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Aggression and Irritability in Middle Childhood: Between- and Within-Person Associations

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ABSTRACT

Objective: This study tested predicted bidirectional associations between irritability and physical and relational forms of aggression, disentangling theorized within- and between-person effects using latent curve models with structured residuals (LCM-SR) over one year in middle childhood. Gender differences and robustness of results when controlling for other externalizing problems (i.e., attention problems, delinquency) were also considered.

Method: Children in third, fourth, and fifth grade ($N = 704$, 49.9% female) were recruited from schools in a large midwestern city. The sample was diverse in regard to race/ethnicity (31% Black, 29% White, 13% Hmong, 14% Latinx, 4% Native American, 4% Asian, 5% other races/ethnicities). Irritability, attention problems, and delinquency were measured using teacher-report, and physical and relational aggression were measured using self-report at three time points over one calendar year.

Results: At the between-person level, higher mean levels of irritability predicted higher initial levels of physical and relational aggression. Irritability continued to predict higher levels of physical aggression across the course of the study, whereas the effect of irritability on relational aggression diminished. Boys showed higher starting levels of physical aggression, but no other significant gender differences emerged. No significant within-person associations were found.

Conclusions: The present study suggests that irritability may represent a between-person risk factor for high levels of physical and relational aggression in middle childhood, although effects on physical aggression may be more persistent. This highlights the importance of considering affective processes to understand the development of aggression trajectories.

Irritability, defined as an increased proneness to experiencing anger and frustration (Brotman et al., 2017), is distributed continuously in the population, with higher levels considered a risk factor for a variety of negative outcomes across internalizing and externalizing domains (e.g., Beauchaine & Tackett, 2020; Klein et al., 2021). Although there is debate surrounding the operationalization of irritability, there is some consensus that it represents a persistent mood state (i.e., differentiable from the emotion of anger and the behavior of aggression), characterized by reactive negative affectivity coupled with increased orientation toward and approach to perceived threat, higher appetitive reward tendencies, and temper outbursts (Brotman et al., 2017; Deveney et al., 2019; Leibenluft & Stoddard, 2013).

Irritability and related constructs (e.g., anger proneness, frustration intolerance) have been associated with higher levels of aggression, both concurrently and longitudinally (e.g., Brotman et al., 2017; Deveney et al., 2019; Hubbard et al., 2010). Aggression, defined as behavior enacted with the intent to hurt or harm another (Eisner & Malti, 2015), has typically included two key forms: physical and relational. Physical aggression involves the use or threat of physical force to hurt or harm another and includes behaviors such as hitting, kicking, and pushing (Crick & Grotpeter, 1995; Eisner & Malti, 2015). Relational aggression uses the relationship as the means of harm, including threats of the removal of the relationship (Crick & Grotpeter, 1995), which may be direct (e.g., social exclusion) or covert (e.g., spreading malicious rumors). Evidence from international studies suggests these two forms of aggression tend to moderately co-occur in middle childhood (e.g., $r = .49$ in a large international sample; Lansford et al.,

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2012), and both forms have been associated with a range of negative individual (e.g., social-psychological adjustment problems), dyadic (e.g., peer victimization), and group (e.g., peer rejection) correlates across childhood and adolescence (Murray-Close et al., 2016).

The literature to date on associations between irritability and aggressive behavior has focused on between-person effects to the neglect of within-person processes and has largely not considered potential reciprocal relations. The present study aims to address these gaps by using latent curve models with structured residuals (LCM-SR models; Curran et al., 2014) to disentangle between- and within-person effects and test potential reciprocal relations between irritability and physical and relational aggression over one year in middle childhood.

Middle Childhood

Middle childhood (i.e., 6–12-years-old) represents a unique developmental period with key tasks involving competence with peers (e.g., formation and maintenance of loyal friendships, functioning within the peer group) and increasing expectations for self-regulation and competence at school (Sroufe, 2013). Although earlier developmental periods are critical for understanding the emergence of externalizing behaviors (Tremblay et al., 2018), middle childhood is an important transition period with unique implications. During this developmental period, physical aggression becomes more serious and concerning as it is less developmentally typical, often associated with comorbid externalizing problems, and relatively stable (Frick & Matlasz, 2018). Relational aggression becomes more covert and indirect, with overall levels declining from elementary school to emerging adulthood, although with significant individual variability including potential increases in late middle childhood, especially for girls (Fite & Pederson, 2018). Relative to early childhood (i.e., 3–5-years-old), when aggression is fairly normative, aggressive behavior in middle childhood reflects more significant public health and clinical concerns (Frick & Matlasz, 2018; Murray-Close et al., 2016).

Similarly, developmentally typical levels of irritability peak in early childhood and are generally stable with a slight decline across childhood to adolescence (Kiefer & Wiggins, 2019; Leibenluft & Stoddard, 2013). However, there is significant between-person variability in these trajectories, and individuals demonstrating persistent high or increasing irritability are at risk for poorer outcomes across domains (Kiefer & Wiggins, 2019; Leibenluft & Stoddard, 2013). Thus, knowledge about theorized mechanisms that could be targeted in intervention or prevention efforts to propel children away from these maladaptive trajectories is important from both developmental psychopathology and public health perspectives (Murray-Close et al., 2016).

Irritability and Aggressive Behavior: Between-Person Associations

Aggression related to high levels of negative emotionality, such as irritability, is thought to occur primarily as a dysregulated response to perceived threat or provocation, and its maintenance is theorized to reflect socialization and reinforcement processes that impair typical developmental process of learning to inhibit aggressive behavior (e.g., Leibenluft & Stoddard, 2013; Moore et al., 2018; Stoddard et al., 2019). Specifically, children with higher levels of irritability perceive more situations as threatening and frustrating, and may respond to these situations with a behavioral approach response of aggression (Brotman et al., 2017; Leibenluft & Stoddard, 2013). Aggressive behavior may then result in the withdrawal of the perceived threat (e.g., a peer who was teasing the child walks away), facilitating escape from the physiologically aversive state of heightened frustration (Moore et al., 2018; Stoddard et al., 2019). That is, the aggressive behavior is negatively reinforced. As a result, aggression would be expected to increase (or not show developmentally typical declines) over time among irritable youth.

The suggestion that irritability would be associated with heightened trajectories of aggression over time is consistent with both frustration models of aggression (Berkowitz, 1993) and the emotionally integrated social information processing (SIP) model (Crick & Dodge, 1994; Lemerise & Arsenio, 2000). Specifically, the SIP model suggests that, consistent with their affective tendencies, irritable children would be more likely to process situations as threatening (e.g., demonstrate a hostile attribution bias [HAB]) and respond with the affectively consistent behavior of aggression; this aggression, in turn, would be reinforced and become more entrenched over time (Crick & Dodge, 1994; Lemerise & Arsenio, 2000).

In addition, associations between irritability and aggression are likely bidirectional in nature. Typical developmental declines in irritability across childhood involve learning that responding irritably to situations leads to undesirable consequences (e.g., peer rejection), and therefore developing more effective strategies to achieve goals and manage provocations (Stoddard et al., 2019). However, engaging in aggressive behavior may interfere with these developmental processes through the reinforcement of the emotional escalation of frustration and anger in challenging social situations.

For instance, aggression may allow children to escape from negative situations through withdrawal of threat (e.g., a teasing peer walking away, as described above), such that the emotional escalation is reinforced, ultimately leading to increases in negative emotional reactivity (i.e., irritability) over time (Moore et al., 2018; Stoddard et al., 2019). Likewise, from an emotionally-integrated SIP framework, reinforcement of aggression via removal of threat (e.g., the child walking away and making sure not to bump you again) reinforces the social cognitive (e.g., HAB) and affective (e.g., irritability) processes underlying the choice to engage in aggressive behavior. Importantly, both the failure to learn to inhibit irritable responding due to the rewarding nature of aggression and the reinforcement of hostile social cognitive processing biases have been highlighted as potential mechanisms in the development and maintenance of severe irritability (Brotman et al., 2017; Stoddard et al., 2019).

Consistent with these perspectives, preliminary research has documented bidirectional associations between irritability and aggression at the between-person level. Specifically, reactive (i.e., perpetrated in response to a perceived threat or provocation; Card & Little, 2006) physical aggression was positively bidirectionally associated with irritability over one year in early childhood (Perhamus & Ostrov, 2021), and temperamental frustration was reciprocally positively associated with relational aggression across the transition from middle childhood to adolescence (Atherton et al., 2017).

Irritability and Aggressive Behavior: Within-Person Associations

To date, the majority of research examining associations between irritability and aggression has focused on between-person processes, such as investigating whether children showing higher levels of irritability exhibit increases in aggression. However, theoretical models also suggest within-person processes. For instance, the SIP model suggests that individuals are more likely to rely on automatic social-cognitive processes when experiencing high levels of emotional arousal. Therefore, when individuals are particularly irritable, they may "skip" processing steps that would lead to more adaptive responding and respond in an aggressive manner (Lemerise & Arsenio, 2000). Likewise, when children are engaging in higher-than-typical levels of aggression, they may experience more negative reinforcement of their irritable social cognitive interpretations and behavior, and therefore show greater increases in irritability.

In support of within-person processes, a recent study found that poorer anger regulation predicted higher levels of aggression at the within-person, in addition to the between-person, level over 4 weeks in middle-childhood (Alsem et al., 2022). An important extension of this work is to examine irritability specifically, distinguish between forms of aggression, and consider potential reciprocal effects. The focus on within-person effects is critical, as most prevention and intervention efforts are targeted at this level (Curran et al., 2014).

Current Study

The current study aims to examine reciprocal associations between irritability and forms of aggression at between- and within-person levels. Although prior work has demonstrated positive associations between irritability and physical and relational forms of aggression, examinations of reciprocal associations are limited, and no prior work has simultaneously considered these processes at both between- and within-person levels. The present study applies LCM-SR models to disentangle these levels of effect and test predicted bidirectional associations between irritability and physical and relational forms of aggression. We also consider gender differences, consistent with the gender-linked model of aggression subtypes (Ostrov & Godleski, 2010). Consistent with this model, some prior work suggests that gender socialization pressures (e.g., against physical aggression in girls) lead to gender differences in processes underlying the enactment of physical vs. relational aggression (e.g., Ettekal & Ladd, 2015), and gender differences in associations between irritability and forms of aggression have been found in early childhood (e.g., Perhamus & Ostrov, 2021). Thus, we expected associations between irritability and relational aggression to be stronger for girls and associations between irritability and physical aggression to be stronger for boys. Finally, we test the robustness of effects, while controlling for commonly co-occurring, but distinct, externalizing problems (i.e., attention problems and delinquency; Leibenluft & Stoddard, 2013). Hypotheses are tested using a secondary analysis of a short-term longitudinal study over one year in middle childhood.

Method

Participants

Participants were part of a short-term, 3-wave longitudinal study on aggression and adjustment (Crick et al., 2005). Participants were recruited through 40 4th grade classrooms in a large, urban Midwestern city in the

United States between 2001 and 2003. Seven hundred and four children (49.9% girls) were included in the present sample from two annually recruited cohorts. Participants were included if they had relevant self- or teacher-report data at the initial wave. Recruitment targeted 4th grade classrooms, but the sample included 3rd grade (3.1%, $n = 22$), 4th grade (86.4%; $n = 608$), and 5th grade (8.8%; $n = 62$) students (1.7% missing grade info, $n = 12$) because some were in mixed-grade classrooms. The sample was diverse with respect to race/ethnicity (31% Black, 29% White, 13% Hmong, 14% Latinx, 4% Native American, 4% Asian, 5% other races/ethnicities), and was estimated to be of low- to middle-income background based on school demographics (i.e., 74% of students at participating schools qualified for free or reduced-cost lunch; Mathieson et al., 2011; Murray-Close & Crick, 2006; Murray-Close et al., 2006). Attrition was low from T1 to T2 (6.8%, $n = 47$) but larger at T3 (37.6%, $n = 265$) due to changing schools (e.g., 5th graders moving to middle school) or lack of consent. See below for details on systematic missingness.

Procedure

Study procedures were approved by the Institutional Review Board of the University of Minnesota, and participating schools and teachers voluntarily agreed to take part in the study. All students in participating classrooms were eligible. Trained research assistants (RAs) provided a 10–15-minute age-appropriate description of the study. Students returned signed parental consent forms to their teacher. Children received a small gift (e.g., candy) to thank them for returning signed consent forms (regardless of permission for participation), and if all children in a classroom returned their consent forms (regardless of permission for participation), the class won a pizza party. Prior to completing assent and questionnaires, children were reminded of the goals and procedures of the study, confidentiality protections, and the voluntary nature of participation. Of students in participating classrooms, 71% provided parental consent and child assent.

Teacher-reports and self-reports were collected at three time points over one calendar year (i.e., Fall of year 1, Time l [T1]; Spring of year 1, Time 2 [T2], Fall of year 2, Time 3 [T3]). Assessments occurred approximately 4–6 months apart. In general, the same teachers completed measures at T1 and T2, but new teachers completed measures at T3 due to the change in school year. Additional procedural details are presented in prior work (Crick et al., 2005; Murray-Close et al., 2007) and supplemental materials.

Measures

Teacher-Reported Irritability

Teachers reported on children's irritability using three items capturing mood, tantrums, and stubbornness on the Teacher Report Form (TRF; Achenbach & Edelbrock, 1991), consistent with prior research with parent reports (Evans et al., 2020). Teachers rated children's symptoms of irritability on a scale of 0 (*Not true*) to 2 (*Very true or often true*). Items were summed to create a total irritability score. Although this is the first known use of the teacher-report version of this subscale, prior work has demonstrated its reliability and validity using equivalent parent-report items (Evans et al., 2020), and it showed good internal consistency in the present sample across waves (Cronbach's αs = .87–.88).

Self-Reported Physical and Relational Aggression

Children provided self-reports of physical and relational aggression using the Children's Social Behavior Scale – Self-Report (Crick & Grotpeter, 1995). Children rated the frequency of their engagement in relational (5 items; e.g., "Some kids tell their friends that they will stop liking them unless the friends do what they say. How often do you tell friends this?") and physical (2 items; e.g., "Some kids hit other kids at school. How often do you do this?") aggression on a scale from 1 (*Never*) to 5 (*All the time*). Items were summed within subscale to yield overall relational and physical aggression scores. This commonly-used measure with strong reliability and validity in the past (e.g., Voulgaridou & Kokkinos, 2019) was reliable in the present study for physical (Cronbach's αs = .77–.78) and relational aggression (Cronbach's αs = .69–.78) at all three time points.

Covariates: Attention Problems and Delinquent Behavior

Attention problems and delinquent behavior assessed using the syndrome scales of the TRF (Achenbach & Edelbrock, 1991) at T1 served as control variables. Teachers were presented with items describing symptoms of attention problems (5 items; e.g., difficulty remaining still) and delinquent behavior (9 items; e.g., stealing) and rated participating children on each item on a scale from 0 (*Not true*) to 2 (*Very true or often true*). Items were summed to create subscale scores. Prior work has documented excellent psychometric properties of the TRF (Achenbach & Rescorla, 2001). Both subscales had adequate internal consistency in the present sample (Cronbach's αs = .80–.85).

Analytic Plan

Prior to primary analyses, descriptive data of all measures were obtained. Outliers were winsorized to ±3 standard deviations from the mean (Kline, 2016). Data generally followed a normal distribution (Skew = 0.95–2.12; Kurtosis = −0.11–3.43; Kline, 2016). There was minimal missing data outside of the attrition at T2 and T3 described above. Little's MCAR test suggested data were not missing completely at random [$\chi^2(342) = 470.97$, $p < .001$]. It was expected that data would be missing at random (MAR) as missingness was not randomly assigned based on the study design (Baraldi & Enders, 2010). Missingness was examined for associations with all model variables (i.e., T1 – T3 irritability, relational and physical aggression, and covariates) and additional demographic factors (i.e., race/ethnicity, gender, cohort, and grade at T1). T1 attention problems were positively associated with attrition at T2 and T3 and T1 physical aggression was positively associated with T3 attrition. Cohort was associated with missingness at all three time points, such that cohort 2 showed higher levels of missing data. There were also significant differences in attrition rate by race/ethnicity, with Black and Asian American participants having higher-than-expected levels of attrition at T3. Additional details on missingness and statistics regarding associations between attrition and model variables are presented in supplemental materials. Analyses including auxiliary demographic variables associated with missingness (i.e., cohort, race/ethnicity) resulted in essentially identical findings, and are presented in the supplemental materials.

LCM-SR Models

The present study applies LCM-SR models (Curran et al., 2014) to test theorized between- and within-person processes. A conceptual bivariate LCM-SR model for associations between irritability and physical aggression is presented in Figure 1. LCM-SR models are an extension of more traditional latent growth models, with the unique ability to isolate and simultaneously model within- and between-person longitudinal associations between variables. Specifically, LCM-SR models isolate and impose a structure (e.g., cross-lagged associations) onto time-specific residual variance of observed variables for each construct. This variance represents time-specific deviations from expected levels given the underlying growth curve. The growth factors (i.e., intercept and slope factors) represent between-person variance, and their associations can be conceptualized as associations between initial levels and growth at the between-person level. The residual variances represent within-person variation, and residual cross-lags represent reciprocal within-person longitudinal effects (Curran et al., 2014). Of note, although LCM-SR models are estimable with three waves of data, this is the minimum number of time points required, and constraints are required on residual variances and/or autoregressive paths for model identification if a slope factor is present (Littlefield et al., 2022). Although simpler models (e.g., a traditional cross-lagged panel model [CLPM]) would allow us to include all freely estimated parameters, this would not differentiate between- and within-person processes (Curran et al., 2014). Furthermore, the CLPM is nested within the LCM-SR, and omitting a random slope and/or intercept term when it is supported by the data results in biased estimates (Littlefield et al., 2022). Therefore, the LCM-SR modeling framework was selected as it allows us to test both theorized between-person and within-person processes and minimize model bias that would result from omitting supported growth and intercept factors.

LCM-SR models were tested within Mplus version 8.6 (Muthén & Muthén, 1998–2022) using the maximum likelihood robust estimator (MLR). Missing data were accommodated using full information maximum likelihood (FIML). Models were constructed in a two-step fashion following Curran et al.'s (2014) approach. First, unconditional univariate growth models were estimated for each construct (i.e., irritability, physical aggression, and relational aggression). Inter-factor covariances, autoregressive residual paths, and equality constraints among residual variances and stability pathways were tested using nested χ^2 difference tests adjusted for the MLR estimator. See the limitations section for a larger discussion on considerations for running these models with three time points.

Model fit was examined with the likelihood ratio χ^2 test, the comparative fit index (CFI) where values greater than .95 suggest good fit and above .90 suggest acceptable fit, the standardized root mean-square residual (SRMR) fit index where values less than .08 represent adequate fit and less than .05 represent good fit (Hu & Bentler, 1999), and the root mean square error of approximation (RMSEA; Steiger, 1990) where values greater than .10 represent poor fit, less than .08 represent mediocre fit, and less than .05 represent close fit (Browne & Cudeck, 1992; MacCallum et al., 1996).

After the best fitting univariate growth model was established for each construct, they were combined into the two bivariate LCM-SR models (i.e., a physical aggression + irritability model, and a relational aggression + irritability model). Irritability and aggression intercept and slope factors were allowed to covary to test between-person growth associations. Within-time

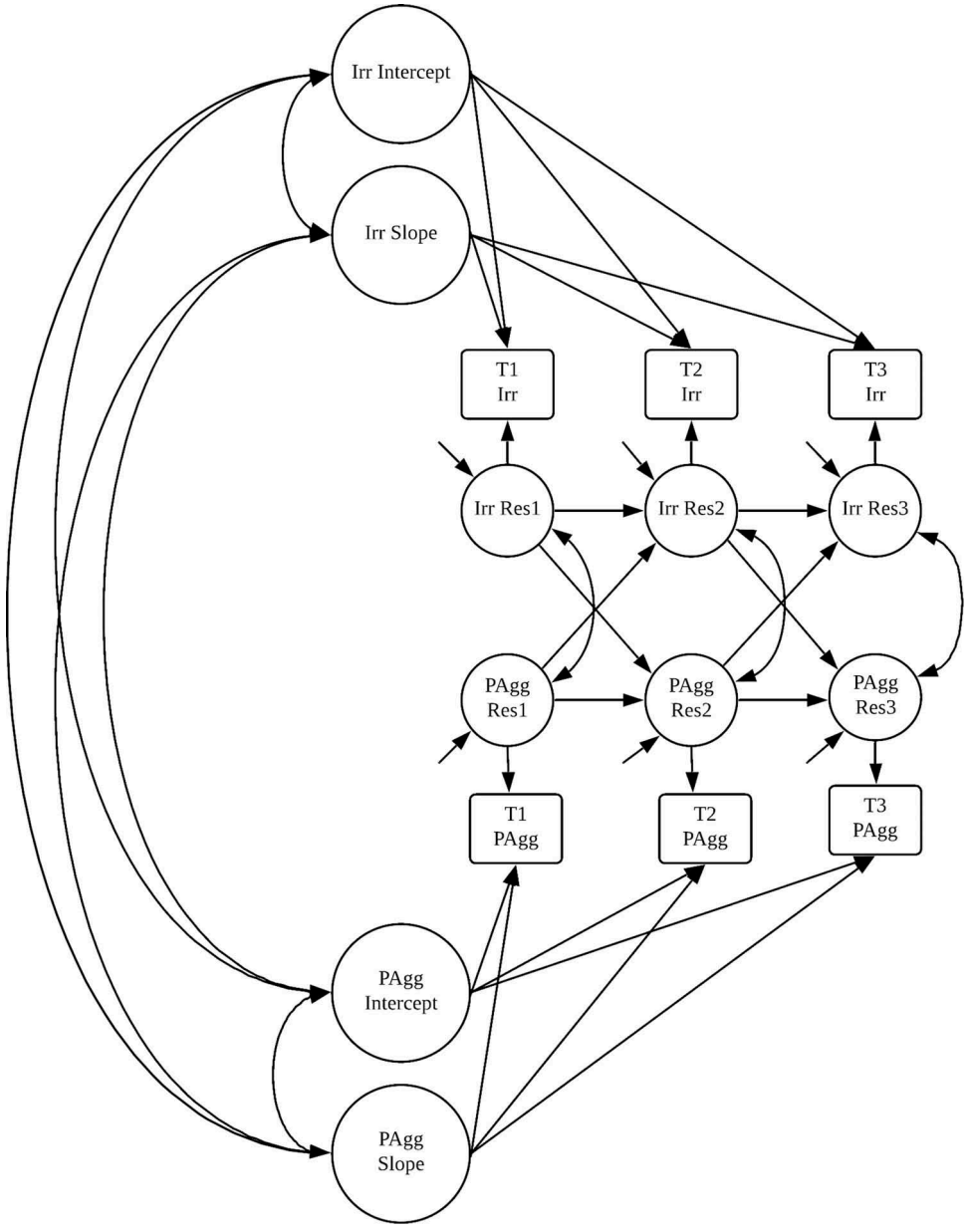

Figure 1. Conceptual unconditional bivariate LCM-SR model for physical aggression and irritability. *Note*. The conceptual model and all parameters were tested using sequential nested tests as detailed in the text. Slope and intercept factors were tested to determine whether they should be random. Covariances across intercept and slope factors represent between-person effects, whereas parameters involving residuals represent within-person effects. The conceptual relational aggression model was identical, with relational aggression replacing physical aggression. T1 = Time 1, T2 = Time 2, T3 = Time 3; Irr = Irritability; PAgg = Physical aggression; Res = Residual.

residual covariances were then tested and retained if supported by nested χ^2 tests. Finally, cross-lagged paths between irritability and the form of aggression's residuals were added to test hypothesized within-person reciprocal effects.

Once a best-fitting bivariate LCM-SR model was established, covariates were added as a robustness test of the initial models. Specifically, the final model slope and intercept factors were regressed onto delinquency, attention problems, and average T1–T3 levels of the alternative form of aggression (i.e., T1–T3 relational aggression in the physical aggression model, T1–T3 physical aggression in the relational aggression model). Both attention problems and delinquency have potential causal relations with irritability and aggression (Kiefer & Wiggins, 2019; Leibenluft & Stoddard, 2013), making them potential confounders that if not accounted for could result in biased estimates (Wysocki et al., 2022). Finally, gender differences were tested using group comparisons. Specifically, gender was entered as

a grouping variable, and models in which all variances, means, and structural paths were constrained to equality were compared to fully freed models. If a nested χ^2 test indicated significant improvement in model fit for the freed model, modification indices were then examined to determine which parameters should be freed.

Results

Preliminary Analyses

Descriptive statistics and bivariate correlations are presented in Table 1. Of note, irritability showed moderate to high stability from T1 to T3 ($rs = .60–.73$, $ps < .001$) despite the change in teacher between T2 and T3. Physical and relational aggression were also moderately stable across time points ($rs = .37–.50$, $ps < .001$). Boys showed higher levels of physical aggression at T1 [$t(660) = 2.79$, $p = .005$; Cohen's $d = .22$] and T2 [$t(628) = 3.99$, $p < .001$; Cohen's $d = .32$], and higher T1 attention problems [$t(682) = 4.23$, $p < .001$; Cohen's $d = .32$].

Univariate Growth Models

Details on these models and model building are presented in supplemental materials.

Irritability

The final irritability univariate model fit the data well [$\chi^2(2) = 2.30$, $p = .32$; CFI = 1.00; RMSEA = .02; SRMR = .01] and consisted of a random intercept with a significant mean ($M = 0.64$, SE = 0.05, $p < .001$) and variance ($\sigma^2 = .91$, SE = .18, $p < .001$), but no slope factor. This indicates that we did not detect significant mean-level change or between-person variability in change in irritability over the course of the study, and the intercept factor represents average levels of irritability over the course of the study. Residual variances were significant at all time points (σ^2s = 0.46–0.82, $ps = .001 – < .001$). Residual autoregressive paths were significant from T1 to T2 ($\beta = .54$, SE = .10, $p < .001$) but not from T2 to T3 ($\beta = .12$, SE = .25, $p = .65$). This may be due to the change in reporter between T2 to T3 given the change in academic year, and therefore teacher, across these time points.

Physical Aggression

The final univariate growth model for physical aggression provided adequate fit to the data [$\chi^2(2) = 10.20$, $p = .006$; CFI = .95; RMSEA = .08; SRMR = .03]. The final model included a random intercept ($M = 3.43$, SE = .05, $p < .001$; $\sigma^2 = 1.88$, SE = .27, $p < .001$) and a random slope with a mean of zero, but significant variance ($\sigma^2 = .26$, SE = 0.13, $p = .04$). This indicates that although there was no mean growth in physical aggression across the study, there was significant individual variability in linear growth trajectories. There was a significant negative covariance between the intercept and slope factors ($r = –.53$, SE = .10, $p = .01$). Finally, residual variances were significant at all time points (σ^2s = 0.76–1.60, $ps = .002 – < .001$).

Relational Aggression

The final relational aggression univariate linear growth model showed good fit to the data [$\chi^2(1) = 2.47$, $p = .12$; CFI = .99; RMSEA = .05; SRMR = .02]. A random intercept ($M = 8.25$, SE = .13, $p < .001$; $\sigma^2 = 6.79$, SE = .95, $p < .001$) and random slope were supported ($M = –0.44$, SE = .08, $p < .001$; $\sigma^2 = 1.28$, SE = .41, $p = .001$). This suggests significant variability in children's T1 relational aggression levels and their rates of change over time, although relational aggression decreased on average. The intercept and slope factors were significantly negatively associated ($r = –.70$, SE = .06, $p < .001$) suggesting that higher initial levels of relational aggression were associated with greater decreases across the study.

Table 1. Bivariate correlations and descriptive statistics.

	1	2	3	4	5	6	7	8	9	10	11
1. T1 Phys Agg	–										
2. T2 Phys Agg	.48***	–									
3. T3 Phys Agg	.42***	.50***	–								
4. T1 Rel Agg	.65***	.41***	.28***	–							
5. T2 Rel Agg	.38***	.57***	.34***	.49***	–						
6. T3 Rel Agg	.31***	.28***	.57***	.37***	.45***	–					
7. T1 Irritability	.21***	.20***	.10*	.21***	.15***	.01	–				
8. T2 Irritability	.22***	.21***	.13**	.19***	.13**	.03	.76***	–			
9. T3 Irritability	.16**	.16**	.10$^+$	.08	.06	.02	.60***	.60***	–		
10. T1 Delinquency	.17***	.21***	.15**	.16***	.20***	.06	.73***	.63***	.55***	–	
11. T1 Attention Problems	.22***	.25***	.18***	.19***	.17***	.11*	.53***	.45***	.42***	.58***	–
M	3.45	3.53	3.25	8.22	7.94	7.24	0.63	0.69	0.58	1.36	2.48
SD	1.79	1.72	1.48	3.28	2.99	2.43	1.30	1.38	1.16	2.23	2.60
Range	2.00 – 8.91	2.00– 8.87	2.00– 7.62	5.00– 18.24	5.00– 17.31	5.00– 15.06	0.00– 4.84	0.00– 5.11	0.00– 4.47	0.00– 8.73	0.00– 10.00

Note. Phys = Physical, Rel = Relational, Agg = Aggression. T1 = Time 1, T2 = Time 2, T3 = Time 3. $^+p < .10$, $*p < .05$, $**p < .01$, $***p < .001$.

Table 2. Between person associations for bivariate LCM-SRs.

		Physical Aggression Model			*Relational Aggression Model*		
Variable		1	2	3	1	2	3
1.	Irritability Int	-			-		
2.	Aggression Int	.38*** (.07)	-		.30*** (.07)	-	
3.	Aggression Slope	−.27* (.13)	−.52* (.10)	-	−.30** (.10)	−.69*** (.06)	-

Note. Standardized factor correlation estimates, standard errors in parentheses. Levels of significance are based on unstandardized estimates. Aggression intercept and slope coefficients are for the target form (e.g., physical aggression in physical aggression model). Int = intercept; *$p < .05$, **$p < .01$, ***$p < .001$.

Finally, the residual factor variances were significant at all time points (σ^2s = 2.22–4.93, ps = .003 – < .001).

Bivariate LCM-SR Models

Irritability and Physical Aggression

An initial combined model showed poor fit to the data [$\chi^2(13) = 59.82$, $p < .001$; CFI = .93; RMSEA = .07; SRMR = .11]. Adding covariances between the irritability intercept and physical aggression intercept and slope factors improved model fit [$\Delta\chi^2(2) = 35.36$, $p < .001$] and so were retained. Within-time residual covariances did not significantly improve model fit [$\Delta\chi^2(3) = 0.52$, $p = .91$] and were non-significant, so they were not retained. Residual cross-lags also did not improve model fit [$\Delta\chi^2(4) = 3.72$, $p = .44$] but were retained for conceptual purposes.

The final irritability and physical aggression bivariate LCM-SR model showed good fit to the data [$\chi^2(9) = 17.76$, $p = .04$; CFI = .99; RMSEA = .04; SRMR = .03]. At the between-person level, the irritability intercept was significantly positively correlated with the physical aggression intercept factor, and significantly negatively correlated with the physical aggression slope factor (Table 2). The covariance estimate between the irritability intercept and physical aggression slope factor was not easily interpretable because the physical aggression slope factor had significant variability but a mean of zero. Therefore, the linear physical aggression slope at high (i.e., +1 SD) and low levels (i.e., scale minimum value because −1 SD was below the scale range) of irritability was examined (Figure 2a). Physical aggression showed significant decreases at high ($B = -0.33$, SE = .11, $p = .004$) but not low ($B = -0.07$, SE = .04, $p = .09$) irritability. Despite declines at high irritability, a follow-up test in which the physical aggression intercept was specified at T3 showed higher irritability continued to be associated with higher levels of physical aggression at the end of the study ($r = .21$, $p = .007$). Overall, this suggests that, at the between-person level, children with high irritability showed significantly higher levels of physical aggression over the course of the study, and although physical aggression showed mean-level declines for these individuals, levels of physical aggression remained elevated compared to their peers low in irritability at the end of the study. No significant within-person longitudinal effects emerged (Figure 3a).

The irritability intercept factor and physical aggression intercept and slope factors were then regressed onto covariates (i.e., attention problems, delinquency, and average T1 – T3 relational aggression). Between-person and within-person effects estimates for this model are available in Supplemental Table 1 and Supplemental Figure 1a, respectively. The model including covariates provided adequate fit to the data [$\chi^2(18) = 48.52$, $p < .001$; CFI = .98; RMSEA = .05; SRMR = .06]. Relative to the unconditional model, the only interpretive change in the conditional model was that the covariance between the irritability intercept factor and physical aggression slope factor became marginally significant ($p = .07$). Given the relative lack of change in interpretation, the more parsimonious unconditional model was retained for multiple group analyses.[1]

With gender entered as a grouping variable, the fully freed model showed significantly better fit than the constrained model [$\Delta\chi^2(18) = 36.49$, $p = .006$], suggesting a significant difference by gender. An examination of MIs suggested significant gender differences in the physical aggression intercept mean (MI = 10.05), with boys having a higher mean than girls. With this parameter freed, the model showed adequate fit to the data [$\chi^2(35) = 57.45$, $p = .01$; CFI = .97; RMSEA = .04; SRMR = .07] and no additional substantial MIs emerged. Therefore, the only significant gender difference in this bivariate LCM-SR model is that boys showed higher initial values of physical aggression than girls.

Irritability and Relational Aggression

Results of the unconditional bivariate LCM-SR model for irritability and relational aggression were similar to

[1]Upon reviewer request, we also ran bivariate models controlling for internalizing problems measured by the Internalizing Problems scale of the TRF at T1 which was internally consistent in prior work with this dataset (Murray-Close et al., 2007) along with the other conceptual covariates. The general pattern of effects did not change.

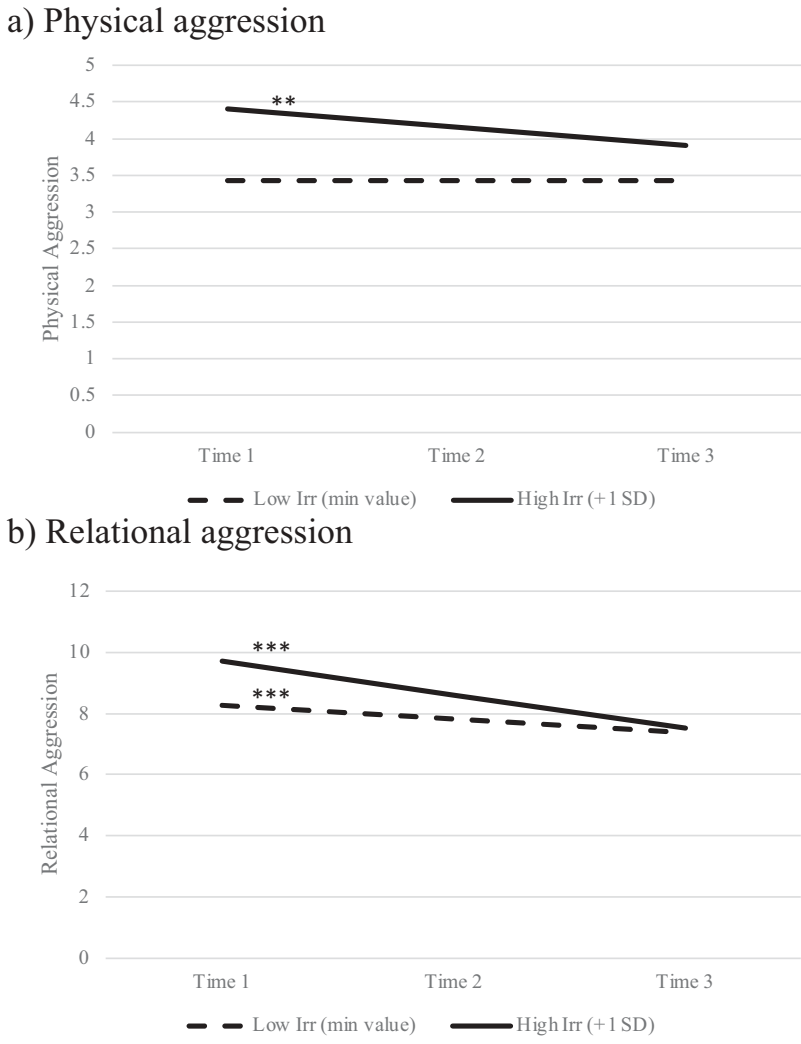

Figure 2. Aggression slopes at low and high irritability. *Note*. Figures display model implied values of physical and relational aggression at each time point at high (+1 SD from mean) and low (scale minimum value) mean levels of irritability. Minimum value of irritability is used because -1 SD is below the scale range. Irr = irritability, SD = standard deviation. $^{**}p < .01$, $^{***}p < .001$.

the physical aggression model. An initial combined model showed adequate fit to the data [$\chi^2(12) = 42.11$, $p < .001$; CFI = .95; RMSEA = .06; SRMR = .07]. Covariances between the irritability intercept and relational aggression intercept and slope factors significantly improved model fit [$\Delta\chi^2(2) = 22.14$, $p < .001$] and so were retained. Within-time residual covariances did not significantly improve model fit [$\Delta\chi^2(3) = 6.05$, $p = .11$] and were non-significant, so were not retained. Adding residual cross-lags did not significantly improve model fit [$\Delta\chi^2(4) = 4.07$, $p = .40$], but were retained for conceptual purposes.

The final model showed good fit to the data [$\chi^2(8) = 16.02$, $p = .04$; CFI = .99; RMSEA = .04; SRMR = .03]. At the between-person level, the irritability intercept was positively correlated with the relational aggression intercept factor and negatively correlated with the relational aggression slope factor (Table 2). This indicates that higher mean levels of irritability were associated with higher starting values of, and decreases in, relational aggression (Figure 2b). A post-hoc examination showed that participants showed decreases in relational aggression at both high irritability (i.e., +1 SD from the mean; $B = -1.09$, SE = .23, $p < .001$) and low irritability (i.e., scale minimum; $B = -0.45$, SE = .08, $p < .001$), but decreases were greater at high levels of irritability. An examination of the covariance between the irritability intercept factor and the relational aggression intercept factor re-parameterized to represent average levels at each time point indicated that higher irritability predicted significantly higher levels of relational aggression at T2 ($r = .22$, $p = .001$), but not at T3 ($r = .04$, $p = .58$). No significant within-person longitudinal effects emerged (Figure 3b).

The conditional model including covariates showed good fit to the data [$\chi^2(17) = 41.52$, $p < .001$; CFI = .98;

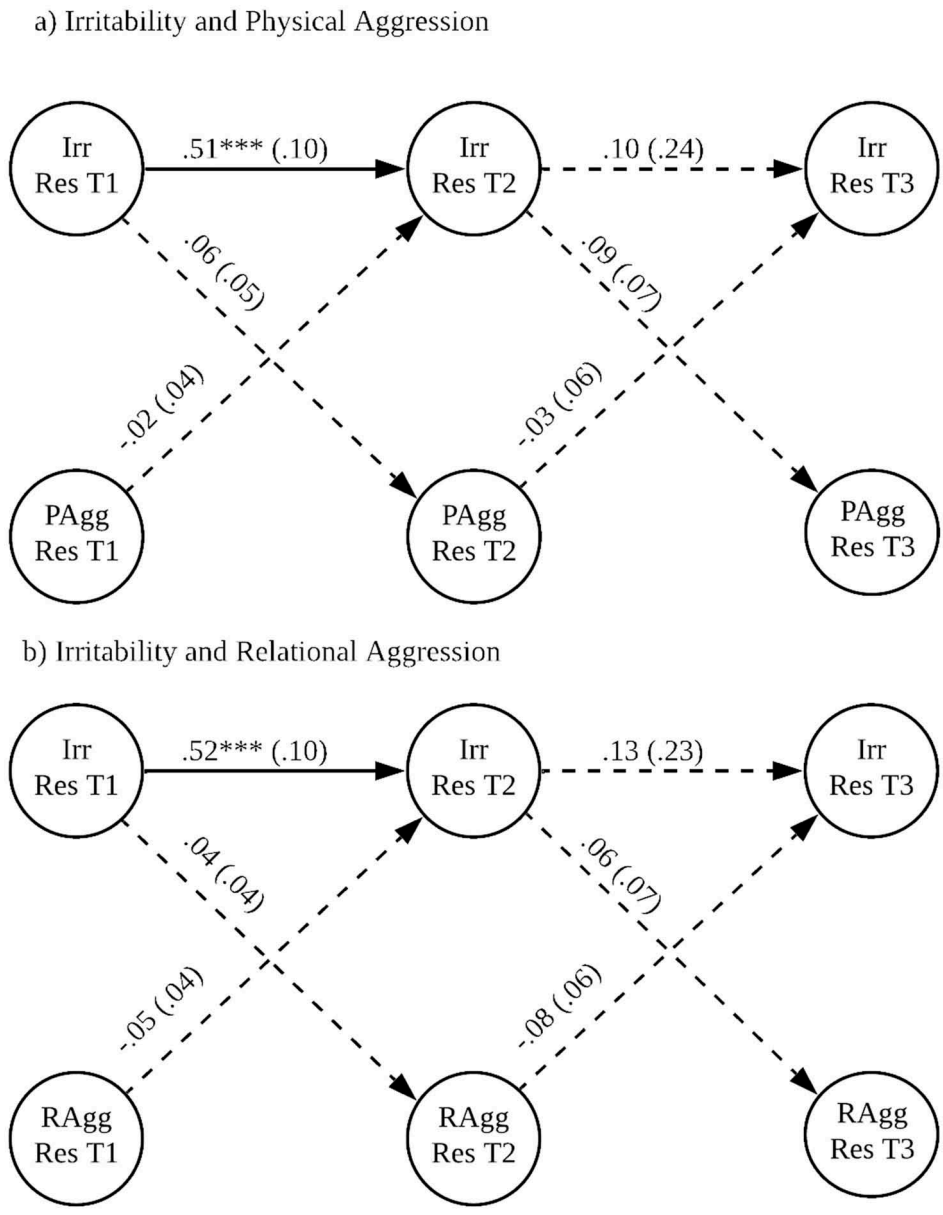

Figure 3. Within-person effects from bivariate LCM-SRs. *Note*. Standardized regression coefficients are presented with standard errors in parentheses. Statistical significance was determined using unstandardized estimates. Within-time covariances and aggression stability paths were tested but not retained (see main text for details). Solid lines are significant, dashed lines are nonsignificant. T1 = Time 1, T2 = Time 2, T3 = Time 3; Irr = Irritability, PAgg = Physical aggression, RAgg = Relational aggression, Res = Residual; ***$p < .001$.

RMSEA = .05; SRMR = .05]. Between- and within-person effect estimates for this model are available (Supplemental Table 1 and Supplemental Figure 1b). The relational aggression and irritability intercept factor correlation became non-significant ($p = .18$). No other interpretive changes emerged, and the more parsimonious unconditional model was retained.

With gender entered as a grouping variable, a constrained model provided good fit to the data [$\chi^2(35) = 43.65$, $p = .15$; CFI = .99; RMSEA = .03; SRMR = .04], and the freed model did not provide significantly better fit [$\Delta\chi^2(19) = 21.20$, $p = .32$]. Therefore, the constrained model was retained, indicating no significant gender differences.

Discussion

The current study tested bidirectional associations between irritability and two forms of aggression (i.e., physical and relational) at the between- and within-person levels over one year in middle childhood. Consistent with frustration models of aggression

(Berkowitz, 1993) and the SIP model (Crick & Dodge, 1994; Lemerise & Arsenio, 2000), we expected that irritability would predict increases in aggression and that engaging in aggressive behavior would predict increases in irritability at the between- and within-person levels. Specifically, irritable children may be more likely to view situations as threatening and respond aggressively, which may be negatively reinforcing, ultimately increasing risk for aggression over time. Additionally, aggressive behavior may lead to the escalation of irritability, which may be reinforced via threat removal (e.g., a provocateur stopping threatening behavior). Importantly, although these processes were expected at both the between- and within-person levels, prevention and intervention efforts in psychology typically target within-person processes. This makes it critical to specifically examine this level of effects, which has been neglected in the literature to date (Curran et al., 2014). We also examined gender differences and anticipated that models would hold even when controlling for relevant covariates, such as attention problems and delinquency.

Hypotheses were tested using LCM-SR models. At the univariate level, relational aggression showed significant mean-level decreases. This is consistent with prior work showing an overall decreasing linear trend in relational aggression in middle childhood (Fite & Pederson, 2018), including using self-reports (Park et al., 2005), but is inconsistent with prior work with this dataset using peer reports, which showed increases in rates of relational aggression (Murray-Close et al., 2007). This difference may reflect changes in self-evaluation abilities and salience of social standing in middle childhood (Davis-Kean et al., 2009), which may make children less willing to admit their own undesirable aggressive behavior but better able to report on peers' behavior. Given the relative lack of studies examining longitudinal trajectories of relational relative to physical aggression (Fite & Pederson, 2018), additional work is needed to clarify these trajectories and potential reporter effects. Both physical and relational aggression also showed significant individual variability in slope, consistent with prior work showing significant individual variability in aggression growth trajectories in this developmental period (Fite & Pederson, 2018). Indeed, physical aggression did not show mean-level growth, highlighting that neglecting to model between-person variability may mask growth in physical aggression during this developmental period. Finally, irritability did not show significant mean level or variability in growth at the between-person level. This may be a reflection of features of the study design (see below), but is also consistent with findings that irritability is largely stable within middle childhood (Kiefer & Wiggins, 2019; Leibenluft & Stoddard, 2013).

Within bivariate models, we found mixed support for hypotheses. At the between-person level, irritability predicted higher levels of, and declines in, both physical and relational aggression. That high irritability predicted declines in physical and relational aggression was unexpected. As high irritability initially predicted higher levels of both forms of aggression, this may reflect a regression to the mean. It may also reflect maturation processes (i.e., typical declines in aggression; Fite & Pederson, 2018; Frick & Matlasz, 2018). However, despite declines, irritability continued to predict higher levels of physical aggression throughout the study, although the effect of irritability on relational aggression was no longer significant at T3. Lasting effects of irritability on physical aggression are consistent with prior work indicating that the temperament construct of negative emotionality serves as a risk factor in the development of persistent aggressive behavior in childhood (Murray-Close et al., 2016). The more acute effects of irritability on relational aggression may be consistent with prior school-based research demonstrating less persistent effects of irritability, relative to other externalizing problems (e.g., ADHD), on a number of social-emotional trajectories (Evans et al., 2020). Alternatively, as irritability has stronger associations with reactive (i.e., in response to perceived threat) relative to proactive (i.e., to achieve instrumental goals) functions of aggression (Brotman et al., 2017; Card & Little, 2006; Hubbard et al., 2010; Stoddard et al., 2019), it may become a less salient predictor of relational aggression across this developmental period due to changes in the relative prevalence of reactive relational aggression (Ojanen & Kiefer, 2013). As growth in irritability was not supported by the data, the study findings do not provide information regarding associations between aggression and change in irritability at the between-person level. Future work addressing this question may be more feasible during developmental periods associated with greater change in irritability levels (e.g., early childhood).

In regard to gender differences, boys had higher initial levels of physical aggression, consistent with prior work (e.g., Lansford et al., 2012). No other significant gender differences emerged. These findings are somewhat inconsistent with the gender-linked model of aggression (Ostrov & Godleski, 2010), which would have also suggested that girls would show higher levels of relational aggression. However, findings are consistent with a prior meta-analysis which found minimal gender differences in relational and related forms (e.g., indirect) of aggression (Card et al., 2008). Notably, only

between-group gender differences were tested, whereas the gender-linked model would also suggest within-group effects, which future work could examine.

Contrary to expectations, no within-person associations emerged in either the physical or relational aggression models. Therefore, hypothesized reciprocal bidirectional associations between irritability and aggression subtypes at the within-person level were not supported. This is inconsistent with prior work with children and adolescents that has found bidirectional associations between irritability and aggression at the between-person level (Atherton et al., 2017; Perhamus & Ostrov, 2021), as well as positive longitudinal associations between poor anger regulation and aggression at the within-person level in middle childhood (Alsem et al., 2022). Our results suggest that effects of irritability on aggression may be more robust at the between-person level, but these results require replication and further study.

Limitations and Future Directions

This study has a number of significant strengths, including a large, diverse sample, multiple informants, and theoretically derived hypotheses. However, there are also several limitations. First, several aspects of the measures could have masked findings. Both the physical aggression and irritability subscales had a limited number of items (i.e., 2 items for physical aggression, 3 for irritability) and therefore may not have adequately captured the constructs of interest. Furthermore, to our knowledge, this is the first use of the teacher report version of this 3-item irritability scale. Although prior work has demonstrated that teachers can reliably and validly report on youth irritability in the school context (Evans et al., 2016), and the items used in the TRF are identical to the validated parent report subscale (Evans et al., 2020), further work may be needed to validate this version. Additionally, a recent item response theory analysis showed that the parent-report version of the 3-item irritability scale may not adequately capture lower levels of irritability, especially in a childhood sample (Dougherty et al., 2021). Overall, this suggests that additional work is needed to develop and validate measures capturing the full spectrum of irritability across reporters, particularly in middle childhood (Dougherty et al., 2021). Likewise, as noted above, children may be less willing to report on their own aggressive behavior, which may have resulted in underestimates of aggression and masked associations with irritability. Finally, there was significant attrition at the last time point, which although accommodated using FIML, may have limited our ability to detect longitudinal associations.

Second, aspects of the study timeline may have masked effects. Although the use of multiple reporters is a strength, the change in academic year between T2 to T3 meant that different teachers reported on irritability at T3 relative to earlier time points. Both this change in reporter and classroom context may have introduced noise; repeated measures with the same reporter would have been preferred for growth modeling. However, it is notable that there was moderate stability in irritability at the bivariate level across this transition. Additionally, the approximately 6-month interval between time points may not adequately capture the more proximal effects of affect on behavior as theorized by the SIP model. The theorized bidirectional reinforcement processes between irritability and aggression would be expected to operate over both proximal and extended time periods (Moore et al., 2018; Stoddard et al., 2019). However, hypothesized within-person effects may be better examined with more frequent assessments. This could explain the difference in our results relative to those by Alsem et al. (2022), as they examined effects with repeated measures over just 4 weeks. It will be important for future work to examine whether more proximal assessments would better capture these processes.

Relatedly, although LCM-SR models are estimable with three waves of data, constraints are needed, and four or more measurement occasions are preferred (Littlefield et al., 2022). Specifically, we were limited to testing linear growth, and equality constraints on residual variances and autoregressive paths were required for identification. As equality constraints on the residual variances in the aggression univariate LCM-SR models were not supported (see supplemental materials), we were unable to include autoregressive paths among the residuals in these models. Although alternative simplified models (i.e., a traditional CLPM or random-intercept CLPM) would have allowed for the inclusion of these paths, these models are nested within the LCM-SR models, and not including growth terms when they are supported by the data results in model misspecification and biased estimates (Littlefield et al., 2022). Therefore, although there are limitations to applying an LCM-SR model with three time points, these limitations should be considered relative to the alternative of model misspecification that would result from relying on a simpler modeling framework. It will be important for future work to replicate and extend these findings with additional time points.

Finally, the study's measures did not distinguish between reactive and proactive functions of aggression, which are differentially related to irritability and associated constructs. Specifically, irritability tends to have

stronger associations with reactive relative to proactive aggression (Brotman et al., 2017; Stoddard et al., 2019). Additionally, social-cognitive biases that tend to co-occur with irritability are theoretically and empirically linked predominantly to reactive aggressive responding (Brotman et al., 2017; Orobio de Castro et al., 2002). Future work may consider whether hypothesized between- and within-person processes may be specifically found in relation to reactive functions of aggression. Relatedly, the study was not able to distinguish between phasic and tonic dimensions of irritability. As phasic irritability may have stronger associations with externalizing problems relative to tonic irritability (Silver et al., 2023), future work should examine potential differences across irritability dimensions.

Conclusions

The current study tested bidirectional associations between irritability and physical and relational forms of aggression over one year in middle childhood. Overall, findings suggest that irritability may represent a stable between-person risk factor for high levels of physical and relational aggression in middle childhood, although effects on relational aggression did not persist across the course of the study. These findings highlight the importance of including affective processes in understanding the development of aggression.

Disclosure statement

No potential conflict of interest was reported by the authors.

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