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The development of forms and functions of aggression during early childhood: A temperament-based approach

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Abstract

This study used a short-term longitudinal design with theoretically derived preregistered hypotheses and analyses to examine the role of temperament in the development of forms (i.e., physical and relational) and functions (i.e., proactive and reactive) of aggressive behavior in early childhood ($N = 300$, M age = 44.70 months, $SD = 4.38$, 44% girls). Temperament was measured via behavioral reports of emotional dysregulation, fearlessness/daring, and rule internalization/empathy and, in a subsample that completed a physiological assessment, via skin conductance and respiratory sinus arrhythmia. Emotion dysregulation generally served as a risk factor for all subtypes of aggression, with evidence of stronger associations with reactive as compared to proactive functions of relational aggression for girls. Daring predicted increases in physical aggression, especially among boys, and rule internalization predicted decreases in relational aggression, especially among girls. Rule internalization mediated longitudinal associations between daring and proactive relational aggression for girls. Some evidence also emerged supporting associations between adaptive functioning (i.e., high empathy, high respiratory sinus arrhythmia) and proactive functions of aggression. Findings highlight distinct temperamental risk factors for physical versus relational aggression and provide partial support for gender-linked theories of the development of aggression.

Keywords: aggression; development; early childhood; gender; temperament

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The development of forms and functions of aggression during early childhood

Aggression is a major risk factor for psychopathology and a symptom of several disorders among children and adolescents (Eisner & Malti, 2015); however, the developmental pathways underlying this behavior are not fully understood (NICHD ECCRN, 2004; Ostrov et al., 2018). As temperamental differences emerge early in life, temperamental characteristics may provide significant insights regarding the development of aggression and antisocial behavior early in development. Thus, the first goal of the present study was to investigate temperamental pathways to aggressive behavior during early childhood, including potential mechanisms that link early temperament with the development of aggression. In addition, given increasing attention to the heterogeneity in aggressive youth over the last decade (Ettekal & Ladd, 2017; Evans et al., 2020; Mann et al., 2018), the second goal was to investigate associations between early temperamental characteristics and distinct subtypes of aggression. Finally, given theory that highlights gender differences in the manifestation of aggression (e.g., Ostrov & Godleski, 2010), we tested gender differences in these processes.

Temperament and developmental pathways to aggressive behavior

Individual differences in temperament have been hypothesized to be a particularly salient risk factor for aggression during early childhood (Lahey & Waldman, 2003; Moore et al., 2018). Three related clusters of temperamental traits have emerged in multiple conceptualizations of temperamental risk for aggression, including the prominent models proposed by Frick and colleagues (e.g., Frick & Morris, 2004) and Lahey and colleagues (e.g., Lahey & Waldman, 2003). First, a tendency to exhibit dysregulated and negative emotional reactions is hypothesized to promote aggressive responding across both models (Frick & Morris, 2004; Frick & Viding, 2009; Lahey & Waldman, 2003; Lahey et al., 2008). This tendency may include high negative emotionality (e.g., the tendency to blow things out of proportion and to exhibit intense, negative reactions) and problems with regulating the display of negative emotions (Izard et al., 2006), which has been shown to predict aggressive behavior in young children (e.g., Nwadinobi & Gagne, 2020; Peterson et al., 2018). In fact, by the end of early childhood, angry reactions become less normative in common peer interactions and consistent negative emotionality coupled with impulsive tendencies may increase the risk of engaging in aggressive behavior when youth are provoked or perceive that they have been harmed by others (Izard et al., 2006).

Second, researchers have hypothesized that temperamental fearlessness and daring promote aggressive behavior

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(e.g., Frick & Morris, 2004). For instance, Lahey and Waldman (2003) argue that children who are "daring," including traits such as adventurousness, sensation-seeking, and low harm-avoidance, may be particularly likely to exhibit aggression, perhaps because they are relatively unconcerned with possible negative consequences (e.g., retaliation) for their behavior and find aggressive behaviors exciting (Lahey et al., 2008). Consistent with these suggestions, researchers have demonstrated that low levels of fear and high levels of daring predict problem behaviors including aggression (e.g., Frick et al., 2003; Lahey et al., 2008; Peterson et al., 2018).

Third, several models have highlighted the role of impaired conscience development (Frick & Morris, 2004) and low prosociality, including a propensity to experience low levels of sympathy, guilt, or respect for rules (Lahey & Waldman, 2003; Lahey et al., 2008) in aggressive conduct. To this end, in their early childhood work, Kochanska and colleagues identified two major components of early conscience development, moral emotions (e.g., empathy) and internalization of parental and societal rules (e.g., Kochanska, 1993), which are associated with lower levels of aggressive behavior (Kochanska et al., 2008). Impaired conscience may be a risk factor for aggression as the typical restraints related to moral behavior, such as a commitment to parental and school-based rules and expectations and feeling bad for harming others, are absent. Temperamental models have successfully predicted trajectories of both physical and nonphysical forms of aggression in middle childhood (Aimé et al., 2018), underscoring the importance of temperamental pathways to aggression.

Physiological indices of temperament and aggressive behavior

In addition to behavioral indicators of temperament, Frick and Morris (2004) suggest that patterns of physiological responding emerge early in life, are often outside of children's voluntary control, and may serve as a foundation for trajectories towards aggressive behavior. Indeed, skin conductance (SCL, a measure of activity of the sweat glands that provides a relatively pure measure of SNS activation) may serve as a physiological indicator of fearlessness. In fact, according to fearlessness theory, underarousal of the sympathetic nervous system (SNS) serves as a risk factor for aggression because it lowers inhibitions against such conduct (Raine, 2002). Consistent with this perspective, low resting skin conductance is related to heightened antisocial behavior and aggression (Lorber, 2004). Further, SCL is related specifically to aggression in young children (Posthumus et al., 2009), and low baseline SCL in infancy predicts aggressive, but not nonaggressive, antisociality at age 3 in typically developing children (Baker et al., 2013).

In addition, parasympathetic nervous system (PNS) activity is hypothesized to serve as a physiological indicator of temperamental emotion dysregulation. PNS activation inhibits reactivity of stress systems; thus, low PNS arousal at rest is hypothesized to index poor emotion regulation (Beauchaine, 2015; Porges, 2007). Consistent with this interpretation, several studies that have mainly focused on adolescence have found that one commonly studied measure of PNS arousal, respiratory sinus arrhythmia (RSA; a measure of the ebbing and flowing of heart rate during the respiratory cycle reflecting PNS influences on the heart), is negatively associated with aggression and externalizing problems (e.g., Beauchaine et al., 2001), and meta-analytic findings indicate that RSA is negatively associated with measures of misconduct and externalizing problems (Kibler et al., 2004). Low RSA appears to serve as a risk factor for aggression in young children; in fact, in one study, children with low levels of RSA across 5–48 months exhibited heightened aggression at 48 months (Patriquin et al., 2015). Further, in one recent study, low RSA was associated with heightened externalizing in younger, but not older, children in a sample of 7–11-year-olds (Quiñones-Camacho & Davis, 2018), suggesting that low RSA may be most strongly related to aggression in young children.

Temperament and functions of aggression

Implications of behavioral and physiological indices of temperament for the development of aggression may depend in part on the function of aggression. Proactive functions of aggression include behaviors that are displayed to serve goal-directed, purposeful, or instrumental functions, such as using aggressive behaviors to gain access to a desired resource (e.g., toys, status, or attention; Prinstein & Cillessen, 2003). In contrast, reactive functions of aggression are displayed in response to a perceived threat and motivated by impulsivity, emotion dysregulation, hostility, or anger (Dodge & Coie, 1987; Vitaro et al., 1998). Proactive and reactive functions are correlated (for review see Bushman & Anderson, 2001), especially among older children and in studies with single informant and non-observational methods (e.g., teacher or self-reports, see Card & Little, 2006). However, past studies conducted primarily in middle childhood or adolescent samples have generally provided support for the distinction of proactive and reactive functions of aggression, including discrete factor loadings (e.g., Poulin & Boivin, 2000) and discriminant validity (e.g., Carroll et al., 2018; Fite et al., 2017, 2021). There is also some evidence supporting the distinction between proactive and reactive functions of aggression in early childhood samples (e.g., Evans et al., 2019).

Several studies in early and middle childhood indicate that nonverbal, physiological, and behavioral displays of anger or frustration are associated with reactive but not proactive physical aggression (e.g., Fite et al., 2016; Hubbard et al., 2004; Jambon et al., 2019; Marsee & Frick, 2007). For instance, Xu et al., (2014) reported that low RSA was correlated with heightened reactive, but not proactive, aggression both concurrently and over the course of 2 years in a sample of Chinese 2nd graders. Further, low RSA appears to increase risk for reactive aggression among adolescents that are victimized by peers (Ungvary et al., 2018; although see Scarpa et al., 2010). In addition, behavioral fearlessness and impaired conscience have been hypothesized to be more strongly related to proactive than to reactive aggression because youth with these traits are unconcerned about punishments or breaking rules (Frick & Morris, 2004). Similarly, physiological indicators of fearlessness, such as low SCL, may serve as a risk factor for unemotional, proactive aggression (Scarpa et al., 2010), although evidence for these theoretical associations has been equivocal (Armstrong et al., 2019; Scarpa et al., 2010), highlighting the need for additional research.

Temperament, forms of aggression, and gender

An additional key distinction is whether aggression is physical or relational in form. Physical forms of aggression include behaviors that harm others via physical force or the threat of physical force, including hitting and kicking (Crick & Grotpeter, 1995; Eisner & Malti, 2015). Relational forms of aggression, in contrast, include behaviors that damage or threaten to damage relationships to harm others (e.g., social exclusion; Crick & Grotpeter, 1995). Although much of the extant research regarding temperamental pathways to aggression has focused on physical aggression, evidence indicates that these factors may be relevant to relational aggression as well. However, much of this work has been conducted with older samples. For instance, recent findings suggest that empathetic concern was related to reduced relational aggression in 10–14-year-olds (Batanova & Loukas, 2016). Additionally, mounting research documents associations between physiological indices and relational aggression, although the majority of this research has been conducted with samples ranging from middle childhood to adulthood and has focused on physiological reactivity to stress (see Murray-Close et al., 2018, for review). In one of the only studies to investigate associations between resting physiological arousal and both physical and relational aggression in preschoolers, Gower and Crick (2011) reported that low resting heart rate was associated with both physical and relational aggression among preschoolers low in effortful control. However, other researchers have documented distinct risk factors for physical and relational aggression; for instance, Sijtsema et al. (2011) reported that, among child and adolescent girls attending a residential summer camp, low skin conductance reactivity was related to heightened relational aggression, whereas a combination of high skin conductance reactivity and other risk factors (e.g., peer rejection) appeared to increase risk for physical aggression. This work underscores the need for additional research investigating how behavioral and physiological indicators of temperament relate to both physical and relational forms of aggression, particularly in the understudied developmental period of early childhood.

Furthermore, the inclusion of both physical and relational forms of aggression may provide important insights regarding gender differences in temperamental pathways to aggression. In fact, Lahey and Waldman (2003) have called for testing of gender differences within their model. Potential risk factors for aggression may promote aggressive conduct in both boys and girls, but the manifestation of aggression may differ by gender, which may explain why the modal form of aggression is relational for girls and physical for boys in early (e.g., Ostrov et al., 2014) and middle (e.g., Putallaz et al., 2007) childhood. This perspective is consistent with theory proposed by Ostrov and Godleski (2010) suggesting that children's decisions to behave aggressively are filtered through gender-linked cognitive processes. Indeed, in one study in middle childhood and early adolescence, low RSA was associated with increases in externalizing problems for boys but not girls (El-Sheikh & Hinnant, 2011). Importantly, to extend this influential work, Armstrong et al., (2019) suggest that research on gender differences in the physiological correlates of aggression should broaden to include relational aggression.

Mechanisms of influence

An important contribution of the temperamental approaches to aggression is that they highlight potential mechanisms linking temperamental characteristics and aggressive conduct. Frick and Morris (2004) suggest that temperamental fearlessness results in a failure to successfully develop an internalized conscience (Frick & Morris, 2004). Specifically, temperamental fearlessness is thought to impair children's internalization of parental socialization efforts against aggressive behavior (e.g., Kochanska, 1993). Importantly, this indirect effect is hypothesized to most strongly predict proactive functions of aggression (Frick & Morris, 2004). Recent evidence that affective empathy and functions of aggression are differentially related in middle childhood (Tampke et al., 2020) provides some support for these predictions. There is also evidence from a sample of 5-, 7-, and 10-year-olds that sympathy and moral respect, which are conceptually related to internalization and conscience development, were uniquely related to proactive, but not reactive, aggression (Peplak & Malti, 2017; see also Jambon et al., 2019).[1]

Current study

In the present study, we employed a two-dimensional conceptualization by crossing forms (i.e., physical and relational aggression) with functions (i.e., proactive and reactive) of aggression to yield four subtypes of aggression. Despite the aforementioned overlap in proactive and reactive as well as some evidence for moderate to high associations among physical and relational aggression (for review see, Murray-Close et al., 2016), these "crossed" forms and functions of aggression subtypes exhibit differential associations with various developmental and clinical outcomes (e.g., Evans et al., 2019, 2020; Frey & Strong, 2018; Fite et al., 2011, 2016; Matlasz et al., 2020), and are reliably detected in children as young as 3 years of age (Evans et al., 2019). In keeping with the preregistered hypotheses and consistent with the emotion dysregulation pathway (Frick & Morris, 2004; Lahey & Waldman, 2003), we predicted that behavioral and physiological (RSA) emotion dysregulation would be associated with reactive physical and relational aggression. Additionally, consistent with the fearlessness pathway (Frick & Morris, 2004; Lahey & Waldman, 2003), we hypothesized that behavioral (daring/fearlessness) and physiological (SCL) fearlessness would be associated with heightened proactive physical and relational aggression. In the fearless models, we tested competing hypotheses: 1) fearlessness and impaired conscience (empathy, rule internalization) would serve as relatively unique predictors of proactive functions of physical and relational aggression, as conceptualized in the model proposed by Lahey and colleagues (Lahey & Waldman, 2003; Lahey et al., 2008); or 2) indices of impaired conscience would mediate the association between fearlessness and proactive physical and relational aggression, as proposed by Frick and colleagues (Frick & Morris, 2004). Given these prior theoretical models as well as past research on gender differences with regard to subtypes of aggression, we predicted that the aforementioned pathways would be moderated by gender. That is, we anticipated that the temperament traits would be stronger predictors of physical aggression for boys, whereas the same traits would be stronger predictors of relational aggression for girls. These preregistered hypotheses were robustly tested in a multi-informant, multimethod short-term longitudinal study.

Method

Participants

A total of 300 children (44.0% girls; $M_{age} = 44.70$ months, $SD = 4.38$ months) across four cohorts were recruited over a 4-year period. The age range for the sample was 3–5-years-old and all children in the preschool classrooms were eligible to participate. Based on parental occupation coded using Hollingshead's (1975)

[1]Two additional potential mechanisms of influence were preregistered. Specifically, we investigated whether hostile attribution biases and peer rejection mediated associations between emotion dysregulation and aggression. Findings indicated no evidence of mediation for these constructs (see theoretical rationale, method, and results in the Supplemental Materials).

four-factor index, on average the sample was middle- to upper-middle class. The sample reflected the larger community where 75% of the two largest surrounding counties are non-Hispanic/Latinx White (3.0% African American/Black, 7.6% Asian/Asian American/Pacific Islander, 1.0% Hispanic/Latinx, 11.3% multi-racial, 62.1% White, and 15.0% missing/unknown). Participants were recruited from ten National Association for the Education of Young Children (NAEYC) accredited or recently accredited centers. Six of the education centers were community-based and four were university affiliated. All age-eligible children (48 months or older) were invited to the lab at T1 to complete the physiological assessment, but only a subsample of participants ($N = 93$) elected to complete this portion of the study. This subsample did not differ from the full sample on demographics (i.e., gender, SES, or race/ethnicity) or any predictor or outcome variables with the exception that those with physiology data had significantly lower levels of proactive physical aggression at Time 1 (T1) and were slightly older, which was expected as physiology sessions began only after participants were 48 months old (see Supplemental Materials). Head teachers completed teacher report forms. On average at T1, they had known the child for approximately 1 year ($M = 12.41$ months; $SD = 9.43$) and had been the child's teacher for two thirds of a year ($M = 8.32$ months; $SD = 2.89$). At Time 2 (T2), when most children had a new teacher due to a change in the academic year (i.e., only 36 children had the same teacher), teachers reported knowing the child for slightly longer than 1 year ($M = 14.38$ months; $SD = 11.03$). On average teachers reported nearly a decade of teaching experience ($M = 9.89$ years; $SD = 8.48$ years). One third reported a bachelor's degree as their highest level of education (33.3%) with many having a master's degree (44.5%), and the remaining reported either an associate degree (3.7%), other credential (3.7%), or missing (14.8%).

Measures

Naturalistic observations of proactive and reactive physical and relational aggression (Time 1 and Time 3)

The Early Childhood Observation System (ECOS; Ostrov & Keating, 2004; Crick et al., 2006) uses a focal child sampling with continuous recording approach. Trained undergraduate ($n = 14$ female and 1 male) or graduate/professional staff ($n = 7$ female) researchers from relatively diverse backgrounds (23% Black, 14% Latinx, 63% White) observed social behavior for each child in the study 8 times for 10-minute intervals during free play (totaling 80 minutes for each time point) in the classroom and on the playground. Observers were typically different at both time points and trained following standard ECOS procedures (see Crick et al., 2006). Consistent with previous findings using the ECOS (e.g., Ostrov & Keating, 2004), average rates of participant reactivity across the 8 sessions per time point was low at roughly 2–3 times across the 80 minutes of observation at each of the two time points (T1: $M = 2.82$; T3: $M = 2.75$). Prior research has demonstrated favorable psychometric properties of the ECOS, including strong inter-rater reliability and evidence of validity (e.g., Ostrov & Keating, 2004). Training followed prior procedures (see Crick et al., 2006) and included detailed review of the ECOS manual, readings with discussion, review of videotapes to support acquisition of codes, a vignette and matching test, a standard observational coding test using six video clips from prior studies of young children, and a practice live reliability session at the school with a trainer and discussion of any errors. Observers spent a minimum of two days within the room to reduce participant reactivity and learn the names of all children. Observers were trained to be minimally responsive and were present in the rooms for about two months at each time point. Observers stayed within earshot of the participants to hear and see the range of peer interactions included in the ECOS. Reliability sessions occurred throughout the study to avoid observer drift and retraining occurred prior to each time point.

Following prior procedures (Ostrov & Crick, 2007; Ostrov et al., 2013), during a secondary coding process, each observed aggressive behavior was coded as one of four mutually exclusive categories (i.e., proactive physical aggression, reactive physical aggression, proactive relational aggression, and reactive relational aggression) by trained graduate-level RAs. In the past (Ostrov & Crick, 2007), Kappa coefficients (a conservative estimate of inter-rater reliability) have exceeded .63, which are acceptable (Pellegrini, 2004). In the current study, 50% of observations were coded by a second independent rater and assessed for reliability. Secondary codes of aggression functions showed acceptable reliability (Cohen's $\kappa s = .60–.88$; Pellegrini, 2004), with the exception of T1 proactive relational aggression ($\kappa = .50$), which deserves caution. However, given the stringent nature of κ (Pellegrini, 2004), that these levels are similar to those in past work using this coding method (Ostrov & Crick, 2007), and that observational methods help distinguish independent effects between aggression subtypes (Card & Little, 2006), these observations were retained consistent with the preregistered plan.

Observer ratings of proactive and reactive physical and relational aggression (Time 1 and Time 3)

Following the conclusion of observations at each time point, one randomly selected observer from each classroom completed the Preschool Proactive and Reactive Aggression – Observer Report (PPRA-OR; Murray-Close & Ostrov, 2009). This measure, adapted from a psychometrically strong teacher report measure (PPRA-TR; Ostrov & Crick, 2007), includes three items assessing each subtype of aggressive behavior (e.g., Proactive physical – "This child often hits, kicks or pushes to get what they want"; Reactive relational – "When this child is upset with others, they will often ignore or stop talking to them"), rated from 1 (*never or almost never true*) to 5 (*always or almost always true*). Items were averaged within aggression subtype to create subscales. Past work has found RAs to be reliable and valid reporters of children's behavior (Murray-Close & Ostrov, 2009), and the ratings were reliable (Cronbach's $\alpha s = .80–.91$) in the current study.

Emotion dysregulation (Time 1). Several teacher-reported measures served as indicators of emotion dysregulation. First, teachers responded to seven items which measured lability/negativity (e.g., "Is easily frustrated") from the lability/negativity subscale of the Emotion Regulation Checklist (ERC; Shields & Cicchetti, 1997). Items were rated on a 4-point scale from 1 (*never*) to 4 (*almost always*). The scale has demonstrated good psychometric properties in prior work (e.g., Graziano et al., 2007) as well as in the current study (Cronbach's $\alpha = .82$). Second, teachers provided reports of negative emotionality (8 items; e.g., "Gets upset easily") on the Child and Adolescent Disposition Scale (CADS; Lahey et al., 2008) rated on a 4-point scale from 1 (*not at all*) to 4 (*very much*). The subscale evidenced acceptable reliability (Cronbach's $\alpha = .90$), which aligns with past work (Lahey et al., 2008). Teachers also rated child anger/frustration using items developed from Hubbard et al. (2004; four items; e.g., "Gets angry during play") rated on a 4-point scale from 1 (*never*) to 4 *(almost* *always*) and using items from the Child Behavior Questionnaire – Short Form (CBQ-SF; Putnam & Rothbart, 2006; six items; e.g., "Has temper tantrums when s/he doesn't get what s/he wants") rated on a 7-point Likert scale from 1 (*extremely untrue*) to 7 (*extremely true*). Reliability was adequate for the anger/frustration (Cronbach's $\alpha = .82$) and CBQ-SF (Cronbach's $\alpha = .91$) scales, consistent with prior work (Ostrov et al., 2013; Putnam & Rothbart, 2006).

Empathy and internalized conduct (Time 1 and Time 2). To assess child conscience, teachers rated children's empathy (three items; e.g., "Will try to comfort or reassure another in distress") and rule internalization (three items; e.g., "Rarely repeats previously prohibited behavior even if an adult is not present") on a scale from 1 (*extremely untrue, not at all characteristic of the child*) to 7 (*extremely true, very characteristic of the child)* using subscales from Hawley and Geldhof (2012). Both subscales have demonstrated good psychometric properties in the past (Hawley & Geldhof, 2012). In the current study, teacher report on the internalization subscale was reliable at T1 (Cronbach's $\alpha = .85$). However, the empathy subscale's internal consistency was slightly lower than convention (Cronbach's $\alpha = .67$). Consistent with the preregistered plan, and due to the centrality of this variable to study hypotheses, this subscale was retained with caution.

Fearlessness and daring (Time 1). Fearlessness was assessed using teacher report and parent report on the CBQ-SF. Reporters rated children's fear in response to potentially threatening situations (6 items; e.g., "Is afraid of loud noises," "Is afraid of the dark") on a 7-point scale from 1 (*extremely untrue of your child*) to 7 (*extremely true of your child*). Items were reverse coded such that higher scores reflected greater fearlessness. In the present study, the fearlessness subscale showed adequate to good internal consistency at Time 1 for teacher (Cronbach's $\alpha = .77$) and parent report (Cronbach's $\alpha = .77$), consistent with previous reliability estimates (Rothbart et al., 2001; Putnam & Rothbart, 2006). Additionally, teacher report was significantly correlated with parent report at T1 ($r = .19$, $p = .02$). Daring at T1 was assessed using both parent and teacher ratings on the CADS. Informants rated child daring (5 items; e.g., "Likes risky and dangerous things") on a 4-point Likert scale that ranged from 1 (*not at all*) to 4 (*very much*). Reliability was good for teacher (Cronbach's $\alpha = .92$) and parent (Cronbach's $\alpha = .81$) report, and these were moderately correlated ($r = .29$, $p < .01$).

Psychophysiological assessment

Skin conductance level (SCL) and respiratory sinus arrhythmia (RSA) were collected using the Biolog UFI 3991 (see Sijtsema et al., 2011). At the start of the session, the participant's height (cm) and weight (lbs) were recorded using a mechanical scale and wall-mounted height chart. The room temperature was recorded via a wall-mounted digital thermometer. The participant was invited to color in an outline of a bear to determine their hand dominance. Next, the participant was invited to place mock electrodes onto a stuffed bear to familiarize them with the procedure. Then, the research assistants placed skin conductance and electrocardiogram (ECG) electrodes on the participant with the participant's parent present, and simultaneously allowed the participant to place stickers representing the electrodes onto their bear coloring picture. The disposable ECG electrodes were affixed to the participant's right and left rib in axial configuration, as well as to their sternum. Using adhesive collars held in place by Velcro straps, the SCL sensors containing a small amount (limited to 1 cm diameter circle) of electrode gel to increase conduction were attached to the distal phalanges of the first and second fingers of the child's nondominant hand. Children were encouraged to wash and dry their hands prior to the session. Finally, a respiration belt was placed around the participant's diaphragm in order to measure respiration as a possible covariate of RSA. A 5-minute accommodation period was given to allow the participant to adjust to the psychophysiological equipment. Next, the participant's parent left the room to observe the session via a video surveillance monitor in an adjacent room to reduce parental interference. Participants viewed a 3-minute developmentally appropriate baseline video clip of neutral valence depicting a cartoon dog, "Spot," interacting with friends and toys in their neighborhood to allow recording of resting autonomic arousal without the child getting bored and restless (see Calkins & Keane, 2004). The ECG electrodes sampled heart rate data at a rate of 1000 Hz, the finger sensors measured SCL data in microsiemens, and the respiration belt sampled respiration at a rate of 10 Hz. RSA was calculated following procedures developed by Porges (1985; see Supplemental Material).

Procedure

All procedures were approved by the local institutional review board (IRB). Upon approval from the schools to recruit at their schools, teachers, directors, and project staff sent consent forms home to all parents who had age-eligible children (i.e., 3–5-year-olds) in their classrooms. Parents provided written consent for their children's participation at the start of the study and again prior to the lab session. Children provided assent for the lab session and teachers provided consent prior to report completion. Approximately 56% of eligible families consented to participate. Teachers were compensated $5–$35 per time point depending on the number of reports they completed. Parents were compensated $20-40 for the laboratory visit/parent report. Children were also given a small educational toy. Participants were assessed at three time points over a 15-month time period: Time 1 (T1) occurred in the spring of academic year 1, Time 2 (T2) occurred in the fall of academic year 2, and Time 3 (T3) occurred in the spring of year 2. T1 included school-based observations, and teacher and parent questionnaires. Psychophysiology assessments were completed in the summer just after T1. T2 included teacher reports and a school-based child interview, and T3 included school-based observations and teacher reports. As mentioned above, for most cases, different teachers completed measures between T1 and T2/T3, but a few schools used multi-age classrooms where children did not transition to a new classroom teacher across the different timepoints. All hypotheses, methods, and the data analysis plan were preregistered prior to analysis on Open Science Framework (OSF; https://osf.io/5mjsw).

Data analytic plan

First, analyses were conducted to examine patterns of missing data and attrition. Next, we conducted preliminary descriptive statistics, including an analysis of outliers, defined as any value that is greater than 3 SD above or below the mean; outliers were winsorized to +/− 3 SD from the mean (Kline, 2016). Confirmatory factor analyses (CFA) were used to test the potential utility of latent factors for key study constructs of emotion dysregulation, behavioral fearlessness, and conscience. In CFA and structural

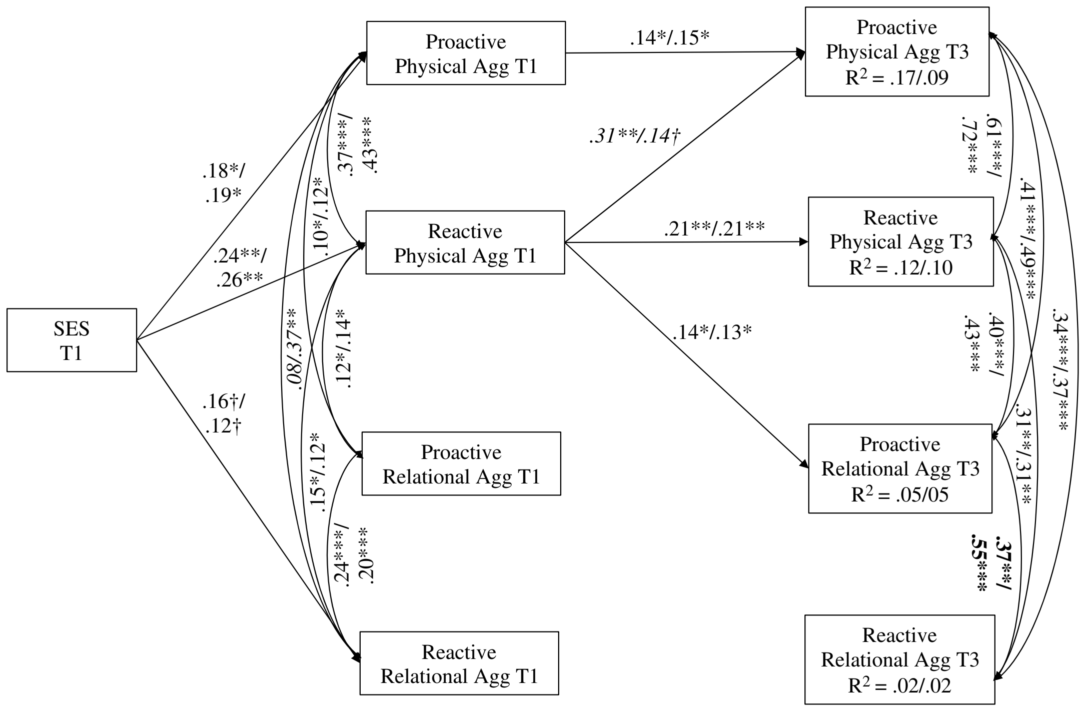

Figure 1. Stability model in the full sample. *Note*. †$p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$. Agg = Aggression, SES = Socioeconomic status, T1 = Time 1, T3 = Time 3. Italicized effects were marginally different across boys and girls ($p < .10$) whereas bolded effects were significantly different across boys and girls ($p < .05$). All non-bolded paths were constrained to be equal across gender but estimates may differ slightly due to differences in standard errors. Only significant paths are shown but all autoregressive and covariance paths were estimated. SES was included as a covariate. CFI = 1.0, RMSEA = .00, SRMR = .07.

models/path analyses, maximum likelihood with robust standard errors (MLR) was used in Mplus version 8.6 (Muthén & Muthén, 1998–2020) to accommodate data skew. The Standardized Root Mean Square Residual (SRMR), the Comparative Fit Index (CFI), and the Root Mean Squared Error of Approximation (RMSEA) were used to evaluate model fit (Hu & Bentler, 1999). Following design effect guidelines (Muthén, 1999), it was necessary to control for the effects of clustering within classroom on aggression at T1 (i.e., T1 reactive physical aggression and proactive relational aggression both had design effects greater than 2) but not at T3. Thus, classroom at T1 was included using the Cluster function in Mplus to control for nesting within classroom. We first conducted a multigroup stability path analysis with gender as the grouping variable in which T3 forms and functions of aggression were regressed onto T1 forms and functions of aggression. SES was included as a covariate (see Figure 1). Detailed estimates for associations of the final stability model, including gender differences, are presented in the Supplemental Materials (Table S4). To investigate key study hypotheses, we added temperament predictors of subtypes of aggression, including models of behavioral emotion dysregulation, RSA, behavioral fearlessness, and SCL, respectively, to the stability models. In these models, when Wald Chi-Square tests of gender moderation was significant or marginally significant, associations were freely estimated across groups; when associations were not moderated by gender, they were constrained across groups. In the case of significant associations between temperament and both proactive and reactive physical or relational aggression, respectively, follow-up tests were conducted to investigate whether the magnitude of effects differed by function. Finally, we tested proposed mediation pathways using the model indirect command in Mplus (Muthén & Muthén, 1998-2020). In these models, we freely estimated mediation pathways across gender and tested gender moderation of mediation effects. Final mediation tests were conducted with bootstrapping with 1,000 bootstrap samples.

Results

Missing data and attrition

Data were examined for systematic missingness. Attrition was anticipated given the longitudinal design. The majority of participants were retained through all time points; attrition occurred primarily during the transition between academic years, with 29.67% ($n = 89$) attrition from T1 to T2 and 31.0% ($n = 93$) from T1 to T3; there was minimal missing data from T2 to T3 ($n = 8$, 1.03%). Attrition from T1 to T2 primarily reflected children transitioning to kindergarten from multi-age classrooms; in some cases, children also changed schools for free universal pre-kindergarten programs or moved from the area. Given that attrition to T3 was only slightly higher than the 30% cutoff identified in our preregistration, and the large number of total analyses, we did not re-run analyses with only participants retained to T3 in an effort to reduce the likelihood of Type 1 errors. Attrition was not associated with any demographic variables other than SES (see Supplemental Materials); SES was included as a covariate in study models and missing data was accommodated using full information maximum likelihood (FIML; Little, 2013). Details regarding missingness on individual variables is available in the Supplemental Materials; most data had minimal missing data, with the exception of parent reports, which had substantial missing data (48% missing) due to parents electing not to complete.

To minimize the impact of missing parent reports, no constructs were solely measured by parent reports.

Preliminary analyses and measure selection

Descriptive statistics and correlations between key study variables are available in Table 1; gender differences in key study variables and correlations among composite indicators are available in Supplemental Materials (Tables S1 and S3). Potential covariates including age, race/ethnicity, study cohort, and SES were examined for associations with attrition; when correlated, these covariates were included as controls, consistent with Little's (2013) recommendation for using FIML to accommodate missing data. Following prior work assessing forms and functions of aggression in the current sample (Perhamus & Ostrov, 2021) and given significant correlations between observer reports and observations at both time points ($rs = .17–.32$, $ps < .05$), composite scores of forms and functions of aggression were computed averaging z-scores of school-based behavioral observations (i.e., "naturalistic observations") and behavioral ratings (i.e., "observer reports"). Details regarding reporter selection and indicator selection decisions for temperament factors are included in the Supplemental Materials. In the final behavioral emotional dysregulation CFA, latent emotion dysregulation was measured via teacher-reported emotional lability/negativity, anger/frustration, CBQ anger, and negative emotionality (see Table S2 for factor loadings); the two residual variances from the anger measures were allowed to correlate; model fit was excellent (CFI = 1.00, RMSEA = .00, SRMR = .003). Based on preliminary analyses, daring and fearlessness were treated as separate manifest variables, and were calculated by averaging parent and teacher reports. Rule internalization and empathy were also treated as manifest variables based on preliminary analyses (see Supplemental Materials). Figure 1 reports the stability model for the full sample (see Table S4 for all model parameter estimates) and shows that proactive and reactive physical aggression were stable across the course of the study for boys and girls. Neither proactive nor reactive relational aggression were stable over time.

Behavioral emotion dysregulation

We examined associations between emotion dysregulation and aggression, including whether emotion dysregulation was more strongly associated with reactive, as compared to proactive, functions of physical and relational aggression and whether effects differed by gender. Concurrent and longitudinal associations between emotion dysregulation and forms and functions of aggression, as well as tests of gender moderation, are detailed in the supplemental materials (Table S5, Model 1). Concurrently, emotion dysregulation was correlated with proactive physical aggression and reactive physical aggression; the strength of associations did not differ by function [Wald $\Delta\chi^2(1) = .45$, $p = .50$]. Concurrently, emotion dysregulation was positively associated with reactive relational aggression and proactive relational aggression for girls only; the strength of associations did not differ by function [Wald $\Delta\chi^2(1) = .31$, $p = .58$]. Higher emotion dysregulation was also related to lower SES for girls but not boys.

Longitudinally (see Figure 2a), emotion dysregulation at T1 was associated with increases in proactive and reactive physical aggression, as well as proactive relational aggression, for both boys and girls across the course of the study. Further, the magnitude of associations between emotion dysregulation and T3 physical aggression did not differ by function [Wald $\Delta\chi^2(1) = .02$, $p = .89$]. However, the association between emotion dysregulation and T3 reactive relational aggression was significant for girls but not boys; further, for girls, the magnitude of the association between emotion dysregulation and increases in reactive relational aggression over time was greater than the association between emotion dysregulation and increases in proactive relational aggression over time [Wald $\Delta\chi^2(1) = 4.74$, $p = .03$].

Behavioral fearlessness and conscience

To investigate associations between fearlessness, conscience, and aggression, including whether fearlessness was more strongly associated with proactive, as compared to reactive, functions of physical and relational aggression and whether effects differed by gender, we conducted a multigroup path analysis with gender as the grouping variable. In the first multigroup model, daring, fearlessness, rule internalization, and empathy at T1 served as simultaneous predictors of T3 forms/functions of aggression, controlling for T1 aggressive behavior. Associations between predictors and concurrent and future aggression are detailed in Supplemental Materials Table S5, Model 2. Concurrently, daring was positively associated with T1 subtypes of aggression for girls and boys, and rule internalization was associated with lower T1 proactive and reactive physical aggression for girls and boys. Concurrently, rule internalization was also related to lower T1 proactive relational aggression and marginally related to lower T1 reactive relational aggression for girls only. Concurrently, empathy predicted higher T1 reactive relational aggression, and marginally predicted T1 proactive relational aggression, for boys only.

Longitudinal findings are presented in Figure 2b. Across the course of the study, daring predicted increases in proactive physical aggression for boys and girls, and reactive physical aggression for boys only. Contrary to hypotheses, fearlessness was longitudinally related to decreases in reactive physical aggression for boys and girls at the trend level. Whereas rule internalization was longitudinally associated with decreases in proactive and reactive relational aggression for girls only, empathy was longitudinally related to increases in proactive relational aggression for boys and girls. Follow-up tests in cases where marginally significant or significant effects emerged across functions of aggression indicated that the strength of associations did not differ by function (all $ps > .10$).

The next set of analyses explored the hypothesis that T2 low rule internalization and empathy mediated the association between T1 fearlessness/daring and T3 forms/functions of aggression, controlling for T1 aggression, and investigated gender differences in this indirect effect. Findings (Supplemental Materials Table S8) indicated that T2 rule internalization mediated the association between T1 daring and T3 proactive relational aggression, respectively, for girls but not boys, and tests of gender moderation were significant. No other indirect effects were significant.

Respiratory sinus arrhythmia

To assess whether RSA was associated with subtypes of aggression, and whether gender moderated these associations, multigroup path analyses by gender were conducted in which aggression at T3 was regressed onto forms and functions of aggression at T1, SES, and RSA using the subsample of participants that attended the in-person interview session ($N = 93$). As body mass index (BMI) was marginally related to lower RSA, $r = -.22$, $p = .05$, it was included as a covariate in RSA analyses. Models were built on the stability models estimated in the physiology subsample,

Table 1. Full sample and physiological subsample descriptive statistics and correlations for observed variables

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.
1. School SES status	–	.18**	.25**	.09	.14*	.11	.17*	.12	.07	−.12*	.04	.30**	.13*	.12	.05				
2. Pro Pagg T1	.24*	–	.44**	.15*	.22**	.29**	.24**	.08	.06	.13*	−.01	−.13*	−.02	−.19**	−.14*				
3. Rea Pagg T1	.35**	.50**	–	.14*	.13*	.37**	.32**	.15*	.10	.20**	.00	−.14*	.07	−.17*	−.07				
4. Pro Ragg T1	.08	.09	.09	–	.23**	.11	.12	.09	.04	.07	−.12*	−.03	.08	.02	−.03				
5. Rea Ragg T1	.11	.28**	.16	.49**	–	.13	.17*	.18*	.11	.12*	−.16*	.02	.19**	.03	−.03				
6. Pro Pagg T3	.09	.32**	.32**	.03	.08	–	.73**	.45**	.34**	.38**	−.07	−.16*	.04	−.23**	−.13				
7. Rea Pagg T3	.25*	.14	.41**	.16	.08	.58**	–	.44**	.31**	.36**	−.12	−.12	.07	−.21**	−.22**				
8. Pro Ragg T3	.22	.05	.23	.11	−.08	.39**	.44**	–	.48**	.21*	−.07	−.10	.15*	−.18**	−.14*				
9. Rea Ragg T3	−.15	.03	.02	.08	−.07	.24*	.13	.36**	–	.11	−.16*	−.05	.08	−.07	.01				
10. Daring TR T1	−.12	.20	.12	.04	.01	.44**	.29*	.21**	−.01	–	−.12*	−.36**	.09	−.31**	−.20**				
11. Fearless TR T1	.18	−.02	.00	−.16	.01	−.06	.01	−.03	−.34**	−.03	–	−.04	−.35**	−.07	−.02				
12. Int TR T1	.20	−.06	−.17	−.12	−.01	−.29*	−.24	−.31*	−.29*	−.36**	.11	–	.38**	.49**	.20**				
13. Empathy TR T1	.22*	.12	.14	−.04	.08	−.05	−.10	−.04	−.02	−.10	−.12	.48**	–	.16*	.16*				
14. Int TR T2	.02	−.07	−.24*	−.05	.05	−.35**	−.26*	−.22	−.04	−.24	−.05	.46**	.34**	–	.46**				
15.Empathy TR T2	.09	.13	−.15	.02	.05	−.14	−.34**	−.33**	−.06	−.11	−.10	.35**	.35**	.53**	–				
16. SCL T1	−.04	−.01	−.05	−.02	−.03	.01	−.15	−.18	−.11	−.09	.05	.17	.03	−.11	.13	–			
17. RSA T1	.17	.07	−.06	−.13	.03	.10	.07	−.06	.13	−.03	−.03	.07	.11	.34**	.21	−.12	–		
18. Daring PR T1	.06	.15	.10	.17	.15	.04	.05	−.30*	.02	.26*	−.03	−.21	−.02	−.07	.06	−.05	.11	–	
19. Fearless PR T1	.16	−.01	−.07	.01	−.14	−.01	.01	−.11	−.06	.08	.24*	−.07	.01	−.13	−.01	−.05	.08	.17	–
M	5.17	0.02	0.01	−0.01	0.01	−0.01	−0.01	0.01	−0.01	2.24	4.59	4.35	4.46	4.27	4.51	14.01	6.95	2.47	4.43
SD	2.36	0.82	0.89	0.79	0.81	0.79	0.75	0.77	0.76	0.85	1.36	1.66	1.27	1.65	1.15	7.84	1.27	0.67	1.13
Range	1.00 to 10.00	−0.75 to 3.00	−0.58 to 3.00	−0.69 to 3.00	−0.90 to 3.00	−0.84 to 3.00	−0.58 to 3.00	−0.66 to 3.00	−0.74 to 2.78	1.00 to 4.00	1.00 to 7.00	1.00 to 7.00	1.00 to 7.00	1.00 to 7.00	1.05 to 7.00	2.30 to 37.84	2.76 to 11.16	1.00 to 4.00	1.67 to 6.83

Note. Correlations from the psychophysiology sample are below the diagonal and correlations from the full sample are above the diagonal. SES = Socioeconomic status, Pro = Proactive, Rea = Reactive, Ragg = Relational aggression, Pagg = Physical aggression, TR = Teacher report, SES = Socioeconomic status, Int = Internalization, SCL = Skin Conductance Level, RSA = Respiratory Sinus Arrythmia, T1 = Time 1, T2 = Time 2, T3 = Time 3, TR = Teacher report, PR = Parent report. Descriptive statistics for the observed variables reflect overall statistics in the entire sample with the exception of the physiological variables which were estimated in the physiological subsample. Descriptive statistics and correlations were examined in SPSS.

*$p < .05$;

**$p < .01$.

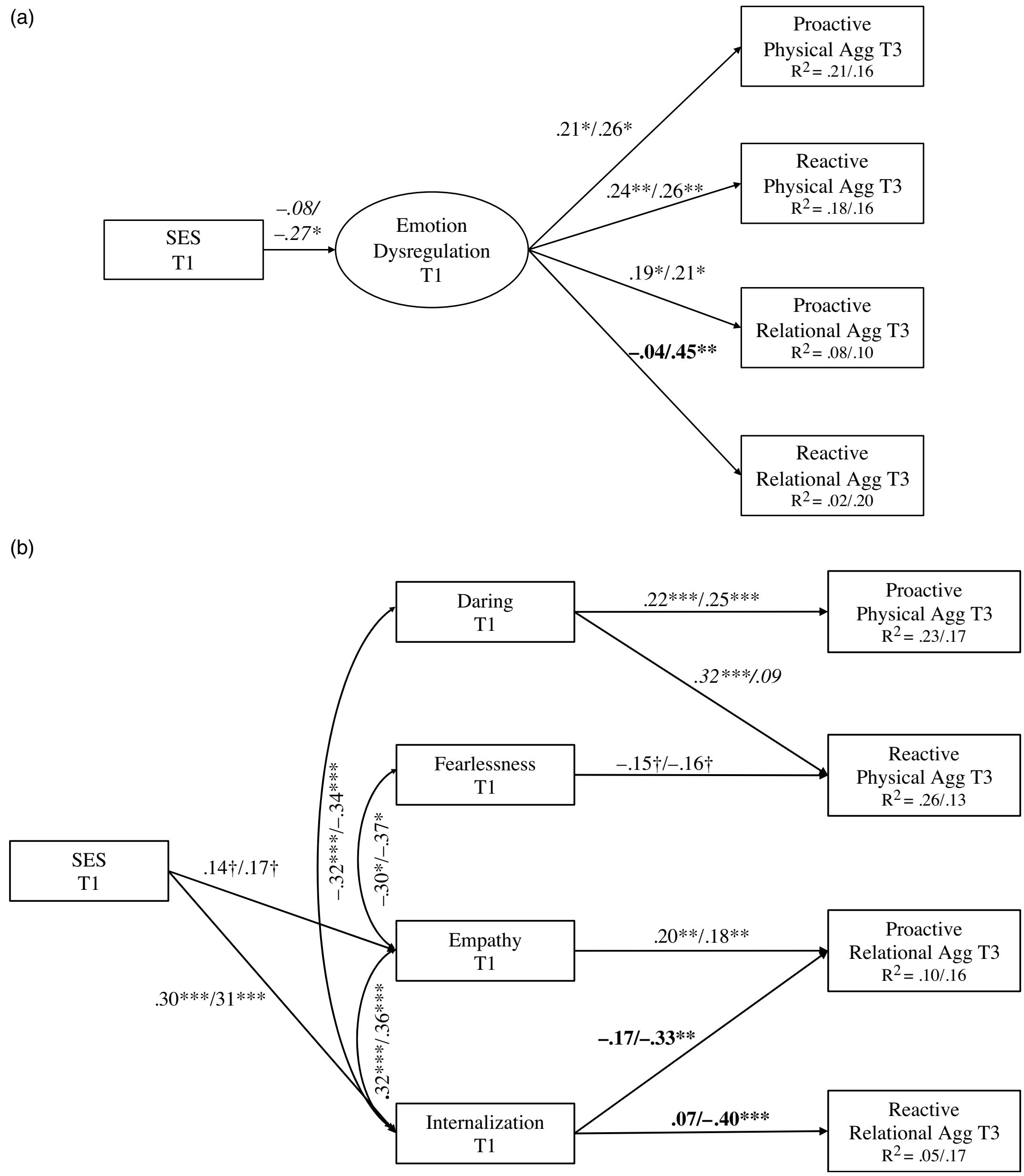

Figure 2. Two temperament path models predicting aggression in the full sample. *Note.* †$p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$. Agg = Aggression, SES = Socioeconomic status, T1 = Time 1, T3 = Time 3. Path estimates show boys on left, girls on right. Italicized effects were marginally different across boys and girls ($p < .10$) whereas bolded effects were significantly different across boys and girls ($p < .05$). All non-bolded paths were constrained to be equal across gender but may differ slightly due to differences in standard errors. Estimates are standardized. T1 aggression variables were controlled and covariances between the T3 aggression variables were estimated but are not shown for ease of interpretation. Only significant paths are shown. SES was included as a covariate. Model a: CFI = .97, RMSEA = .05, SRMR = .07; Model b: CFI = 1.0, RMSEA = .00, SRMR = .07.

depicted in the Supplemental Materials (Figure S1; Table S9). Based on the stability models, separate models were run for physical versus relational forms of aggression. In the first multigroup path analysis with gender as the grouping variable, T3 proactive and reactive physical aggression were regressed on RSA and proactive and reactive physical aggression at T1; SES and BMI were covariates. Details regarding associations are included in Supplemental Materials (Table S10). Concurrently, for girls only, lower RSA was marginally associated with heightened T1 proactive physical aggression, and significantly associated with T1 reactive physical aggression; the strength of the associations between low RSA and physical aggression for girls did not differ by function [Wald $\Delta\chi^2(1) = .44$, $p = .51$]. Longitudinally, higher RSA was associated with increases in proactive physical aggression at T3 for boys only (see Figure 3a). In the parallel relational aggression model, concurrently, higher RSA was associated with lower T1 proactive relational aggression; longitudinally, higher RSA was related to increases in reactive relational aggression across the course of the study at a trend level for boys and girls (see Table S10; Figure 3b).

Skin conductance

To assess whether SCL was associated with subtypes of aggression, as well as whether gender moderated these associations, multigroup path analyses with gender as the grouping variable were

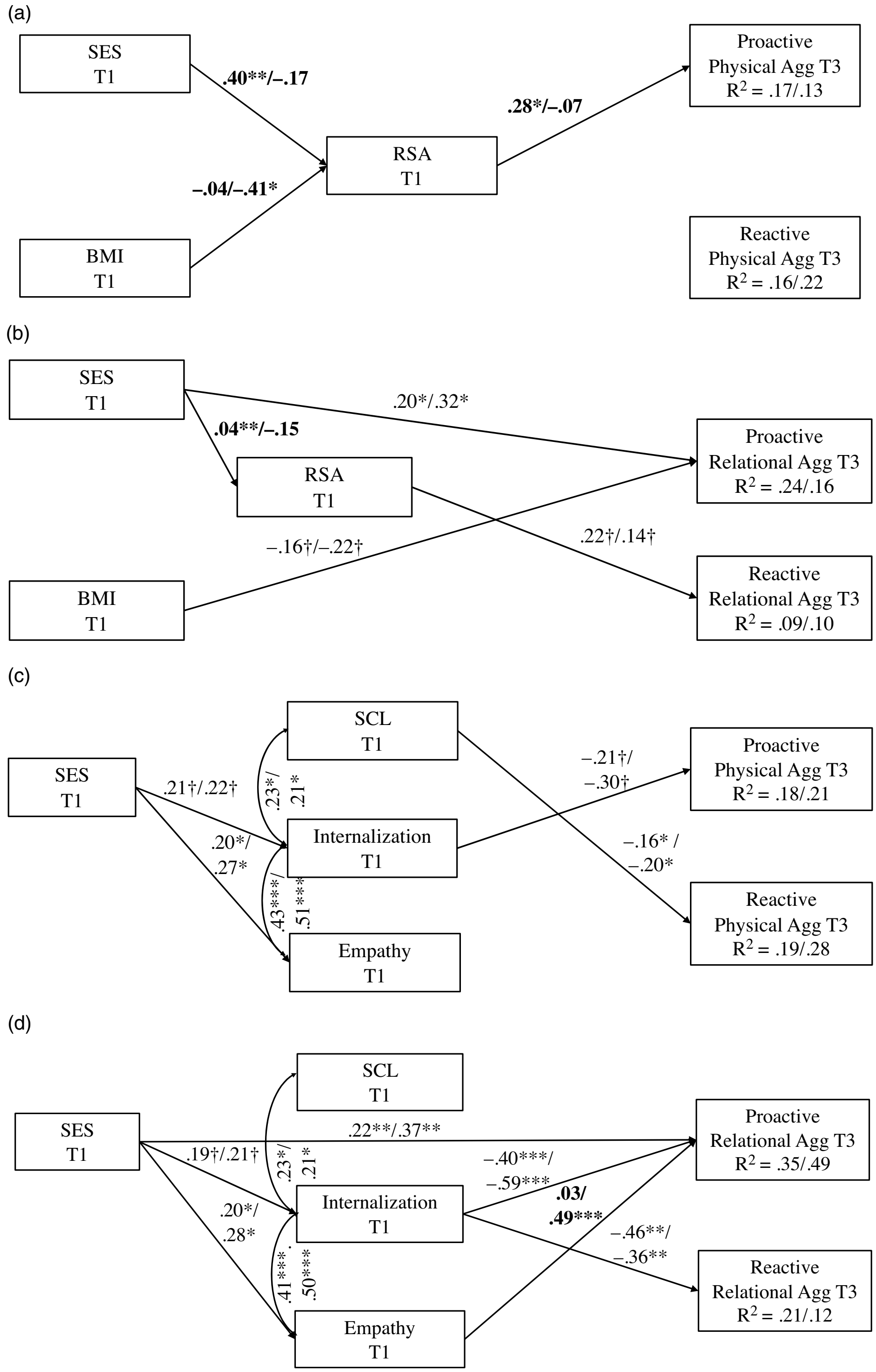

Figure 3. Four path models in the physiological subsample. *Note.* †$p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$. SCL = Skin Conductance Level, RSA = Respiratory Sinus Arrythmia, T1 = Time 1, T3 = Time 3, Agg = Aggression, SES = Socioeconomic status, BMI = Body Mass Index. Path estimates show boys on left, girls on right. Bolded effects were significantly different across boys and girls ($p < .05$), non-bolded paths were constrained to be equal across gender but may differ slightly due to differences in standard errors. Estimates are standardized. T1 aggression variables were controlled and covariances between the T3 aggression variables were estimated but not shown for ease of interpretation. Only significant paths are shown. SES and BMI were included as covariates. Model a: CFI = .98, RMSEA = .05, SRMR = .12; Model b: CFI = 1.0, RMSEA = .00, SRMR = .06; Model c: CFI = 1.0, RMSEA = .00, SRMR = .10; Model d: CFI = 1.0, RMSEA = .00, SRMR = .07.

run in which aggression at T3 was regressed onto forms and functions of aggression at T1, as well as SCL and rule internalization, using the psychophysiology subsample. SES was included as a covariate. As with RSA models, separate models were run for physical versus relational forms of aggression. In the physical aggression model, concurrently, rule internalization was related to lower T1 reactive physical aggression. Longitudinally, higher rule internalization marginally predicted decreases in proactive physical aggression and higher SCL predicted decreases in reactive physical aggression over the course of the study (see Figure 3c and Table S10). Finally, rule internalization was related to higher SCL and empathy for boys and girls.

In the relational aggression model, concurrently, rule internalization was associated with lower T1 proactive relational aggression at the trend level (see Supplemental Materials Table S10). Longitudinally, rule internalization predicted decreases in proactive and reactive relational aggression across the course of the study; the longitudinal association between rule internalization and change in relational aggression did not differ by function [Wald $\Delta\chi^2(1) = 2.16$, $p = .13$]. Longitudinally, empathy predicted increases in proactive relational aggression for girls only. Skin conductance was not associated with concurrent or future proactive or reactive relational aggression for boys or girls (see Figure 3d).

Although we had proposed the alternative hypothesis that, rather than serving as unique predictors, rule internalization at T2 mediated associations between T1 skin conductance and T3 aggression, these indirect effects are not reported due to inadequate power (see Supplemental Materials).

Discussion

The purpose of the present study was to examine the associations between temperament and forms (i.e., physical and relational) and functions (i.e., proactive and reactive) of aggression across the course of 1 year in a sample of preschoolers. We included both behavioral (i.e., emotion dysregulation, fearlessness/daring) and physiological (i.e., SCL and RSA) indicators of child temperament to test theoretically derived predictions regarding how early childhood temperament relates to the development of subtypes of aggression (Frick & Morris, 2004). Further, we investigated competing hypotheses regarding whether impaired conscience (assessed via rule internalization and empathy) served as a unique predictor versus a mediator of associations between fearlessness/daring and aggression (Frick & Morris, 2004; Lahey & Waldman, 2003). The study also aimed to highlight gender differences in these unique pathways to subtypes of aggression, an approach that has been advocated by theorists in the field (Lahey & Waldman, 2003).

Overall, emotion dysregulation emerged as a key temperamental risk factor associated with increased levels of proactive and reactive physical and relational aggression both concurrently and over time. Further, although emotion dysregulation was generally related to subtypes of aggression for both boys and girls, associations between emotion dysregulation and concurrent proactive and reactive relational aggression, as well as longitudinal increases in reactive relational aggression, emerged for girls only. Further, for girls, the longitudinal path from emotion dysregulation to increases in reactive relational aggression was larger in magnitude compared to the path from emotion dysregulation to increases in proactive relational aggression. These findings provide partial support for the preregistered hypothesis that temperamental risk factors would be more strongly associated with relational aggression in girls than in boys, as well as the hypothesis that emotion dysregulation would be more strongly related to reactive as compared to proactive aggression. In the prediction of physical aggression, in contrast, emotion dysregulation appeared to function as a more generalized risk factor for both functions of physical aggression in boys and girls.

In the path analysis model with behavioral fearlessness (manifest fearlessness and daring) and conscience (manifest rule internalization and empathy), findings indicated that daring was related to heightened physical functions of aggression, especially in boys. Specifically, concurrently, daring was associated with all four subtypes of aggression; longitudinally, daring predicted increases in proactive physical aggression for boys and girls, and reactive physical aggression for boys only. These findings provide partial support for the suggestion that daring would be more strongly associated with physical forms of aggression for boys than for girls. Rather than being more strongly associated with proactive than reactive functions of aggression, longitudinal findings indicated that daring was especially linked to physical forms of aggression. It is possible that young children recognize that physical aggression may be especially likely to result in adult intervention and negative peer responses (Coplan et al., 2015), with daring youth more willing to engage in the behaviors despite these potential risks.

Contrary to hypotheses, fearlessness was longitudinally related to decreases in reactive physical aggression over time at the trend level. These findings suggest that high levels of fear may predispose young children to enact reactive aggression over time; it is possible, for instance, that the negative emotional reactions that precipitate aggressive responding to threat or provocation include fear as well as anger. Indeed, some prior research has demonstrated associations between reactive aggression and dysregulation in fear (Moore et al., 2018). The findings further suggest that daring, rather than low fear, may serve as a particularly robust risk factor for aggression.

In addition, consistent with the suggestion that fearlessness and conscience serve as unique predictors of aggression (Lahey & Waldman, 2003), concurrently, rule internalization was significantly or marginally associated with lower levels of all subtypes of aggression at T1, although associations between rule internalization and T1 relational aggression emerged for girls only. Longitudinally, rule internalization predicted decreases in proactive and reactive relational aggression over time for girls only. Kochanska (1991) has argued that the ability to inhibit misbehavior is a key goal of socialization and that self-regulation is a critical component of moral development. Indeed, Kochanska et al. (2013) found that toddlers' willing stance toward mothers' socialization, including self-regulated compliance with maternal prohibitions, was associated with lower levels of externalizing problems and peer aggression 10 months later. Findings from the present study are consistent with this prior work and further underscore the importance of rule internalization in the development of relationally aggressive behavior, especially among girls. Because adults are less likely to intervene in relationally, as compared to physically, aggressive episodes (Coplan et al., 2015; Swit et al., 2018; Werner et al., 2006), self-inhibition of relational aggression via rule internalization may be especially important. In effect, as rule internalization involves self-inhibition of transgressions, even in the absence of prohibitions by socialization agents such as parents (Kochanska et al., 2013), it may play an especially important role in the development of negative behaviors that are less regulated by adults, such as relational aggression.

Further, consistent with hypothesized gender differences, longitudinal associations between rule internalization and decreases in relational aggression over the course of the study emerged for girls but not boys. Some research with elementary school children suggests that girls are more likely than boys to believe that relational aggression is harmful (e.g., Murray-Close et al., 2006). Further, relational aggression is the modal or most frequent form of aggression/victimization between young girls within gender segregated early childhood peer contexts, and is relevant to girls' relational self-construals and dyadic interpersonal social goals (see Crick & Grotpeter, 1995; Crick et al., 1996, 2006; Ostrov & Godleski, 2010). Thus, girls may be especially attuned to the problematic nature of relationally aggressive behavior and, for those high in rule internalization, adhere to expectations that they do not engage in these negative behaviors.

Interestingly, and contrary to hypotheses, concurrently, empathy was related to heightened relational aggression for boys, and, longitudinally, empathy predicted *increases* in proactive relational aggression over time for boys and girls. These findings are reminiscent of theoretical formulations suggesting that young children with high levels of social cognitive skills may at times understand how to use relational aggression effectively (see Gomez-Garibello & Talwar, 2015); this possibility is further bolstered by the finding that empathy was uniquely related to growth in proactive aggression over time, which may be more strategic than reactive aggression.

Consistent with theory suggesting that fearlessness increases risk for aggression because it interferes with conscience development (Frick & Morris, 2004), T2 rule internalization mediated the longitudinal association between T1 daring and T3 proactive relational aggression for girls but not boys. These findings highlight impaired rule internalization specifically as a process that increases risk for aggressive behavior among daring youth (see Kochanska, 1993). Interestingly, associations emerged for proactive functions of relational aggression only, suggesting that impaired rule internalization may play a significant role in daring girls' engagement in proactive functions specifically. These findings are consistent with the hypothesis that impaired conscience would be more strongly related to proactive than to reactive aggression because youth with these traits are unconcerned about punishments or breaking rules (Frick & Morris, 2004).

Importantly, these findings have implications for interventions with relationally aggressive girls who are high in daring. In effect, targeting and fostering rule internalization processes may be an effective way to reduce these behaviors among young children. Prior work has demonstrated that parent-child relationship quality plays a critical role in committed compliance with parental rules and prohibitions (Kochanska et al., 2005); further, some work has documented interactions between difficult temperament and maternal responsiveness in predicting children's committed compliance (Kochanska & Kim, 2013). These findings suggest that supporting parents in implementing practices that foster a positive parent-child relationship may play a protective role among girls that are at temperamental risk for proactive relational aggression, including those high in daring. Further, maternal socialization via effective social coaching (i.e., discussion of norm violations, maternal elaboration, and emotion references) has been shown to reduce the probability of stable high rates of relational aggression among young children (Werner et al., 2014). Thus, interventions that target parent-child quality and parenting practices that help daring children understand prohibitions against relational aggression and develop an internalized desire to comply with these prohibitions may play a critical role in reducing these negative behaviors during early childhood.

To examine hypotheses using physiological indices, path analysis models with RSA and SCL, respectively, predicting functions of physical or relational aggression were also evaluated in a subsample of participants. In RSA models, concurrently, lower RSA was associated with heightened T1 reactive physical aggression for girls. These concurrent findings support the conceptualization of low PNS arousal as an index of poor emotion regulation (Beauchaine, 2015; Porges, 2007), and further suggest that low RSA serves as a risk factor for aggression in young children (Patriquin et al., 2015). In addition, the findings are consistent with the behavioral models indicating that emotion dysregulation may be related to reactive functions of aggression. However, longitudinally, higher RSA was associated with *increases* in proactive physical aggression at T3 for boys. Although unexpected, Scarpa et al., (2010) found that higher heart rate variability (an index related to parasympathetic activity) was positively associated with proactive aggression in a sample of 6–13-year-old children. Boys with high emotion regulatory abilities, as reflected by high RSA, may be especially able to use proactive physical aggression strategically. In fact, in one study, Ostrov et al., (2013) found that behavioral emotion regulation skills were associated with increases in proactive physical aggression at the trend level in a sample of young children. In addition, in the present study, RSA was longitudinally associated with increases in reactive relational aggression for boys and girls at the trend level. This finding was unexpected, and because effects only approached statistical significance, results require future replication.

Finally, longitudinally, lower SCL levels were associated with increases in reactive physical aggression over time for girls and boys. These findings are consistent with the suggestion that SNS underarousal serves as a risk factor for aggression because it lowers inhibitions against such conduct (Raine, 2002), and with prior work documenting that low resting skin conductance is related to heightened antisocial behavior and aggression (Baker et al., 2013; Lorber, 2004; Posthumus et al., 2009). However, findings are not consistent with the suggestion that low SCL may serve as a risk factor for unemotional, proactive aggression (Scarpa et al., 2010). Interestingly, Scarpa et al., (2010) also found that low skin conductance was related to reactive aggression. It is possible that the lower inhibitions against aggression may make children more willing to retaliate with physically aggressive behaviors when provoked, despite potential negative repercussions such as physical harm or getting into trouble.

Broadly, evidence emerged for gender differences in the associations between temperamental constructs and aggressive subtypes in several models; further, when gender differences emerged, they were largely consistent with the hypothesis temperament would be more strongly associated with physical forms of aggression for boys and relational forms of aggression for girls. These gender differences appeared especially pronounced in the longitudinal findings. For example, consistent with hypotheses, behavioral emotion dysregulation predicted increases in reactive relational aggression for girls only, and rule internalization was significantly related to decreases in both functions of relational aggression among girls only. Likewise, daring predicted increases in reactive physical aggression for boys only, and RSA predicted increases in proactive physical aggression for boys only. These findings are consistent with a gender-linked model of aggression, which suggests that temperamental factors would be stronger predictors of relational forms of aggression for girls and physical forms of aggression for boys in early childhood due to a confluence of developmental and social factors (Ostrov & Godleski, 2010). However, it is notable that in many analyses, effects emerged for both boys and girls, suggesting a number of similar processes in the development of subtypes of aggression across gender. Moreover, the absence of several predicted differences in associations does suggest the need for caution in the interpretation of these results and warrants further study. Indeed, the results underscore the importance of including relational forms of aggression and testing for gender differences in temperamental models of aggression.

Although limited, partial support emerged for our hypotheses related to the specificity of temperamental pathways to proactive and reactive functions of aggression; for instance, emotion dysregulation was more strongly associated with longitudinal increases in reactive than proactive relational aggression in girls, and rule internalization mediated longitudinal associations between daring and proactive, but not reactive, relational aggression in girls. In addition, for girls, daring was associated with longitudinal increases in proactive but not reactive functions of physical aggression. Finally, for boys and girls, empathy was related to longitudinal increases in proactive but not reactive relational aggression. However, in many analyses, temperamental factors appeared to predict both functions of aggression, and the strength of associations did not differ by function. For instance, dysregulated negative emotions were related to longitudinal increases in both proactive and reactive functions of physical aggression, and, among boys, temperamental daring was associated with longitudinal increases in proactive and reactive physical aggression. Although this lack of specificity across functions was unexpected, prior studies on the development and correlates of forms and functions of aggression in early childhood have been equivocal (e.g., Evans et al., 2019; Ostrov et al., 2013; Poland et al., 2016; Song et al., 2020). For instance, in early childhood, dysregulated anger and negative emotionality predict the development of both proactive and reactive aggression, despite being particularly associated with reactive functions theoretically and empirically at older ages (Song et al., 2020). This has led to suggestions that, potentially due to poor planning and impulse-control abilities, differences across functions of aggression are less pronounced in early childhood, relative to later ages (Evans et al., 2019; Poland et al., 2016).

However, this should not be taken to imply that there are not meaningful differences between forms and functions of aggression and various predictors/outcomes during early childhood. In fact, prior work has shown differential associations with constructs such as functional impairment (Hart & Ostrov, 2013), dysregulated anger (Jambon et al., 2019), sympathy and moral respect (Peplak & Malti, 2017), peer rejection, and emotion regulation skills (Ostrov et al., 2013). Further, the processes linking temperamental traits and aggression may differ by function; indeed, in the present study, low rule internalization mediated the association between daring and proactive, but not reactive, relational aggression for girls. These findings raise the possibility that during early childhood, similar temperamental factors may at times increase risk for both proactive and reactive aggression, but the underlying mechanisms may differ by function of aggression; future work is needed to examine this possibility. It will also be important for future research to investigate the role of slowly developing higher order executive functioning skills that may be at play during this period of development (Evans et al., 2019). In fact, when differences across function did emerge in the present study, they often occurred among girls only. As both aggressive and nonaggressive girls are less likely than boys to exhibit impairments in executive functioning skills during early childhood (Raaijmakers et al., 2008), poor executive functioning skills may play a role in a lack of differentiation of correlates of functions of aggression for boys. Future research is needed to investigate this possibility.

Strengths, limitations, and future directions

The present study has several notable strengths including the use of multiple methods and multiple levels of analysis with a short-term longitudinal design. In addition, the preregistration of study hypotheses is a notable strength of the study. Nevertheless, findings should be evaluated in the context of study limitations. For example, although the present study represented the larger geographic area from which it was drawn, future work is needed to replicate the findings in a more diverse sample that includes more families from lower socioeconomic backgrounds and greater racial and ethnic diversity. In addition, the use of composite variables for several key constructs rather than latent variables is an important study limitation. Composite variables were selected to simplify models because of difficulties in model estimation of structural models with latent variables. However, the use of composite variables has limitations relative to latent variables, including an inability to estimate measurement error and assess fit indices to support the latent factors. Although these limitations were partially addressed via preliminary simplified models providing support for the fit of latent constructs, future research with larger samples would benefit from using latent variables rather than composites when possible. It will also be important to include observations of temperamental factors, in addition to teacher and parent reports, in future research. Further, although best practices were followed with respect to missing data, relatively high levels of missing data in parent reports are a limitation.

Similarly, the limited findings in the physiological analyses may reflect limited power due to the small sample size resulting from relatively low participation rates in the physiological assessment; it will be important for future work to incorporate psychophysiology indicators of temperament in larger samples of young children. In fact, as preliminary analyses indicated inadequate power for testing mediation in the physiological subsample, it was not possible to test theoretically derived hypotheses related to mechanisms linking physiological functioning and subtypes of aggression. It will be important for future research with larger samples to investigate these proposed mechanisms. Further, several measures had marginal reliability (e.g., observations of proactive relational aggression, empathy); thus, caution regarding findings related to these measures should be exercised. It will also be important for future research to examine temperamental pathways to forms and functions of aggression across longer developmental periods. It is possible, for instance, that distinct associations emerge with early childhood indicators of temperament and middle childhood functions of aggression. However, it is important to consider the challenges associated with conducting in depth observational and physiological studies with large samples and over multiple years. In fact, the present study represents the largest sample to date using the ECOS. Future research that attempts to replicate and extend the current project will need to consider balancing sample size/power considerations with design and methodology constraints.

Despite these limitations, the present study has multiple implications for future theoretical and empirical work examining the development of aggressive behavior in young children. First, the findings suggest that emotion dysregulation may serve as a nonspecific temperamental risk factor for the development of proactive and reactive physical aggression as well as proactive relational aggression in boys and girls. However, for girls only, emotion dysregulation appears to be especially strongly associated with reactive relational aggression. Second, findings indicated that daring, but not fearlessness, served as a risk factor for the development of physically aggressive behavior, especially in boys, and rule internalization, but not empathy, was related to reductions in relational aggression, especially in girls. Thus, findings clarify which facets of key temperamental constructs are most relevant for the development of aggression in early childhood. Indeed, contrary to expectations, fearlessness was related to decreases in reactive physical aggression over time at the trend level, and empathy was related to increases in proactive relational aggression over time. These findings highlight how related, but distinct, aspects of temperament may exhibit unique associations with subtypes of aggression. Further, in addition to serving as unique predictors of aggression, impaired rule internalization was a key mechanism linking daring with proactive relational aggression in girls. These findings provide support for theoretical formulations proposed by Frick and Morris (2004) as well as Lahey and Waldman (2003). In addition, although results were mixed, some evidence emerged indicating that temperamental risk factors exhibited distinct associations with functions of aggression, and were more strongly associated with the development of physical aggression in boys and relational aggression in girls, highlighting the importance of including relational aggression and testing gender differences in temperamental models of aggression. Findings also have significant clinical implications, as the results underscore early predispositions that may place boys and girls on maladaptive trajectories. Using early markers of temperament may provide early identification of those children at risk for maladaptive pathways toward heightened aggressive behavior. This work reinforces the importance of understanding the role of early precursors to aggression, which may be evident as early as 6 months of age (Hay et al., 2014). Moreover, the present findings suggest several possible mechanisms that could, when replicated, be targeted in future interventions. For example, existing interventions for subtypes of aggression focus on social cognitions (e.g., Leff et al., 2009); findings from the current study suggest that future efforts that focus on reducing emotion dysregulation and daring, as well as promoting rule internalization, may be particularly fruitful in this developmental period. Finally, the current findings illustrate the unique nature of this developmental period relative to past work with older samples, and as such we call for more clinical treatments and interventions for forms and functions of aggression that are designed specifically for this developmental period.

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References

Aimé, C., Paquette, D., Déry, M., & Verlaan, P. (2018). Predictors of childhood trajectories of overt and indirect aggression: An interdisciplinary approach. *Aggressive Behavior*, *44*(4), 382–393. https://doi.org/10.1002/ab.21759

Armstrong, T., Wells, J., Boisvert, D. L., Lewis, R., Cooke, E. M., Woeckener, M., & Kavish, N. (2019). Skin conductance, heart rate and aggressive behavior type. *Biological Psychology*, *141*, 44–51. https://doi.org/10.1016/j.biopsycho.2018.12.012

Baker, E., Shelton, K. H., Baibazarova, E., Hay, D. F., van, Goozen, & Stephanie, H. M. (2013). Low skin conductance activity in infancy predicts aggression in toddlers 2 years later. *Psychological Science*, *24*(6), 1051–1056. https://doi.org/10.1177/0956797612465198

Batanova, M., & Loukas, A. (2016). Empathy and effortful control effects on early adolescents' aggression: When do students' perceptions of their school climate matter? *Applied Developmental Science*, *20*(2), 79–93. https://doi-org/10.1080/10888691.2015.1067145

Beauchaine, T. P. (2015). Respiratory sinus arrhythmia: A transdiagnostic biomarker of emotion dysregulation and psychopathology. *Current Opinion in Psychology*, *3*, 43–47. https://doi.org/10.1016/j.copsyc.2015.01.017

Beauchaine, T. P., Katkin, E. S., Strassberg, Z., & Snarr, J. (2001). Disinhibitory psychopathology in male adolescents: Discriminating conduct disorder from attention-deficit/hyperactivity disorder through concurrent assessment of multiple autonomic states. *Journal of Abnormal Psychology*, *110*(4), 610–624.

Bushman, B. J., & Anderson, C. A. (2001). Is it tie to pull the plug on the hostile versus instrumental aggression dichotomy? *Psychological Review*, *108*, 273–279. https://doi.org/10.1037/0033-295X.108.1.273

Calkins, S. D., & Keane, S. P. (2004). Cardiac vagal regulation across the preschool period: Stability, continuity, and implications for childhood adjustment. *Developmental Psychobiology*, *45*(3), 101–112. https://doi.org/10.1002/dev.20020

Card, N. A., & Little, T. D. (2006). Proactive and reactive aggression in childhood and adolescence: A meta-analysis of differential relations with psychosocial adjustment. *International Journal of Behavioral Development*, *30*, 466–480. https://doi.org/10.1177/0165025406071904

Carroll, A., McCarthy, M., Houghton, S., O'Connor, E. S., & Zadlow, C. (2018). Reactive and proactive aggression as meaningful distinctions at the variable and person level in primary school-aged children. *Aggressive Behavior*, *44*, 431–441. https://doi.org/10.1002/ab.21763

Coplan, R. J., Bullock, A., Archbell, K. A., & Bosacki, S. (2015). Preschool teachers' attitudes, beliefs, and emotional reactions to young children's peer group behaviors. *Early Childhood Research Quarterly*, *30*, 117–127.

Crick, N. R., Bigbee, M. A., & Howes, C. (1996). Gender differences in children's normative beliefs about aggression: How do I hurt thee? Let me count the ways. *Child Development*, *67*(3), 1003–1014. https://doi.org/10.2307/1131876

Crick, N. R., & Grotpeter, J. K. (1995). Relational aggression, gender, and social-psychological adjustment. *Child Development*, *66*(3), 710–722. https://doi-org/10.2307/1131945

Crick, N. R., Ostrov, J. M., Burr, J. E., Cullerton-Sen, C., Jansen-Yeh, E., & Ralston, P. (2006). A longitudinal study of relational and physical aggression in preschool. *Journal of Applied Developmental Psychology*, *27*(3), 254–268. https://doi-org/10.1016/j.appdev.2006.02.006

Dodge, K. A., & Coie, J. D. (1987). Social-information-processing factors in reactive and proactive aggression in children's peer groups. *Journal of Personality and Social Psychology*, *53*(6), 1146–1158. https://doi.org/10.1037//0022-3514.53.6.1146

Eisner, M. P., & Malti, T. (2015). Aggressive and violent behavior. In M. E. Lamb, & R. M. Lerner (Eds.), *Handbook of child psychology and developmental science: Socioemotional processes* (Vol. *3*, 7th ed., pp. 794–841). John Wiley & Sons, Inc. https://doi-org/10.1002/9781118963418.childpsy319

El-Sheikh, M., & Hinnant, J. B. (2011). Marital conflict, respiratory sinus arrhythmia, and allostatic load: Interrelations and associations with the development of children's externalizing behavior. *Development and Psychopathology*, *23*(3), 815–829. https://doi.org/10.1017/S0954579411000320

Ettekal, I., & Ladd, G. W. (2017). Developmental continuity and change in physical, verbal, and relational aggression and peer victimization from childhood to adolescence. *Developmental Psychology*, *53*, 1709–1172. https://doi.org/10.1037/dev0000357

Evans, S. C., Diaz, K. I., Callahan, K. P., Wolock, E. R., & Fite, P. J. (2020). Parallel trajectories of proactive and reactive aggression in middle childhood and their outcomes in early adolescence. *Journal of Abnormal Child Psychology*. https://doi.org/10.1007/s10802-020-00709-5

Evans, S. C., Frazer, A. L., Blossom, J. B., & Fite, P. J. (2019). Forms and functions of aggression in early childhood. *Journal of Clinical Child & Adolescent Psychology*, *48*(5), 790–798. https://doi.org/10.1080/15374416.2018.1485104

Fite, P. J., Cushing, C., & Odell, C. (2021). Examination of the links between functions of aggression and risk for e-cigarette use among middle school-age youth: A comparison with risk for alcohol use. *Journal of Substance Use*, *26*(2), 138–143. https://doi.org/10/1080/14659891.2020.1784302

Fite, P. J., Poquiz, J., Cooley, J. L., Stoppelbein, L., Becker, S. P., Luebbe, A. M., & Greening, L. (2016). Risk factors associated with proactive and reactive aggression in a child psychiatric inpatient sample. *Journal of Psychopathology and Behavioral Assessment*, *38*(1), 56–65. https://doi.org/10.1007/s10862-015-9503-0

Fite, P. J., Poquiz, J., Frazer, A. L., & Reiter, N. (2017). Further evaluation of associations between reactive and proactive aggression and suicidal behavior in a treatment seeking sample of youth. *Child Psychiatry & Human Development*, *48*(6), 903–910. https://doi.org/10.1007/s10578-017-0713-4

Fite, P. J., Stoppelbein, L., Gaertner, A. E., Greening, L., & Elledge, C. (2011). Further evaluation of the forms and functions of aggression measure with a child inpatient population. *Residential Treatment for Children & Youth*, *28*(1), 1–16. https://doi.org/10.1080/0886571X.2011.541840

Frey, K. S., & Strong, Z. H. (2018). Aggression predicts changes in peer victimization that vary by form and function. *Journal of Abnormal Child Psychology*, *46*(2), 305–318. https://doi.org/10.1007/s10802-017-0306-5

Frick, P. J., Cornell, A. H., Barry, C. T., Bodin, S. D., & Dane, H. E. (2003). Callous-unemotional traits and conduct problems in the prediction of conduct problem severity, aggression, and self-report of delinquency. *Journal of Abnormal Child Psychology*, *31*(4), 457–470. https://doi-org/10.1023/A:1023899703866

Frick, P. J., & Morris, A. S. (2004). Temperament and developmental pathways to conduct problems. *Journal of Clinical Child and Adolescent Psychology*, *33*(1), 54–68. https://doi.org/10.1207/S15374434JCCP3301_6

Frick, P. J., & Viding, E. (2009). Antisocial behavior from a developmental psychopathology perspective. *Development and Psychopathology*, *21*(4), 1111–1131. https://doi-org/10.1017/S0954579409990071

Gomez-Garibello, C., & Talwar, V. (2015). Can you read my mind? Age as a moderator in the relationship between theory of mind and relational aggression. *International Journal of Behavioral Development*, *39*(6), 552–559. https://doi.org/10.1177/0165025415580805

Gower, A. L., & Crick, N. R. (2011). Baseline autonomic nervous system arousal and physical and relational aggression in preschool: The moderating role of effortful control. *International Journal of Psychophysiology*, *81*(3), 142–151. https://doi.org/10.1016/j.ijpsycho.2011.06.001

Graziano, P. A., Reavis, R. D., Keane, S. P., & Calkins, S. D. (2007). The role of emotion regulation and children's early academic success. *Journal of School Psychology*, *45*(1), 3–19. https://doi.org/10.1016/j.jsp.2006.09.002

Hart, E. J., & Ostrov, J. M. (2013). Functions of aggressive behavior and future impairment. *Early Childhood Research Quarterly*, *28*(4), 683–691. https://doi.org/10.1016/j.ecresq.2013.05.005

Hawley, P. H., & Geldhof, J. G. (2012). Preschoolers' social dominance, moral cognition, and moral behavior: An evolutionary perspective. *Journal of Experimental Child Psychology*, *112*(1), 18–35. https://doi.org/10.1016/j.jecp.2011.10.004

Hay, D. F., Waters, C. S., Perra, O., Swift, N., Kairis, V., Phillips, R., Jones, R., Goodyer, I., Harold, G., Thapar, A., & van Goozen, S. (2014). Precursors to aggression are evident by 6 months of age. *Developmental Science*, *17,3*, 471–480. https://doi.org/10.1111/desc.12133

Hollingshead, A. A. (1975). *Four-factor index of social status. Unpublished manuscript*. Yale University.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, *6*(1), 1–55. https://doi-org/10.1080/10705519909540118

Hubbard, J., Parker, E., Ramsden, S., Flanagan, K., Relyea, N., Dearing, K., Smithmyer, C., Simons, R., & Hyde, C. (2004). The relations among observational, physiological, and self-report measures of children's anger. *Social Development*, *13*(1), 14–39. https://doi.org/10.1111/j.1467-9507.2004.00255.x

Izard, C. E., Youngstrom, E. A., Fine, S. E., Mostow, A. J., & Trentacosta, C. J. (2006). Emotions and developmental psychopathology. In D. Cicchetti, & D. J. Cohen (Eds.), *Developmental psychopathology, Vol 1: Theory and method* (2nd ed., pp. 244–292). John Wiley & Sons, Inc.

Jambon, M., Colasante, T., Peplak, J., & Malti, T. (2019). Anger, sympathy, and children's reactive and proactive aggression: Testing a differential correlate hypothesis. *Journal of Abnormal Child Psychology*, *47*, 1013–1024. https://doi.org/10.1007/s10802-018-0498-3

Kibler, J. L., Prosser, V. L., & Ma, M. (2004). Cardiovascular correlates of misconduct in children and adolescents. *Journal of Psychophysiology*, *18*(4), 184–189.

Kline, R. B. (2016). *Principles and practice of structural equation modeling* (4th ed.). Guilford Press.

Kochanska, G. (1991). Socialization and temperament in the development of guilt and conscience. *Child Development*, *62*(6), 1379–1392. https://doi.org/10.2307/1130813

Kochanska, G. (1993). Toward a synthesis of parental socialization and child temperament in early development of conscience. *Child Development*, *64*(2), 325–347.

Kochanska, G., Barry, R. A., Aksan, N., & Boldt, L. J. (2008). A developmental model of maternal and child contributions to disruptive conduct: The first six years. *Journal of Child Psychology and Psychiatry*, *49*(11), 1220–1227.

Kochanska, G., Forman, D. R., Aksan, N., & Dunbar, S. B. (2005). Pathways to conscience: Early mother-child mutually responsive orientation and children's moral emotion, conduct, and cognition. *Journal of Child Psychology and Psychiatry*, *46*(1), 19–34. https://doi.org/10.1111/j.1469-7610.2004.00348.x

Kochanska, G., & Kim, S. (2013). Difficult temperament moderates links between maternal responsiveness and children's compliance and behavior problems in low-income families. *Journal of Child Psychology and Psychiatry*, *54*(3), 323–332. https://doi.org/10.1111/jcpp.12002

Kochanska, G., Kim, S., & Boldt, L. J. (2013). Origins of children's externalizing behavior problems in low-income families: Toddlers' willing stance toward their mothers as the missing link. *Development and Psychopathology*, *25*(4), 891–901. https://doi.org/10.1017/S0954579413000254

Lahey, B. B., Applegate, B., Chronis, A. M., Jones, H. A., Williams, S. H., Loney, J., & Waldman, I. D. (2008). Psychometric characteristics of a measure of emotional dispositions developed to test a developmental propensity model of conduct disorder. *Journal of Clinical Child and Adolescent Psychology*, *37*(4), 794–807.

Lahey, B. B., & Waldman, I. D. (2003). A developmental propensity model of the origins of conduct problems during childhood and adolescence. In B. B. Lahey, T. E. Moffitt, & A. Caspi (Eds.), *Causes of conduct disorder and juvenile delinquency* (pp. 76–117). The Guilford Press.

Leff, S. S., Gullan, R. L., Paskewich, B. S., Abdul-Kabir, S., Jawad, A. F., Grossman, M., Munrol, M. A., & Power, T. J. (2009). An initial evaluation of a culturally adapted social-problem solving and relational aggression prevention program for urban African-American relationally aggressive girls. *Journal of Prevention & Intervention in the Community*, *37*, 260–274. https://doi.org/10.1080/10852350903196274

Little, T. D. (2013). *Longitudinal structural equation modeling*. Guilford.

Lorber, M. F. (2004). Psychophysiology of aggression, psychopathy, and conduct problems: A meta-analysis. *Psychological Bulletin*, *130*(4), 531–552. https://doi.org/10.1037/0033-2909.130.4.531

Mann, F. D., Tackett, J. L., Tucker-Drob, K., & Harden, P. (2018). Callous-unemotional traits moderate genetic and environmental influences on rule-breaking and aggression: Evidence for gene x trait interaction. *Clinical Psychological Science*, *6*(1), 123–133. https://doi.org/10.1177/2167702617730889

Marsee, M. A., & Frick, P. J. (2007). Exploring the cognitive and emotional correlates to proactive and reactive aggression in a sample of detained girls. *Journal of Abnormal Child Psychology*, *35*(6), 969–981. https://doi-org/10.1007/s10802-007-9147-y

Matlasz, T. M., Frick, P. J., Robertson, E. L., Ray, J. V., Thornton, L. C., Wall Myers, T. D., Steinberg, L., & Cauffman, E. (2020). Does self-report of aggression after first arrest predict future offending and do the forms and functions of aggression matter? *Psychological Assessment*, *32*(3), 265–276. https://doi.org/10.1037/pas0000783

Moore, C. C., Hubbard, J. A., & Bookhout, M. K. (2018). Temperament and aggression. In T. Malti, & K. Rubin (Eds.), *Handbook of child and adolescent aggression: Emergence, development, and intervention* (pp. 107–126). Guilford.

Murray-Close, D., Breslend, N. L., & Holterman, L. A. (2018). Psychophysiology indicators of relational aggression. In S. M. Coyne, & J. M. Ostrov (Eds.), *The development of relational aggression* (pp. 127–151). Oxford University Press.

Murray-Close, D., Crick, N. R., & Galotti, K. M. (2006). Children's moral reasoning regarding physical and relational aggression. *Social Development*, *15*(3), 345–372. https://doi.org/10.1111/j.1467-9507.2006.00346.x

Murray-Close, D., Nelson, D. A., Ostrov, J. M., Casas, J. F., & Crick, N. R. (2016). Relational aggression: A developmental psychopathology perspective. In D. Cicchetti (Eds.), *Developmental Psychopathology* (3rd ed., pp. 660–722). Wiley. https://doi.org/10.1002/9781119125556.devpsy413

Murray-Close, D., & Ostrov, J. M. (2009). A longitudinal study of forms and functions of aggressive behavior in early childhood. *Child Development*, *80*, 828–842. https://doi.org/10.1111/j.1467-8624.2009.01300.x

Muthén, L. K. (1999, October 29). *It is really not the size of the intraclass correlation that is the issue* [Comment on the online forum post *My intraclass correlations are very small. Do I really need to use multilevel modeling with my data?*]. Statmodel. http://www.statmodel.com/discussion/messages/12/18.html

Muthén, L. K., & Muthén, B. O. (1998–2020). *Mplus user's guide* (8th ed.). Muthén & Muthén.

NICHD Early Child Care Research Network. (2004). Trajectories of physical aggression from toddlerhood to middle childhood. In *Monographs of the Society for Research in Child Development* (Vol. 69, Serial No. 278). Wiley.

Nwadinobi, O. K., & Gagne, J. R. (2020). Preschool anger, activity level, inhibitory control, and behavior problems: A family study approach. *Merrill-Palmer Quarterly*, *66*. https://doi.org/10.13110/merrpalmquart1982.66.4.03339

Ostrov, J. M., & Crick, N. R. (2007). Forms and functions of aggression during early childhood: A short-term longitudinal study. *School Psychology Review*, *36*(1), 22–43.

Ostrov, J. M., & Godleski, S. A. (2010). Toward an integrated gender-linked model of aggression subtypes in early and middle childhood. *Psychological Review*, *117*(1), 233–242. https://doi.org/10.1037/a0018070

Ostrov, J. M., Kamper, K. E., Godleski, S. A., Hart, E. J., & Blakely-McClure, S. J. (2014). A gender-balanced approach to the study of peer victimization and aggression subtypes in early childhood. *Development and Psychopathology*, *26*, 575–587. https://doi.org/10.1017/S0954579414000248

Ostrov, J. M., & Keating, C. F. (2004). Gender differences in preschool aggression during free play and structured interactions: An observational study. *Social Development*, *13*(2), 255–277. https://doi.org/10.1111/j.1467-9507.2004.000266.x

Ostrov, J. M., Murray-Close, D., Godleski, S. A., & Hart, E. J. (2013). Prospective associations between forms and functions of aggression and social and affective processes during early childhood. *Journal of Experimental Child Psychology*, *116*(1), 19–36. https://doi.org/10.1016/j.jecp.2012.12.009

Ostrov, J. M., Perry, K. J., & Blakely-McClure, S. J. (2018). Developmental trajectories of aggression subtypes: From early to late childhood. In T. Malti, & K. H. Rubin (Eds.), *Handbook of child and adolescent aggression* (pp. 41–61). The Guilford Press.

Pellegrini, A. D. (2004). *Observing children in their natural worlds: A methodological primer* (2nd ed.). Erlbaum.

Peplak, J., & Malti, T. (2017). That really hurt, Charlie!' investigating the role of sympathy and moral respect in children's aggressive behavior. *The Journal of Genetic Psychology*, *178*(2), 89–101. https://doi.org/10.1080/00221325.2016.1245178

Patriquin, M. A., Lorenzi, J., Scarpa, A., Calkins, S. D., & Bell, M. A. (2015). Broad implications for respiratory sinus arrhythmia development: Associations with childhood symptoms of psychopathology in a community sample. *Developmental Psychobiology*, *57*(1), 120–130. https://doi.org/10.1002/dev.21269

Perhamus, G. R., & Ostrov, J. M. (2021). Emotions and cognitions in early childhood aggression: The role of irritability and hostile attribution biases. *Journal of Abnormal Child Psychology*, *49*(1), 63–75. https://doi.org/10.1007/s10802-020-00707-7

Peterson, E. R., Dando, E., D'Souza, S., Waldie, K. E., Carr, A. E., Mohal, J., & Morton, S. M. B. (2018). Can infant temperament be used to predict which toddlers are likely to have increased emotional and behavioral problems? *Early Education and Development*, *29*(4), 435–449, https://doi.org/10.1080/10409289.2018.1457391,

Poland, S. E., Monks, C. P., & Tsermentseli, S. (2016). Cool and hot executive function as predictors of aggression in early childhood: Differentiating between the function and form of aggression. *British Journal of Developmental Psychology*, *34*, 181–197. https://doi.org/10.1111/bjdp.12122

Porges, S. W. (1985). *Method and apparatus for evaluating rhythmic oscillations in aperiodic physiological response systems. Patent Number: 4,510,944.* U.S. Patent Office.

Porges, S. W. (2007). The polyvagal perspective. *Biological Psychology*, *74*(2), 116–143. https://doi-org/10.1016/j.biopsycho.2006.06.009

Posthumus, J. A., Böcker, K. B. E., Raaijmakers, M. A. J., Van Engeland, H., & Matthys, W. (2009). Heart rate and skin conductance in four-year-old children with aggressive behavior. *Biological Psychology*, *82*(2), 164–168. https://doi.org/10.1016/j.biopsycho.2009.07.003

Poulin, F., & Boivin, M. (2000). Reactive and proactive aggression: Evidence of a two-factor model. *Psychological Assessment*, *12*, 115–122. https://doi.org/10.1037/1040-3590.12.2.115

Prinstein, M. J., & Cillessen, A. H. N. (2003). Forms and functions of adolescent peer aggression associated with high levels of peer status. *Merrill-Palmer Quarterly*, *49*(3), 310–342. https://doi-org/10.1353/mpq.2003.0015

Putallaz, M., Grimes, C. L., Foster, K. J., Kupersmidt, J. B., Coie, J. D., & Dearing, K. (2007). Overt and relational aggression and victimization: Multiple perspectives within the school setting. *Journal of School Psychology*, *45*(5), 523–547. https://doi-org.proxy.lib.umich.edu/10.1016/j.jsp.2007.05.003

Putnam, S. P., & Rothbart, M. K. (2006). Development of short and very short forms of the Children's Behavior Questionnaire. *Journal of Personality Assessment*, *87*(1), 103–113.

Quiñones-Camacho, L. E., & Davis, E. L. (2018). Discrete emotion regulation strategy repertoires and parasympathetic physiology characterize psychopathology symptoms in childhood. *Developmental Psychology*, *54*(4), 718–730. https://doi.org/10.1037/dev0000464

Raaijmakers, M. A. J., Smidts, D. P., Sergeant, J. A., Maassen, G. H., Posthumus, J. A., van Engeland, H., & Matthys, W. (2008). Executive functions in preschool children with aggressive behavior: Impairments in inhibitory control. *Journal of Abnormal Child Psychology*, *36*(7), 1097–1107. https://doi.org/10.1007/s10802-008-9235-7

Raine, A. (2002). Biosocial studies of antisocial and violent behavior in children and adults: A review. *Journal of Abnormal Child Psychology*, *30*(4), 311–326. https://doi-org/10.1023/A:1015754122318

Rothbart, M. K., Ahadi, S. A., Hershey, K. L., & Fisher, P. (2001). Investigations of temperament at 3-7 years: The Children's Behavior Questionnaire. *Child Development*, *72*, 1394–1408. https://doi.org/10.1111/1467-8624.00355

Scarpa, A., Haden, S. C., & Tanaka, A. (2010). Being hot-tempered: Autonomic, emotional, and behavioral distinctions between childhood reactive and proactive aggression. *Biological Psychology*, *84*(3), 488–496.

Shields, A., & Cicchetti, D. (1997). *Emotion regulation checklist.* Educational Testing Service.

Sijtsema, J. J., Shoulberg, E. K., & Murray-Close, D. (2011). Physiological reactivity and different forms of aggression in girls: Moderating roles of rejection sensitivity and peer rejection. *Biological Psychology*, *86*, 181–192. https://doi.org/10.1016/j.biopsycho.2010.11.007

Song, J., Colasante, T., & Malti, T. (2020). Taming anger and trusting others: Roles of skin conductance, anger regulation, and trust in children's aggression. *British Journal of Developmental Psychology*, *38*, 42–58. https://doi.org/10.1111/djdp.12304

Swit, C. S., McMaugh, A. L., & Warburton, W. A. (2018). Teacher and parent perceptions of relational and physical aggression during early childhood. *Journal of Child and Family Studies*, *27*, 118–130. https://doi.org/10.1007/s10826-017-0861-y

Tampke, E. C., Fite, P. J., & Cooley, J. L. (2020). Bidirectional associations between affective empathy and proactive and reactive aggression. *Aggressive Behavior*, *46*(4), 317–326. https://doi.org/10/1002/ab.21891

Ungvary, S., McDonald, K. L., Gibson, C. E., Glenn, A. L., & Reijntjes, A. (2018). Victimized by peers and aggressive: The moderating role of physiological arousal and reactivity. *Merrill-Palmer Quarterly*, *64*(1), 70–100. http://dx.d/10.13110/merrpalmquar1982.64.1.0070

Vitaro, F., Gendreau, P. L., Tremblay, R. E., & Oligny, P. (1998). Reactive and proactive aggression differentially predict later conduct problems. *Journal of Child Psychology and Psychiatry*, *39*(3), 377–385. https://doi.org/10.1017/S0021963097002102

Werner, N. E., Eaton, A. D., Lyle, K., Tseng, H., & Holst, B. (2014). Maternal social coaching quality interrupts the development of relational aggression during early childhood. *Social Development*, *23*(3), 470–486. https://doi.org/10.1111/sode.12048

Werner, N. E., Senich, S., & Przepyszny, K. A. (2006). Mothers' responses to preschoolers' relational and physical aggression. *Journal of Applied Developmental Psychology*, *27*(3), 193–208. https://doi.org/10.1016/j.appdev.2006.02.002

Xu, Y., Raine, A., Yu, L., & Krieg, A. (2014). Resting heart rate, vagal tone, and reactive and proactive aggression in Chinese children. *Journal of Abnormal Child Psychology*, *42*(3), 501–514, https://doi-org/10.1007/s10802-013-9792-2