and anxiety specifically, as opposed to other kinds of psychopathology such as externalizing problems (see Epkins & Heckler, 2011 for a review). Future work is needed to examine this possibility. Given the temporal separation between assessment of the three variables in the mediation model, this finding lends preliminary support for in-group favoritism as a social information processing mechanism explaining variability in internalizing psychopathology outcomes following violence exposure in childhood.

Limitations

Strengths of the present study, including a three wave longitudinal design and examination of both behavioral and neural indices of in-group bias, should be considered alongside several limitations. We did not see differences in neural activation when classifying in-group versus out-group members in the whole group after FDR-correction, in contrast to prior research (Guassi Moreira et al., 2017). There are several explanations for this discrepancy. For one, prior work focused on children and adolescents aged 8–16 years old, whereas our imaging sample was comprised of 7–8-year-olds, representing a narrower and younger developmental window. In addition, the sample used for our imaging analyses was smaller than expected after exclusion for signal dropout, which is common in the vmPFC, and poor task performance, owing to the younger age of our sample. As such, it is difficult to conclude whether these null results reflect the absence of an effect or a lack of statistical power to detect a small effect. Additionally, whereas participants in our study were asked to categorize individuals into groups based on the color of their shirt, prior work involved making an evaluative rating (i.e., like or dislike) of in-group and out-group members, representing a functionally different task.

Use of a dichotomous violence exposure variable is another important limitation. As highlighted previously, there may be specific features of experiences of violence

(e.g., the child's relationship to the perpetrator) that differentially influence inter-group categorization and preferences. In addition, greater attention to recruitment of participants who have experienced different forms of violence (e.g., interpersonal abuse vs. witnessing community violence vs. experiencing peer violence) would facilitate interesting explorations of how outcomes presented herein may differ following experiences with different types of violence. Future studies should include more detailed assessments of violence exposure to be able to examine these potential sources of variability. In addition, we used peers as the stimuli for the minimal group assignment, consistent with prior literature (Cvencek et al., 2016; Dunham et al., 2011; Guassi Moreira et al., 2017; Master et al., 2017). Given that most of the violence experienced in the present sample was perpetrated by adults, it is possible that the implicit bias patterns for same-aged peers exhibited in the present study would manifest differently if the target stimuli were adults. New tasks would need to be developed to test that possibility.

It is also important to highlight that we used a different measure of psychopathology at baseline (CBCL) than during the follow-up mental health assessment (SDQ). While it would have been ideal to have the same measure at all time points, the CBCL is much longer than the SDQ and we were focused on minimizing participant burden during a period of time when families were facing numerous stressors and loss of access to typical childcare options due to the COVID-19 pandemic. Thus, we chose to use a shorter questionnaire that is strongly correlated with the CBCL (Goodman & Scott, 1999). Finally, some of our analyses were exploratory and not pre-registered and were incorporated into the paper to facilitate interpretation of unexpected findings. Given this and the relatively small sample size of our neuroimaging sample, replicating these patterns is an important goal for future research. Still, it is important to highlight that pre-registration is meant to provide a means for researchers to increase the transparency of the scientific process and replicability of results. That said, it is not always possible to fully anticipate what kinds of follow-up analyses may be warranted to provide a thorough interpretation of observed results. In our case, additional unexpected analyses were needed to clarify a pattern of results in the opposite direction of what we expected.

Conclusion

Childhood exposure to violence is pervasive and can negatively influence social information processing. For example, youths who are exposed to violence experience hostile attribution bias and preferential bias for detecting angry faces (Dodge et al., 2015; Pollak & Sinha, 2002; Pollak et al., 2000, 2009), which are in turn linked with increases in a wide range of psychopathology symptoms (Briggs-Gowan

et al., 2016; Dotterer et al., 2017; Swartz et al., 2015). We extend this prior work by demonstrating preliminary evidence that early-life violence exposure is associated with reduced implicit in-group bias, an important aspect of social categorization. Children exposed to violence also did not exhibit the typical pattern of negative functional connectivity between the left vmPFC and left amygdala when classifying in-group relative to out-group members. Reduced implicit in-group bias was associated prospectively with internalizing symptoms and mediated the longitudinal association between violence exposure and internalizing symptoms. This pattern may reflect that youth who experience violence have greater difficulty liking, trusting, and experiencing positivity towards in-group members. This may negatively influence mental health due to a lack of social closeness and in-group affiliation.

Compliance with Ethical Standards

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