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# Dual Trajectories of Reactive and Proactive Aggression from Mid-childhood to Early Adolescence: Relations to Sensation Seeking, Risk Taking, and Moral Reasoning

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**Abstract** We examined the roles of sensation seeking, risk taking, and moral reasoning in the development of reactive and proactive aggression. Data were drawn from a multiethnic, longitudinal study of children from Switzerland ($N$=1571; 52 % male; assessed annually over 6 years; 7-years-old at Time 1). At all 6 time points, teachers reported children's reactive and proactive aggression via questionnaire. Children's sensation seeking (at Time 1) and risk taking (at Time 2) were assessed with two interactive computer tasks and their moral reasoning was assessed at Time 2 in response to four hypothetical vignettes depicting moral transgressions. Parallel process Latent Class Growth Analysis (PP-LCGA) identified six dual trajectories of reactive and proactive aggression. Children with either childhood-limited or adolescent-onset aggression showed high sensation seeking. Children with persistent, high levels of both reactive and proactive aggression across time showed high levels of sensation seeking and risk taking, as well as low levels of moral reasoning. Children with only high risk taking were more likely to display moderate levels of aggression across time. These findings highlight the shared and differential roles of sensation seeking, risk taking, and moral reasoning in the dual development of reactive and proactive aggression from mid-childhood to early adolescence. We discuss implications for common and tailored strategies to combat these aggression subtypes.

**Keywords** Reactive aggression · Proactive aggression · Sensation seeking · Risk taking · Moral reasoning · Longitudinal study

Reactive (i.e., hot-headed or emotional) and proactive (i.e., cold-blooded or unemotional) forms of aggression have been associated with distinct, adverse outcomes across development (see Hubbard et al. 2010 for a review). For example, reactive aggression has been linked to internalizing symptoms, such as anxiety and depression (Fite et al. 2014), whereas proactive aggression has been associated with subsequent externalizing symptoms, such as violence and vandalism (Vitaro and Brendgen 2005; Vitaro et al. 2006). The most effective reduction of these aggression subtypes and their respective consequences will likely require knowledge of their shared and unique sources, and early developmental antecedents. However, little is known about the shared and differential developmental antecedents that contribute to the emergence and persistence of reactive and/or proactive aggression.

In the present investigation, we aimed to clarify the regulatory and moral antecedents of the dual development of reactive and proactive aggression. Specifically, we examined relations of sensation seeking, risk taking, and moral reasoning to dual developmental trajectories of reactive and proactive aggression, which were identified with parallel process Latent Class Growth Analysis (PP-LCGA; e.g., Wardenaar et al. 2015). Given the dearth of longitudinal studies on reactive and proactive aggression spanning childhood and adolescence, we focused on the period of mid-childhood to early

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adolescence (i.e., from age 7 to 12). This allowed us to assess the antecedents and correlates of childhood-onset/-limited and adolescent-onset aggression, which have been shown to vary in their severity and persistence across the lifetime (e.g., Moffitt 1993, 2003; Xie et al. 2011).

## The Development of Reactive and Proactive Aggression

Both reactive and proactive aggression involve an intention to physically and/or mentally harm others (Arsenio et al. 2009). However, reactive aggression is characterized by emotional, defensive harm in response to goal blocking or provocation (Dodge et al. 2006), whereas proactive aggression is characterized by unemotional, goal-oriented harm in anticipation of self-serving outcomes (Arsenio et al. 2009). A person-centered approach can help to better understand how aggression unfolds within children across development and to outline differential patterns of within-child change (Nagin 2005). A number of studies adopting this approach have found the following groups of generalized aggression trajectories from childhood to adolescence: a small High-Stable/High group with childhood onset, a Low-Increasing group with adolescence onset, a High-/Moderate-Decreasing childhood-limited group, a large Low-Stable group, and other groups stemming from unique sample characteristics (e.g., Bongers et al. 2004; Nagin and Tremblay 1999).

Reactive and proactive aggression appear to follow similar trajectories, at least in adolescence (Barker et al. 2006; Fite et al. 2008). For example, Barker et al. (2006) identified three trajectories of both reactive and proactive aggression among adolescent boys from 13- to 17-years-of-age: a High-Stable group (that peaked at age 15; approximately 7 % of the sample), a Moderate-Decreasing group, and a Low-Stable group (approximately 50 % of the sample). The present study was among the first to assess reactive and proactive aggression across childhood and adolescence, which allowed us to explore the distinction between childhood- and adolescent-onset/limited groups. Childhood-onset aggression (excluding childhood-limited) tends to persist across the lifetime and predicts long-term maladjustment. Adolescent-onset aggression typically desists into adulthood and more often relates to concurrent adjustment issues (Moffitt 1993, 2003; Xie et al. 2011).

In addition, there is evidence that both forms of aggression tend to co-occur within the same child (see Card and Little 2006). Developmental researchers have therefore begun to study the comorbidity or overlap of reactive and proactive aggression. Various empirical studies have demonstrated that children and adolescents who display both types of aggression may be at particularly high risk for poor developmental outcomes, including both internalizing and externalizing problems (e.g., Barker et al. 2006; Pang et al. 2013; Salmivalli and Nieminen 2002). However, relatively few studies have investigated the comorbidity of reactive and proactive aggression over time. To fill this research gap, we aimed to identify the dual developmental trajectories of reactive and proactive aggression from mid-childhood to early adolescence.

## Sensation Seeking, Risk Taking, and the Development of Reactive and Proactive Aggression

Sensation seeking and risk taking have been strongly implicated in the development of aggressive behavioral disorders (Roberti 2004; Swaim et al. 2004; Wilson and Scarpa 2011). *Sensation seeking* is the tendency to pursue exciting experiences with the end goal of increasing arousal and high levels thereof reflect strong, arousal-related impulses (Zuckerman 1994). A recent meta-analysis of 43 independent effect sizes and 32, 217 participants from late childhood to early adulthood found a significant, positive association between sensation seeking and aggression ($d$=0.19, $p$<0.001; Wilson and Scarpa 2011). *Risk taking* implies a propensity to act on impulses for reward despite the potential for undesirable consequences (Lejuez et al. 2002). Behaviors endemic to early risk taking include aggression and delinquency (e.g., Romer 2010; Swaim et al. 2004).

Relatively few studies have considered sensation seeking and risk taking in relation to reactive and proactive aggression. However, it is reasonable to argue that sensation seeking and risk taking are more apparent in children with reactive aggression because they have the tendencies to seek excitement and act on their impulses in the heat of the moment, whereas children with proactive aggression are able to channel their misconduct in a calculated manner (see Dodge et al. 2006). Empirically, low levels of behavioral inhibition (including high sensation seeking) have been associated with both reactive and proactive aggression in studies with 2- to 5-year-olds (Kimonis et al. 2006) and 16-year-olds (Raine et al. 2006). Collectively, these findings suggest that both reactive and proactive aggression are associated with impulsive tendencies, although proactively aggressive children may be more apt at regulating immediate, aggressive impulses and translating them into planned aggressive acts. Nonetheless, these studies were cross-sectional and mostly relied on questionnaire measures of temperamental impulsivity rather than direct measures of sensation seeking and risk taking. The present study was the first to utilize behavioral measures of both constructs and to account for relations of both to reactive and proactive aggression in a longitudinal framework.

## Moral Reasoning and the Development of Reactive and Proactive Aggression

Developmental scientists have argued that both moral emotions and moral reasoning (i.e., the use of moral logic, norms, and self-reflection to guide and justify behavior) can highlight the negative consequences of aggressive conduct, reduce the likelihood of its occurrence, and motivate moral behavior in children and adolescents (e.g., Arsenio 2014; Malti and Krettenauer 2013). There has been some empirical support for the link between moral reasoning and aggression. For example, Murray-Close et al. (2006) found that children who endorsed physical aggression were more aggressive than children who perceived such conduct as morally wrong.

Limited evidence also suggests that moral reasoning may be differentially related to reactive and proactive aggression. Arsenio et al. (2009) found that moral emotion attributions and moral reasoning in response to vignettes depicting deliberate harm were collectively and negatively related to proactive but not reactive aggression in a sample of adolescents from low-SES families. There is also evidence that both reactively and non-aggressive children, but not proactively aggressive children, tend to share the belief that harming others is morally wrong and unfair (see Arsenio 2010). Together, these findings suggest that factors other than morality (e.g., deficient regulatory abilities and foresight) may prevent reactively aggressive children from capitalizing on their moral reasoning skills in provoking situations. Proactively aggressive children, on the other hand, may favor the positive emotional and material incentives of aggressive acts at the expense of lacking moral judgment and moral reasoning skills (Arsenio et al. 2009; Blair 2011). Building on this limited, cross-sectional evidence, the present study was the first to examine whether mid-childhood deficits in moral reasoning trigger proactive, but not reactive aggression trajectories into early adolescence.

## The Present Study

Our major research questions were two fold: First, what are the distinct and dual developmental trajectories of reactive and proactive aggression from mid-childhood to early adolescence? Second, how do sensation seeking, risk taking, and moral reasoning in mid-childhood relate to these dual trajectories? Similar to longitudinal studies in adolescence (e.g., Barker et al. 2006; Fite et al. 2008), we expected to uncover the following groups of both reactive and proactive aggression trajectories: a small High-Stable group, a High-/Moderate-Decreasing group, and a large Low-Stable group. Based on past longitudinal studies of generalized aggression (e.g., Bongers et al. 2004; Nagin and Tremblay 1999), we also expected a Low-Increasing group from childhood to adolescence. Previous longitudinal studies on aggression subtypes, being restricted to adolescence, have been unable to investigate the latter. As for dual developmental trajectories, we expected to find similar Dual High-Stable, Dual Low-Stable, and Dual High-/Moderate-Decreasing groups, and due to lack of empirical evidence, we aimed to explore other possible combinations of distinct trajectories of both subtypes.

In line with cross-sectional findings (e.g., Kimonis et al. 2006), we expected high sensation seeking and risk taking to predict problematic pathways of reactive and proactive aggression. Finally, we hypothesized that deficient moral reasoning would relate to high-stable trajectories of proactive, but not reactive, aggression because past findings and theorizing suggest that deficits in the moral domain may be unique to proactively aggressive children (Blair 2011). We controlled for socioeconomic status (SES) and sex in light of previous studies linking SES to aggression (Dodge et al. 1994) and moral development (Malti and Ongley 2014), and sex to aggression (Archer 2004).

## Method

### Participants

Data were drawn from an ongoing combined longitudinal and intervention study in Switzerland, the Zürich Project on the Social Development of Children and Youths (z-proso), which includes 56 elementary schools (stratified by enrollment size and SES). At Time 1, the target sample consisted of all first grade students from these schools ($N$=1675; 52 % male; $M$age=7.5 years). The present analysis included annual data from teachers between 2004/5 and 2009/10 (i.e., Times 1–6; ages 7–12) and data from children at Times 1 and 2 (i.e., ages 7 and 8). The same teachers completed assessments from Times 1–3 and 4–6, respectively. The final sample consisted of 1571 children who had aggression data for at least one time point (97.6 % of children had at least two waves of data; 85.9 % had at least three, 83.1 % had at least four, 74.1 % had at least five, and 55.3 % had all six; $N$s=1349; 1325; 1294; 1269; 1266; and 1288 at each respective time point for teacher reports). The present analysis focused on the longitudinal component of the study, for which there was an intervention component with treatment and control groups. There were no statistically significant baseline differences on any of the teacher outcome measures across treatment conditions and there were also no statistically significant intervention effects observed for most child development outcomes (see Malti et al. 2011).

The city of Zürich has one of the highest populations of immigrants in Europe, which contributed to the sample's representativeness (see Eisner et al. 2011). Eleven percent of children were born outside of Switzerland and both parents were born outside of Switzerland in 46 % of cases. Birth countries of both

parents combined included ex-Yugoslavia (16 %), Germany (5 %), Portugal (5 %), Sri Lanka (5 %), Turkey (4 %), rest of Asia (4 %), Italy (3 %), Spain (2 %), EU-15 countries (4 %), other South/East Europe (2 %), Sub-Saharan Africa (3 %), North Africa (1 %), Brazil (1 %), rest of Latin America (3 %), Middle East (2 %), USA/CAN/NZ/AUS (1 %), and unknown origins (0.1 %). In terms of educational attainment, 24 % of parents had little or no secondary education, 32 % had vocational training, 29 % had a baccalaureate degree or advanced vocational diploma, and 16 % had a university degree.

## Procedure

Institutional Review Board (IRB) approval was obtained prior to recruitment and data collection. Parents provided written informed consent at Time 1 (valid until Time 3) and Time 4 (valid until Time 6). At Times 1 and 2, children partook in computer-assisted interviews that lasted approximately 45 min. Forty-four intensively trained research assistants administered the interviews at the schools and recorded children's responses on computers. Children also completed interactive, computer-based tasks as part of the interviews. To accommodate immigrant participants, special care was taken to recruit native speaking research assistants and ensure cross-cultural competence. At all time points, teachers completed a questionnaire. Two experts with experience in questionnaire design translated all instruments that had originally been developed in English (Eisner and Ribeaud 2007).

## Measures

**Aggression Subtypes** We chose to analyze teacher reports of children's reactive and proactive aggression because they were collected across all six time points of the study and evidence suggests that teachers provide valid assessments of aggressive behavior in middle childhood (Henry and Metropolitan Area Child Study Research Group 2006), whereas children often have difficulty providing consistent reports of their own externalizing behavior (Loeber et al. 1991). Teachers reported children's aggression using the reactive and proactive aggression subscales of the Social Behavior Questionnaire (SBQ; Tremblay et al. 1991), a comprehensive assessment of children's problem and prosocial behaviors. SBQ reactive and proactive aggression measures assessed by teachers have shown good predictive validity (e.g., Vitaro et al. 1998).

*Reactive aggression.* Teachers rated three reactive aggression items (e.g., "The child responds in an aggressive manner when teased" and "…is aggressive when contradicted") on a 5-point Likert scale ranging from 0 (*never*) to 4 (*very often*). Mean scores were calculated and higher scores indicated higher levels of reactive aggression. Cronbach's αs ranged from 0.92 to 0.94 in the current study.

*Proactive aggression.* Teachers rated four proactive aggression items (e.g., "The child scares other children to get what he/she wants" and "…tries to dominate other children") on a 5-point Likert scale ranging from 0 (*never*) to 4 (*very often*). Mean scores were calculated and higher scores indicated higher levels of proactive aggression. Cronbach's αs ranged from 0.87 to 0.90 in the current study.

**Sensation Seeking** At Time 1, children's sensation seeking was assessed with the "Travel Game", which was developed by Alsaker and Gutzwiller-Helfenfinger (2010) and adapted as a computer-based task for the current study. The Travel Game involves the child taking a hypothetical "trip". As they move their token along the trip (i.e., a line), the child is required to make a series of choices between two alternative situations, one sensational and one less sensational (e.g., choose to travel with a fast motorbike vs. a funny steam locomotive; choose to watch a horror film or kids' animated cartoon). A proportional score for each child was calculated by dividing their number of sensational choices by the total number of choices. Higher scores indicated higher levels of sensation seeking. In the z-proso study, sensation seeking assessed using the Travel Game has shown substantial cross-informant associations with teacher-assessed ADHD problems ($r$=0.22) and interviewer-assessed restlessness and impulsivity ($r$=0.14).

**Risk Taking** At Time 2, children's risk taking was assessed with the Balloon Analogue Risk Task (BART; Lejuez et al. 2002), a computer-based, behavioral assessment of risk taking propensity. Scores on the BART task have been shown to predict real-world risk-taking behavior among adolescents (e.g., Lejuez et al. 2003). During this task, children are told to earn as many coins as possible by clicking a "pump" button several times to inflate a balloon. The more the balloon is inflated, the more coins are earned. However, the balloon is programmed to burst after a certain number of pumps and all coins of that trial are lost. Children played a total of 20 trials. As recommended by Lejuez et al. (2002), we quantified risk taking by calculating the average number of pumps across all trials (excluding those in which the balloon burst) for each child, which ranged from 0.67 to 91.25, and standardized these scores for further analyses. Higher scores indicated higher levels of risk taking.

**Moral Reasoning** At Time 2, children's moral reasoning was assessed in response to four vignettes depicting moral transgressions (e.g., pushing another child, teasing or bullying).

For each vignette, children were asked if the hypothetical character's actions were right or wrong (i.e., to provide their judgment). They were then asked to provide their reasoning as to why the actions in question were right or wrong. Nineteen interviewers, mostly female, graduated social science students of psychology, sociology, and education (aged 25–30 years), received intensive training on moral reasoning coding and coded children's answers as the following based on a standard manual: (a) golden rule; (b) moral norms; (c) empathy; (d) hedonistic; (e) sanction-oriented; (f) repetition; and (g) undifferentiated. In line with related research on children's moral reasoning (Malti et al. 2009), responses coded as a, b, or c were combined and coded as 1 (*moral*), whereas all other responses were recoded as 0 (*non-moral*). Resulting binary scores were aggregated across the four vignettes to create a composite score for each child. Higher scores indicated higher levels of moral reasoning.

**Socioeconomic Status** As a proxy of socioeconomic status (SES), parents' professions were coded according to Elias and Birch (1994) and transformed into International Socio-Economic Index (ISEI) of occupational status scores ranging from 16 to 90 (Ganzeboom et al. 1992). Final ISEI scores (based on the parent with the highest score) were standardized for further analyses.

### Missing Data and Data Analysis Strategy

Retention rates were higher than 80 % for teacher assessments across all time points and the retention rate for Time 2 child assessments was 95 %. Little's Test (1988) in SPSS 22 revealed that data were not Missing Completely at Random (MCAR), $\chi^2$ (571)=679.81, $p$=0.001. Since SES predicted missingness, we controlled for this variable in all further analyses. To account for missing data, we employed maximum likelihood with robust standard errors (MLR) for parameter estimation in M*plus* 7.11 (Muthén and Muthén 1998–2012).

The following data analysis strategy was utilized to investigate our research questions: to answer our first research question, we used Latent Growth Curve Modeling (LGCM) to examine overall changes in reactive and proactive aggression, respectively, based on a comparative fit index (CFI) near 0.95, a root mean square error of approximation (RMSEA) near 0.06, and a maximum likelihood-based standardized root mean squared residual (SRMR) near 0.08 (Hu and Bentler 1999). We then identified distinct developmental trajectories of reactive and proactive aggression using Latent Class Growth Analysis (LCGA). At last we used PP-LCGA (Wardenaar et al. 2015) to identify dual developmental trajectories of reactive and proactive aggression. Evaluation of the best fitting models was based on the following criteria: (1) Low Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) scores; (2) high entropy; (3) significant Vuong-Lo-Mendel-Rubin Likelihood Ratio Test (LMR-LRT) and the Bootstrap Likelihood Ratio Test (BLRT); (4) a parsimonious and conceptually clear model; and (5) sufficient number of members in each trajectory group (Haltigan and Vaillancourt 2014; Wardenaar et al. 2015). Random start numbers and final stage optimizations were increased to avoid local maxima. To answer our second research question, multinomial logistic regression was used to predict dual trajectory membership from children's levels of sensation seeking, risk taking, and moral reasoning (controlling for sex and SES) in SPSS 21.

## Results

### Descriptive Statistics

Descriptive statistics and zero-order correlations are shown in Table 1. At all time points, high levels of sensation seeking and risk taking were associated with high levels of reactive and proactive aggression. At Time 2, high levels of moral reasoning were associated with low levels of reactive aggression. Boys had higher levels of reactive aggression, proactive aggression, and sensation seeking, whereas girls had higher levels of moral reasoning. Higher SES was associated with lower levels of reactive aggression, proactive aggression, and risk taking, and higher levels of moral reasoning. Children showed stability in both reactive and proactive aggression across time. Reactive and proactive aggression were positively associated with each other at all time points.

### Distinct Developmental Trajectories of Reactive and Proactive Aggression

LGCM indicated that a cubic model fit the data for reactive aggression, $\chi^2$ (11)=100.69, $p$<0.001, CFI=0.95, RMSEA=0.07, SRMR=0.04, better than a quadratic model, $\Delta\chi^2$ (1)=6.41, $p$<0.03. Overall, children's reactive aggression started stable, decreased at a high rate, and then decreased at a lower rate into early adolescence. From this overall LGC model, we estimated 1-, 2-, 3-, 4-, and 5-class models of reactive aggression using LCGA (see Table 2 for fit indices). A 4-class model fit the data best. Figure 1a depicts the four identified classes or groups of reactive aggression trajectories from Time 1 to 6: Class 1 High-Stable trajectory (7.6 %, $n$=119); Class 2 Low-Increasing trajectory (8.3 %, $n$=130); Class 3 Moderate-Decreasing trajectory (25 %, $n$=390); and Class 4 Low-Stable trajectory (59 %, $n$=932).

For proactive aggression, LGCM indicated that a quadratic model fit the data, $\chi^2$ (12)=128.09, $p$<0.001, CFI=0.93, RMSEA=0.08, SRMR=0.05, and a cubic model was not better than a quadratic model, $\Delta\chi^2$ (1)=1.75, $p$>0.05. Overall,

**Table 1** Descriptive statistics and correlations between study variables

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Sex[a] | – | | | | | | | | | | | | | | | | |
| 2. SES | -0.04 | – | | | | | | | | | | | | | | | |
| 3. SS | -0.41*** | -0.02 | – | | | | | | | | | | | | | | |
| 4. RT | -0.05 | -0.06* | 0.05 | – | | | | | | | | | | | | | |
| 5. MR | 0.08** | 0.08** | -0.03 | 0.03 | – | | | | | | | | | | | | |
| 6. RA T1 | -0.17*** | -0.10*** | 0.17*** | 0.06* | -0.04 | – | | | | | | | | | | | |
| 7. RA T2 | -0.13*** | -0.12*** | 0.12*** | 0.10** | -0.06* | 0.63*** | – | | | | | | | | | | |
| 8. RA T3 | -0.17*** | -0.09** | 0.16*** | 0.06* | 0.02 | 0.48*** | 0.58*** | – | | | | | | | | | |
| 9. RA T4 | -0.20*** | -0.05 | 0.14*** | 0.06* | -0.01 | 0.30*** | 0.25*** | 0.32*** | – | | | | | | | | |
| 10. RA T5 | -0.18*** | -0.10** | 0.11*** | 0.06* | -0.00 | 0.28*** | 0.27*** | 0.25*** | 0.32*** | – | | | | | | | |
| 11. RA T6 | -0.16*** | -0.14*** | 0.12*** | 0.07* | -0.03 | 0.21*** | 0.18*** | 0.19*** | 0.23*** | 0.45*** | – | | | | | | |
| 12. PA T1 | -0.03 | -0.09** | 0.12*** | 0.12*** | -0.04 | 0.60*** | 0.45*** | 0.36*** | 0.25*** | 0.20*** | 0.15*** | – | | | | | |
| 13. PA T2 | 0.01 | -0.11*** | 0.11*** | 0.12*** | -0.02 | 0.41*** | 0.62*** | 0.45*** | 0.18*** | 0.22*** | 0.13*** | 0.61*** | – | | | | |
| 14. PA T3 | -0.01 | -0.13*** | 0.10*** | 0.08** | 0.02 | 0.33*** | 0.40*** | 0.61*** | 0.23*** | 0.19*** | 0.16*** | 0.45*** | 0.61*** | – | | | |
| 15. PA T4 | -0.13*** | -0.05 | 0.13*** | 0.10*** | 0.00 | 0.26*** | 0.22*** | 0.32*** | 0.65*** | 0.23*** | 0.20*** | 0.31*** | 0.26*** | 0.31*** | – | | |
| 16. PA T5 | -0.13*** | -0.11*** | 0.09** | 0.09** | -0.05 | 0.23*** | 0.21*** | 0.19*** | 0.27*** | 0.63*** | 0.39*** | 0.24*** | 0.25*** | 0.20*** | 0.25*** | – | |
| 17. PA T6 | -0.11*** | -0.13*** | 0.10** | 0.08** | -0.05 | 0.11*** | 0.09** | 0.13*** | 0.19*** | 0.32*** | 0.61*** | 0.13*** | 0.14*** | 0.16*** | 0.19*** | 0.40*** | – |
| Mean | 1.48 | 45.64 | 0.58 | 23.48 | 0.80 | 0.94 | 0.87 | 0.95 | 0.86 | 0.68 | 0.71 | 0.41 | 0.41 | 0.43 | 0.43 | 0.27 | 0.25 |
| SD | 0.50 | 19.32 | 0.25 | 11.31 | 0.23 | 0.96 | 0.93 | 0.93 | 1.00 | 0.87 | 0.87 | 0.64 | 0.63 | 0.64 | 0.68 | 0.56 | 0.53 |

*SES* socioeconomic status, *SS* sensation seeking, *RT* risk taking, *MR* moral reasoning, *RA* reactive aggression, *PA* proactive aggression, *T1-T6* time 1 to time 6, *SD* standard deviation

* $p<0.05$. ** $p<0.01$. *** $p<0.001$

[a] Sex was coded as 1=boy and 2=girl

**Table 2** Comparison of models with different classes

| | | LL | AIC | BIC | Entropy | LMRT *p* | BLRT *p* | # of parameters |
|---|---|---|---|---|---|---|---|---|
| RA | 1-class | −10459.41 | 20938.82 | 20992.41 | NA | NA | NA | 10 |
| | 2-class | −9730.81 | 19491.61 | 19572.01 | 0.77 | < 0.001 | < 0.001 | 15 |
| | 3-class | −9533.00 | 19106.00 | 19213.19 | 0.76 | < 0.001 | < 0.001 | 20 |
| | **4-class** | **−9333.47** | **18716.94** | **18850.93** | **0.78** | **0.03** | **< 0.001** | **25** |
| | 5-class | −9333.47 | 18726.94 | 18887.73 | 0.58 | 0.50 | 1.00 | 30 |
| PA | 1-class | −7247.22 | 14512.43 | 14560.67 | NA | NA | NA | 9 |
| | 2-class | −6356.77 | 12739.54 | 12809.22 | 0.89 | < 0.001 | < 0.001 | 13 |
| | **3-class** | **−5942.39** | **11918.77** | **12009.88** | **0.90** | **0.02** | **< 0.001** | **17** |
| | 4-class | −5762.32 | 11566.64 | 11679.19 | 0.88 | 0.26 | < 0.001 | 21 |
| | 5-class | −5590.34 | 11230.68 | 11364.66 | 0.89 | 0.27 | < 0.001 | 25 |
| PP-LCGA | 1-class | −17706.63 | 35451.25 | 35553.08 | NA | NA | NA | 19 |
| | 2-class | −16010.30 | 32074.61 | 32219.31 | 0.91 | < 0.001 | < 0.001 | 27 |
| | 3-class | −15613.03 | 31296.05 | 31483.64 | 0.79 | 0.06 | < 0.001 | 35 |
| | 4-class | −15044.76 | 30175.51 | 30405.97 | 0.83 | 0.04 | < 0.001 | 43 |
| | 5-class | −14776.01 | 29654.01 | 29927.35 | 0.84 | 0.63 | < 0.001 | 51 |
| | **6-class** | **−14596.95** | **29311.90** | **29628.11** | **0.83** | **0.19** | **< 0.001** | **59** |
| | 7-class | −14444.12 | 29022.23 | 29381.32 | 0.82 | 0.25 | < 0.001 | 67 |
| | 8-class | −14336.98 | 28823.96 | 29225.92 | 0.83 | 0.17 | < 0.001 | 75 |
| | 9-class | −14220.46 | 28606.92 | 29051.75 | 0.83 | 0.36 | < 0.001 | 83 |
| | 10-class | −14192.57 | 28567.14 | 29054.85 | 0.83 | 0.73 | < 0.001 | 91 |
| | 11-class | −14070.30 | 28338.60 | 28869.18 | 0.84 | 0.29 | < 0.001 | 99 |
| | 12-class | −14009.98 | 28233.97 | 28807.43 | 0.84 | 0.60 | < 0.001 | 107 |

Values of each chosen model are bolded

*RA* reactive aggression, *PA* proactive aggression, *PP-LCGA* parallel process latent class growth analysis, *LL* log-likelihood

children's proactive aggression started stable and gradually decreased into early adolescence. From this overall LGC model, we estimated 1-, 2-, 3-, 4-, and 5-class models of proactive aggression using LCGA (see Table 2 for fit indices). A 3-class model fit the data best. Figure 1b depicts the three identified groups of proactive aggression trajectories from Time 1 to 6: Class 1 High-Decreasing trajectory (11 %, $n$=176); Class 2 Low-Increasing trajectory (8 %, $n$=130); and Class 3 Low-Stable trajectory (81 %, $n$=1265).

## Dual Developmental Trajectories of Reactive and Proactive Aggression

In the PP-LCGA (see Table 2 for fit indices), the AIC and BIC decreased and the BLRT remained significant ($p$<0.001) with each class solution, giving no definitive clues of the optimal model. Thus, model parsimony, class size, conceptual clarity, and interpretability were considered as well as information given by the distinct developmental trajectory models. The 5-, 6-, and 7-class models all showed clear and conceptually interesting dual trajectories. The 6-class model showed clear differentiation and combinations of distinct reactive and proactive aggression trajectories (Fig. 2): Class 1 Dual Low-Stable group that showed stable low levels of both aggression subtypes across time (56 %, $n$=881); Class 2 that showed moderate levels of aggression with slightly higher levels during pre-adolescence (8.5 %, $n$=134), which we labeled a Dual Moderate group; Class 3 RA Moderate-Decreasing group that showed moderate initial levels of reactive aggression only and decreased from middle childhood to early adolescence, but relatively low levels of proactive aggression across time (19.7 %, $n$=310); Class 4 that showed high initial levels of aggression and decreases across time (6.4 %, $n$=101), which we labeled a Dual High-Decreasing group; Class 5 Dual High-Stable group that showed high levels of aggression across time (3.1 %, $n$=49); and Class 6 that showed low initial levels of aggression and increases across time (6.1 %, $n$=96), which we labeled a Dual Low-Increasing group. Compared to the 6-class solution, the 5-class model failed to distinguish the Dual Moderate group from the RA Moderate-Decreasing group. The 7-class model was not further considered due to small class-sizes. Thus, the 6-class PP-LCGA model was selected for further analyses.

## Predicting the Dual Development of Reactive and Proactive Aggression

We conducted a multinomial logistic regression predicting the likelihood of belonging to each dual trajectory group using the

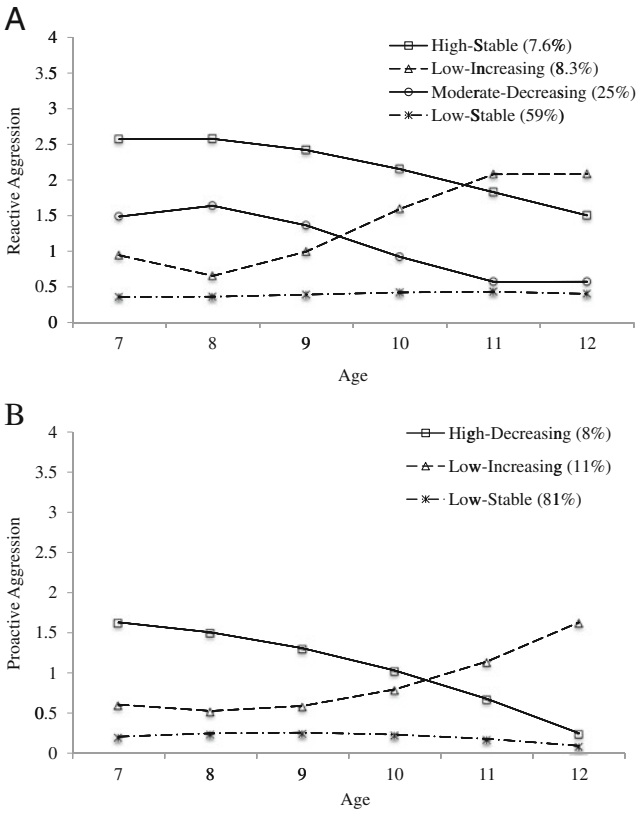


**Fig. 1** Distinct developmental trajectories of (**A**) reactive and (**B**) proactive aggression from mid-childhood to early adolescence (7–12 years)

dual Low-Stable group as reference group. As shown in Table 3, relative to the dual Low-Stable reference group, boys were more than 2 times more likely to follow the Dual Moderate trajectory. Low SES increased the likelihood of following all other five dual trajectories with any moderate or high levels of aggression. As for our focal predictors, children with high levels of risk taking were more likely to follow the Dual Moderate trajectory and almost 2 times more likely to follow the Dual High-Stable trajectory. High sensation seeking drastically increased the likelihood of following the RA Moderate-Decreasing, Dual High-Decreasing, Dual High-Stable, and Dual Low-Increasing trajectories. Finally, children with low moral reasoning were more likely to belong to the Dual High-Stable trajectory, but not the Dual Low-Increasing trajectory. Means and standard deviations of each predictor across dual trajectory classes are presented in Table 4.

## Discussion

The reactive-proactive aggression distinction has garnered considerable empirical support in terms of differential outcomes across childhood and adolescence (Hubbard et al. 2010). The sources of reactive and/or proactive aggression, however, have received much less attention. Addressing the short- and long-term consequences of these distinct subtypes requires a better understanding of their shared and differential antecedents in a longitudinal framework. Here, we assessed the regulatory and moral developmental antecedents of reactive and proactive aggression from mid-childhood to early adolescence. Overall, both aggression subtypes followed similar trajectories. Importantly, levels of sensation seeking, risk taking, and moral reasoning in mid-childhood predicted different dual trajectories of reactive and proactive aggression into adolescence.

We identified four trajectory groups of reactive aggression from mid-childhood to early adolescence: a High-Stable group, a Moderate-Decreasing group, a Low-Increasing group, and a Low-Stable group, and three trajectory groups of proactive aggression: a High-Decreasing group, a Low-Increasing group, and a Low-Stable group. These groups largely align with those identified by other longitudinal studies of generalized aggression spanning childhood and adolescence (e.g., Bongers et al. 2004; Nagin and Tremblay 1999; Xie et al. 2011), and longitudinal studies on reactive/proactive aggression trajectories spanning adolescence (Barker et al. 2006; Barker et al. 2010). Overall, both aggression subtypes appeared to follow similar developmental trajectories from mid-childhood to adolescence and reactively aggressive children outnumbered proactively aggressive children (showing moderate to high levels of aggression at any time point; see Fig. 1), which is consistent with Barker and colleagues' findings with adolescent males (Barker et al. 2006, 2010; also see Tremblay 2000).

Although aggression levels of the High-Stable reactive group tapered into adolescence, they were still comparatively high at all time points (in relation to other groups). Aggression levels of the High proactive group, however, decreased into adolescence. Decreases in both reactive and proactive aggression into adolescence may reflect a normative, overall decreasing trend for aggression (see Bongers et al. 2004; Xie et al. 2011). They may also reflect fluctuations or temporary changes during this particular period (e.g., changes in peer groups) and may increase again into mid-adolescence (Barker et al. 2010; Nagin and Tremblay 1999). Finally, these two trajectories may represent childhood-limited aggression subtypes (i.e., that high levels of reactive and proactive aggression are limited to childhood for such children; Xie et al. 2011). The Low-Increasing groups of both aggression subtypes showed significant increases from late childhood to the cusp of adolescence. These increases may continue until mid-adolescence since previous longitudinal studies indicate that reactive and proactive aggression peak at mid-adolescence (e.g., Barker et al. 2006, 2010). Further, these trajectories may reflect the early stages of adolescent-onset reactive and proactive aggression (Xie et al. 2011), although future waves of data are needed to corroborate this claim.

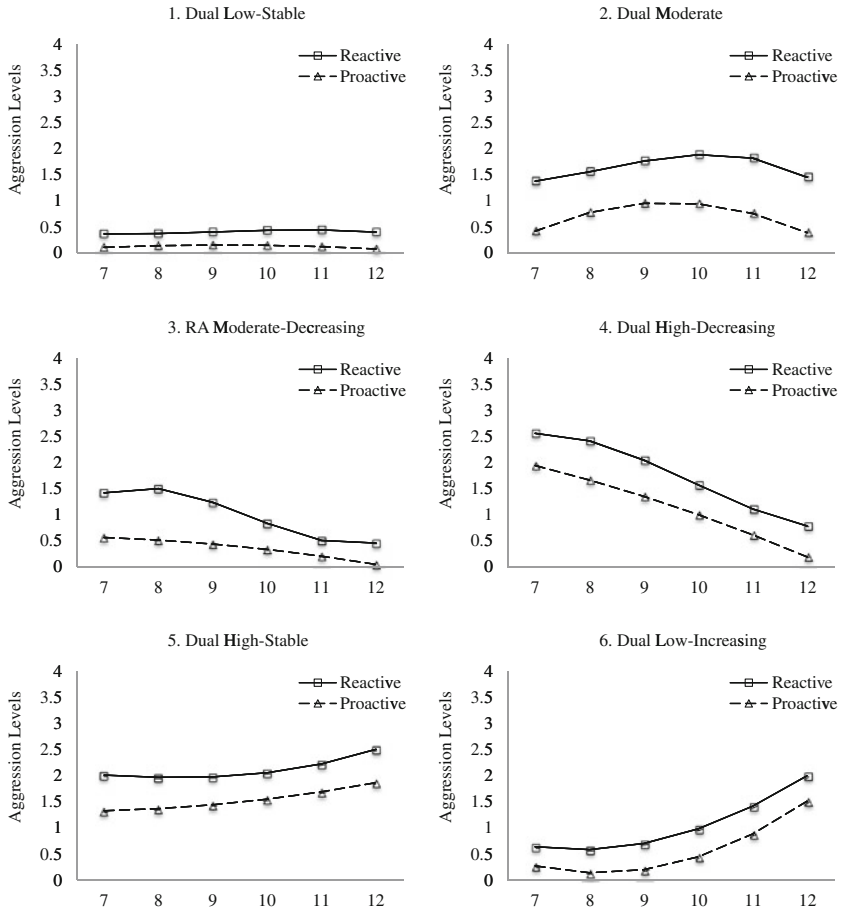


**Fig. 2** Dual developmental trajectories of reactive and proactive aggression from mid-childhood to early adolescence (7–12 years)

Given the overlap of reactive and proactive aggression, we identified dual developmental trajectories of the two subtypes. Consistent with the distinct trajectories and our expectations, we found a Dual Low-Stable group, a Dual Moderate group, and a Dual High-Stable group. We also found a Dual High-Decreasing group, which may reflect childhood-limited aggression, and a Dual Low-Increasing group, which may reflect adolescent-onset aggression (Xie et al. 2011). Furthermore, we found a reactive aggression only Moderate-Decreasing group without evidence of proactive aggression. There was not a High or Moderate proactive aggression only group without reactive aggression, empirically. Taken together, our findings suggest that proactive aggression seems to always be comorbid with certain levels of reactive aggression, whereas reactive aggression is not always comorbid with proactive aggression (i.e., asymmetry of overlap; Pang et al. 2013; Vitaro and Brendgen 2005). Moreover, there was no reactive Low-Increasing/proactive High-Decreasing group, nor were

**Table 3** Prediction of dual reactive aggression and proactive aggression trajectories

| | Dual trajectory groups (OR [95 % CI]) | | | | |
|---|---|---|---|---|---|
| Predictors | Dual Moderate | RA Moderate-Decreasing | Dual High-Decreasing | Dual High-Stable | Dual Low-Increasing |
| Boy | 2.20** [1.35, 3.58] | 0.98 [0.72, 1.35] | 1.50 [0.88, 2.55] | 1.55 [0.69, 3.46] | 1.12 [0.66, 1.92] |
| SES | 0.69** [0.56, 0.87] | 0.76***[0.66, 0.88] | 0.67** [0.52, 0.85] | 0.43***[0.28, 0.66] | 0.52***[0.40, 0.69] |
| SS | 1.46 [0.56, 3.78] | 3.11** [1.63, 5.92] | 7.79*** [2.57, 23.68] | 7.06* [1.25, 39.80] | 3.49* [1.14, 10.68] |
| RT | 1.24* [1.01, 1.52] | 1.11 [0.96, 1.28] | 1.12 [0.89, 1.42] | 1.89***[1.44, 2.49] | 1.01 [0.78, 1.30] |
| MR | 1.22 [0.45, 3.32] | 0.72 [0.38, 1.37] | 0.54 [0.20, 1.50] | 0.20* [0.05, 0.79] | 0.65 [0.22, 1.90] |

Reference group: Dual Low-Stable group

*OR* odds ratio, *SS* sensation seeking, *RT* risk taking, *MR* moral reasoning

* $p<0.05$. ** $p<0.01$. *** $p<0.001$

**Table 4** Means and SDs of predictors across dual trajectory classes

| | | Mean (SD) of each predictor | | | | |
|---|---|---|---|---|---|---|
| Predictors | Dual Low-Stable | Dual Moderate | RA Moderate-Decreasing | Dual High-Decreasing | Dual High-Stable | Dual Low-Increasing |
| SES | 0.24 (1.03) | −0.09 (0.93) | −0.03 (0.97) | −0.13 (0.95) | −0.55 (0.81) | −0.36 (0.77) |
| SS | 0.54 (0.25) | 0.60 (0.23) | 0.60 (0.25) | 0.67 (0.23) | 0.66 (0.23) | 0.61 (0.23) |
| RT | −0.09 (0.91) | 0.17 (1.16) | 0.03 (1.11) | 0.05 (0.99) | 0.81 (1.24) | −0.05 (0.97) |
| MR | 0.82 (0.22) | 0.82 (0.22) | 0.80 (0.23) | 0.78 (0.21) | 0.71 (0.30) | 0.79 (0.20) |

SES and RT are standardized scores

*SD* standard deviation, *SS* sensation seeking, *RT* risk taking, *MR* moral reasoning

there reactive High-Stable or Moderate-Decreasing/proactive Low-Increasing groups in our data. These findings suggest that children who show childhood-limited proactive aggression may not suddenly start to show reactive aggression from early adolescence and vice versa, which further underscores the comorbidity of these two subtypes of aggression. Overall, in designing intervention and/or prevention programs targeting subtypes of aggression, educators and practitioners should note the comorbidity of these two subtypes and particularly the asymmetry of their overlap (i.e., many children may show reactive aggression without proactive aggression but most children who show proactive aggression usually also show reactive aggression).

Children high in both sensation seeking and risk taking were particularly more likely to follow a Dual High-Stable trajectory. Showing high levels of both sensation seeking and risk taking appears to put children at risk of developing persistent high levels of both reactive and proactive aggression from an early age. Risk takers, and not necessarily sensation seekers, are naive to undesirable consequences (Lejuez et al. 2002). Given the negative consequences of aggression, this difference may explain why risk taking appears to add risk of developing persistent high levels of aggression on top of seeking exciting experiences. Further, early risk taking seems to particularly predict moderate levels of both reactive and proactive aggression from childhood to adolescence when sensation seeking is not evident. On the other hand, children high in sensation seeking were more likely to follow Dual Low-Increasing and Dual High-Decreasing trajectories, and were more than three times more likely to belong to a RA Moderate-Decreasing group. Taken together, these findings suggest that early sensation seeking may contribute to the development of both reactive and proactive aggression across various trajectories (e.g., childhood-limited, childhood-onset, adolescent-onset), consistent with previous studies (e.g., Kimonis et al. 2006; Raine et al. 2006).

Collectively, our findings suggest that sensation seeking and risk taking are related to high levels of both reactive and proactive aggression. This largely aligns with previous, concurrent studies relating sensation seeking and risk raking to aggression (e.g., Kimonis et al. 2006; Romer 2010; Wilson and Scarpa 2011). Thus, both constructs appear to be part of the constellation of factors that contribute to both aggression subtypes. Nonetheless, it should be noted that our indices of sensation seeking and risk taking were not assessed longitudinally. Continued, high levels of sensation seeking and risk taking may have contributed to elevated levels of reactive and proactive aggression into adolescence, whereas decreases in sensation seeking and risk taking after childhood may have resulted in a high/moderate-decreasing trend of both subtypes of aggression. On the other end of the spectrum, children low in risk taking and sensation seeking were more likely to follow Low-Stable trajectories of both aggression subtypes, which may have stemmed from their enhanced regulatory skills and related impulse control (see Eisenberg et al. 2011).

In addition, we also found evidence for the distinct role of moral reasoning in the dual development of proactive and reactive aggression. Besides high levels of sensation seeking and risk taking, children of the Dual High-Stable group also reported low moral reasoning. It is not surprising that this Dual High-Stable group showed problems in both regulatory and moral domains. Deficits in moral development, for instance, low sympathy or inability to acknowledge the wrongfulness of aggressive conduct, together with deficits in self-regulation, may well characterize this persistent reactive and proactive aggressive group (childhood-onset aggression; Xie et al. 2011). These results suggest that acts of reactive aggression are not devoid of moral concern (also see Arsenio 2006; Arsenio et al. 2009), whereas acts of proactive aggression from childhood to adolescence may be heightened by low levels of moral reasoning and consistently blunted by high levels of moral reasoning. However, as reactive and proactive aggression were comorbid most of the time, we were not able to find differential effects of moral reasoning on reactive versus proactive aggression. It is possible that low moral reasoning is linked to high levels of proactive aggression

across time whereas a combination of sensation seeking and risk taking are associated with persistent reactive aggression. Although low moral reasoning was related to both reactive and proactive aggression in the current study, the mechanisms might also be distinct. More research is needed to investigate the role of morality in relation to these two subtypes of aggression.

Despite its novel focus on the associations of early sensation seeking, risk taking, and moral reasoning to the dual developmental trajectories of reactive and proactive aggression, our study had several limitations. First, we only assessed sensation seeking, risk taking, and moral reasoning at one time point. Without longitudinal measures thereof, we were unable to determine if developmental shifts in these constructs were related to our observed shifts in reactive and proactive aggression into adolescence. Furthermore, beyond risk taking, sensation seeking, and moral reasoning, other regulatory and moral development variables, such as effortful control, emotion regulation, and moral emotions, may be differentially associated with reactive and proactive aggression (see Eisner and Malti 2015). Second, our Travel Game for assessing sensation seeking is not widely used yet. However, in the current study, sensation seeking was positively linked to reactive and proactive aggression both concurrently and across time. We also found that boys scored much higher in sensation seeking than girls did. These findings are in line with previous studies using distinct measures of sensation seeking (see Wilson and Scarpa 2011). Overall, our study demonstrated the predictive validity of this task but future studies are needed to further validate this measure. Also, sensation seeking was not correlated with risk taking in the current study. They may be different constructs as sensation seekers may accept risk as a possible outcome for obtaining arousal, but they do not necessarily seek out risk for its own sake (Roberti 2004; Zuckerman 1994). Both measures were also behavioral measures administered at different time points. The situation-based and occasion-specific nature of behavioral measures may have contributed to the lack of correspondence in the current study (De Los Reyes and Kazdin 2005). These reasons may explain the fact that we did not find significant correlations between sensation seeking, risk taking, and moral reasoning. Also, moral reasoning concerns the moral domain and is more cognitively infused as children need to weigh the complexity of social situations, while sensation seeking and risk taking concern the regulatory domain and may reflect reward sensitivity. However, some regulation is needed for individuals to conduct moral thinking and experience moral emotions without personal distress (Eisenberg 2000), such that sensation seeking, risk taking, and moral reasoning may not be totally independent. Third, since risk taking and moral reasoning were assessed at T2, it is possible that early aggression trajectories may have influenced these measures. The current study was unable to determine the direction of such influence and future research therefore should examine causality.

In sum, our findings suggest that sensation seeking, risk taking, and moral reasoning are differentially related to dual trajectories of reactive and proactive aggression. These findings deepen our understanding of the antecedents of reactive and proactive aggression and are useful for the design of differential assessments and developmentally tailored intervention strategies for these aggression subtypes. Specifically, reducing high levels of sensation seeking and risk taking by teaching children self-regulating strategies, and increasing moral reasoning by enhancing children's moral awareness may be critical in curbing their persistent reactive and proactive aggression. Reducing sensation seeking may be particularly important in curbing various forms of aggression across various developmental trajectories.

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**Conflict of Interest** The authors declare that they have no conflict of interest.

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