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Reciprocal associations between early adolescent antisocial behavior and depressive symptoms: A longitudinal study in Victoria, Australia and Washington State, United States

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Abstract

Purpose—Reciprocal prospective associations between adolescent antisocial behavior and depressive symptoms were examined.

Methods—Seventh grade students (average age 13 years; N=2,314/2,348) were surveyed (T1), and then followed-up 12 (T2) and 24 months (T3) later, using the same methods in Washington State and Victoria, Australia.

Results—Negative binomial regressions showed antisocial behavior (T1, T2) did not prospectively predict depressive symptoms (T2, T3). T1 multivariate predictors for T2 depressive symptoms included female gender (incident rate ratio [IRR] = 1.70), prior depressive symptoms (IRR = 1.06), alcohol use (IRR = 1.13), family conflict (IRR = 1.13), antisocial peers (IRR = 1.08)

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Declaration of conflicting interests

None to declare.

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and bullying victimization (IRR = 1.06). Depressive symptoms (T1, T2) did not predict antisocial behavior (T2, T3). T1 multivariate predictors for T2 antisocial behavior included female gender (IRR = .96), age (IRR = .97), prior antisocial behavior (IRR = 1.32), alcohol use (IRR = 1.04), antisocial peers (IRR = 1.11) and academic failure (IRR = 1.03).

Conclusions—Depressive symptoms and antisocial behaviors showed considerable predictive stability in early adolescence but were not reciprocally related. Prevention and intervention strategies in adolescence may benefit by targeting common predictors such as alcohol, peer interactions and early symptoms for depression and antisocial behavior.

Keywords

depressive symptoms; antisocial behavior; adolescence; risk factors; protective factors; cross-national study

Introduction

Adolescence is a peak period for the development of common mental health concerns such as depressive symptoms and antisocial behavior problems; burden associated with the incidence of these concerns and behaviors is commonly cited as a major cause of adolescent mortality and disability adjusted life years (Gore, et al., 2011). The prevention of depressive symptoms and antisocial behaviors is imperative. Depressive disorders impact approximately 5% of adolescents worldwide each year (Costello, Erkanli, & Angold, 2006). Antisocial behaviors, defined as behaviors that violate social rules and conventions or personal rights (e.g. violence, weapon carrying, stealing; Kazdin, 1987) are known to peak in mid-late adolescence (Baker, 1998; Sawyer, et al., 2001) and are of concern in Western countries. Recent estimates suggest rates of adolescent antisocial behavior range between 5% and 18% percent (Costello, Mustillo, Erkanli, & Angold, 2003; Hemphill, Toumbourou, Herrenkohl, McMorris, & Catalano, 2006). Critically, antisocial behaviors in adolescence have been associated with further development of both internalizing (e.g. depression) and externalizing (e.g. violence) behaviors into later adolescence and adulthood (Caspi, Henry, McGee, Moffitt, & Silva, 1995; Moffitt, 1993). Depressive symptoms and antisocial behaviors have also been longitudinally associated (Loeber, Stouthamer-Loeber, & Raskin White, 1999; Measelle, Stice, & Hogansen, 2006). Costs associated with both mental health concerns and antisocial behaviors extend beyond the individual to the broader health care and criminal justice systems (Hemphill, 1996; Thapar, Collishaw, Pine, & Thapar, 2012). The current study seeks to contribute to extant literature by examining reciprocal prospective associations between adolescent antisocial behavior and depressive symptoms.

Predictors of depressive symptoms and antisocial behaviors

The development of prevention and early intervention approaches that aim to reduce rates of antisocial behavior and depressive symptoms requires an understanding of the influence of risk and protective factors. Risk factors prospectively increase the probability of developing social and health problems (Lösel & Farrington, 2012). Although inconsistencies exist regarding how protective factors are defined (Lösel & Farrington, 2012), as defined here protective factors prospectively decrease the probability of problems or buffer (i.e., mediate

or moderate) the effect of risk factors (Catalano & Hawkins, 1996; Pollard, Hawkins, & Arthur, 1999). Numerous modifiable risk and protective factors have been linked with both adolescent antisocial behavior and mental health concerns, within the domains of the individual (that is, characteristics of the individual), peer group, family, school, and community.

Depressive symptoms

Among the most commonly reported individual risk factors for adolescent depressive symptoms are prior depressive symptoms (Bond, Toumbourou, Thomas, Catalano, & Patton, 2005; Mazza, et al., 2009; Shortt & Spence, 2006), anxiety symptoms (Bond, et al., 2005; Mazza, et al., 2009; Shortt & Spence, 2006), negative life events (e.g. trauma) (Shortt & Spence, 2006), substance use (Bond, et al., 2005), and engagement in antisocial behavior (Beyers & Loeber, 2003; Bond, et al., 2005; Fergusson & Woodward, 2002). Family risk factors including family violence, family relationship problems (Aseltine, Gore, & Colten, 1994), poor communication between family members and high levels of family conflict (Shortt & Spence, 2006) are consistently reported risk factors for adolescent depressive symptoms. Associations between school risk factors, for instance academic failure, and depressive symptoms have also been reported (Mazza, et al., 2009; Patton, et al., 2000; Shortt & Spence, 2006). Community-based violence, poverty, and increased frequency of school and home transitions also pose risks for increased depressive symptoms among adolescents (Shortt & Spence, 2006; Stirling, Toumbourou, & Rowland, 2015). Although less frequently examined, protective factors such as opportunities and rewards for prosocial involvement (e.g. school, family) are cited as reducing risk for adolescent depressive symptoms (Bond, et al., 2005; Seiffge-Krenke, Weidemann, Fentner, Aegenheister, & Poeblau, 2001).

Antisocial behaviors

The most consistently reported risk factor for antisocial behaviors are prior engagement in these behaviors (e.g. Moffitt, 1993). Other individual factors shown to predict antisocial behavior include child behavior problems and low impulse control (Smart, Vassallo, Sanson, & Dussuyer, 2004), depressive symptoms (Ritakallio, Kaltiala-Heino, Kivivuori, & Rimpela, 2005), alcohol use (Hemphill, et al., 2014; Hingson, Edwards, Heeren, & Rosenbloom, 2009), and attitudes favorable to antisocial behavior (Herrenkohl, et al., 2000). Associations between family factors, such as coercive and inconsistent discipline within the family environment (Smart, et al., 2004), poor parental supervision and lack of family rules, fewer family interactions, low attachment to parents and family conflict and violence (Catalano & Hawkins, 1996; Herrenkohl, et al., 2000; Loeber & Farrington, 2000), have also been reported as predictors of antisocial behavior. Characteristics of the peer group, including interacting with peers who engage in antisocial and delinquent behaviors (Hawkins, et al., 2000; Hemphill, et al., 2009; Herrenkohl, et al., 2003; Smart, et al., 2004), are commonly cited predictors of antisocial behavior. At the school level, low academic performance and school failure have been shown to predict antisocial behavior (Jakobsen, Fergusson, & Horwood, 2012; Maguin & Loeber, 1996). Several risk factors have been cited at the community level. These include higher levels of neighborhood crime and disadvantage, community and social disorganization (e.g. economic disadvantage, lower housing

affordability, higher crime rates; Wikstrom & Sampson, 2013), lower perceived risks for punishment (Wikstrom & Sampson, 2013) and greater availability of drugs within the community (Hemphill, et al., 2009).

Associations between antisocial behavior and depressive symptoms

Antisocial behaviors have consistently been associated with risk for depressive symptoms and disorders among adolescents. For instance, Angold, Costello, and Erkanli (1999) in their meta-analysis of population-based studies, reported the odds of conduct disorder (clinically significant antisocial behavior) were increased over seven times among depressed adolescents, compared to their non-depressed counterparts, after controlling for other comorbidities. Other studies have also reported associations between internalizing problems (including depressive symptoms) and engagement in antisocial behaviors (Hemphill, Heerde, Herrenkohl, & Farrington, 2015; Loeber, Russo, Stouthamer-Loeber, & Lahey, 1994; Loeber, et al., 1999; Ritakallio, et al., 2005; Vermeiren, Deboutte, Ruchkin, & Schwab-Stone, 2002). To date, many studies examining associations between antisocial behavior and depressive symptoms have investigated the role of gender (Costello, et al., 2003; Flannery, Singer, & Wester, 2001; Maughan, Rowe, Messer, Goodman, & Meltzer, 2004). Findings from these studies suggest gender may have a moderating role in associations between antisocial behavior and depressive symptoms. For instance, Costello, et al. (2003) reported the cumulative prevalence of conduct disorder was greater in males compared to females, while multivariate analyses showed depression was comorbid with conduct disorder in females, but not males. Higher levels of depression were apparent among violent females, compared to males, in the study by Flannery, et al. (2001). Similar findings were reported by Maughan and colleagues (2004) in relation to conduct disorder. Reciprocal associations between antisocial behavior and depressive symptoms for adolescent females have also been reported (Measelle, et al., 2006; Obeidallah & Earls, 1999).

The Current Study

Given the paucity of evidence on the directionality of the relationship between antisocial behavior and depression, the current study examines predictive reciprocal associations between early adolescent antisocial behavior and depressive symptoms, controlling for prior levels of depressive symptoms and antisocial behavior and a broad range of risk and protective factors known to influence the development of these symptoms and behaviors. Data are analyzed from a state-representative sample of adolescents participating in the International Youth Development Study (IYDS) in Victoria, Australia, and Washington State in the United States. Three research questions are examined: (1) Is engagement in antisocial behavior prospectively associated with depressive symptoms in adolescents? (2) Are adolescent depressive symptoms prospectively associated with engagement in antisocial behavior? and (3) To what extent do risk factors and protective factors increase risk for adolescent depressive symptoms and antisocial behavior? The moderating role of gender in associations between antisocial behavior and depressive symptoms are also examined.

Method

Participants

The present study analyzed data from seventh grade students enrolled in the International Youth Development Study (IYDS). The IYDS is a longitudinal study exploring the development of healthy and problematic behaviors, including mental health and antisocial behavior, among adolescents and young adults from Victoria, Australia, and Washington State, United States. At the time of sample recruitment, the Victorian and Washington State populations were similar in terms of population size, urbanicity, having higher than national levels of educational participation, and in having low proportions of residents living in poverty (McMorris, Hemphill, Toumbourou, Catalano, & Patton, 2007).

The original sampling and recruitment methods for the IYDS have been described elsewhere (McMorris, et al., 2007). Briefly, the IYDS used standardized methodologies across both states (e.g. sample recruitment, survey content). A two-stage cluster-sampling approach was used in 2002 (T1): (1) 60 public and private schools with Grades 5, 7 and 9 were randomly selected for recruitment into the study using a probability proportionate to grade-level size sampling procedure (Kish, 1965) and (2) one class at the appropriate grade level was randomly selected within each school (McMorris, et al., 2007). The IYDS includes three participant cohorts: youngest cohort (Grade 5), middle cohort (Grade 7) and the oldest cohort (Grade 9). Written parental consent was obtained for all participants. Participants provided their assent on the day of the survey. Of all eligible participants, 75% and 74% participated in the first survey in Washington State and Victoria, respectively. The retention rate was 98% or above in both states at 2003 (T2) and 2004 (T3). The data analyzed in the current study comprised 2,906 Grade 7 (middle cohort) participants (51% female), first surveyed in T1 at age 12-14 years ($M = 13.63$, $SD = .98$) and resurveyed in T2 and T3. At the first survey the Victorian sample was comprised mainly of students identifying as Australian (89%), and the Washington State sample had a majority identifying as white (67%).

Measures

The self-report measures of antisocial behavior, depressive symptoms and risk and protective factors contained in the IYDS survey were adapted from the Communities That Care youth survey (Arthur, Hawkins, Pollard, Catalano, & Baglioni, 2002; Glaser, Lee Van Horn, Arthur, Hawkins, & Catalano, 2005; Pollard, et al., 1999). Similar versions of the survey have been published previously (Social Development Research Group, 2006). Prior research has shown the measures of risk and protective factors used here are valid and reliable when administered to students in Victoria (Hemphill, et al., 2011) and the United States (Arthur, et al., 2002; Glaser, et al., 2005; Pollard, et al., 1999). Table 1 provides the descriptive statistics for all measures in the current study. Online supplemental material Table 1 provides a list of example items for all measures use in the current study.

Depressive symptoms—Depressive symptoms in the past month were measured at each survey using 13-items from the Short Mood and Feelings Questionnaire (Angold, Costello, Messer, & Pickles, 1995). “I felt miserable or unhappy” and “I found it hard to think

properly or concentrate” are example items. Each statement was answered on a 3-point scale of ‘True’ (2), ‘Sometimes True’ (1) or ‘Not True’ (0). Scores across all scale items were summed to form a total depressive symptoms score (0-26), where higher scores indicated higher depressive symptoms.

Antisocial behavior—Past year engagement in antisocial behavior were assessed at each survey using 9-items. Participants were asked about various forms of antisocial behavior including: carried a weapon; stolen something worth more than \$10; sold illegal drugs; stolen or tried to steal a motor vehicle; been drunk or high at school; been suspended from school; been arrested; attacked someone with the idea of seriously hurting them; and taken a handgun to school. Each statement was answered on an 8-point scale ranging from ‘Never’ to ‘40 or more times’. Scale scores were the mean of the 9-items, where higher scores reflected higher engagement in antisocial behavior.

Predictors—A range of risk and protective factors at T1 and T2 were examined as predictors of antisocial behavior and depressive symptoms, due to their known influence on the development of these behavior and symptoms (e.g. Bond, et al., 2005; Herrenkohl, et al., 2000; Loeber & Farrington, 2000; Mazza, et al., 2009; Moffitt, 1993; Smart, et al., 2004). Risk factors included: accommodation transitions in the past year; favorable attitudes towards antisocial behavior; impulsivity; family conflict; low attachment to parents; poor family management; interaction with antisocial peers; peer rewards for antisocial involvement; bullying victimization; academic failure; low commitment to school; low neighborhood attachment; community disorganization; and past month alcohol, tobacco and cannabis use (See Table 1). Protective factors included: peer recognition for prosocial involvement; family opportunities for prosocial involvement; interaction with prosocial peers; school opportunities for prosocial involvement; school recognition for prosocial involvement; community opportunities for prosocial involvement; and community recognition for prosocial involvement. All measures have been previously validated (Glaser, et al., 2005) and are known predictors for the development of healthy and problematic behaviors in previous IYDS analyses (Heerde, et al., 2015; Hemphill, et al., 2015; Hemphill, et al., 2011; Hemphill, Heerde, & Scholes-Balog, 2016). Higher scores indicated higher levels of the factor across all predictors. Scores for each predictor were obtained through averaging the responses for scale items. Response options were recoded to reflect “Not at all” (0) versus “one or more occasion” (1) in the past month for alcohol, tobacco and cannabis use.

Procedure

Ethics approval

Ethics approval for this study was obtained from the Royal Child Children’s Hospital Ethics in Human Research Committee and The University of Melbourne Human Ethics in Research Committee in Victoria, and the University of Washington Human Subjects Review Committee in Washington State. Permission from relevant school district authorities and principals was obtained in each state.

Survey administration

Trained survey staff in both states used a single survey administration protocol. Surveys were administered to class groupings within schools and took approximately 50-60 minutes to complete. The self-report pen and paper survey was voluntary and completed by participants without any interaction or collaboration with peers. Instructions on how to answer the questions (e.g. place a clear 'X' inside the box) and assurances of confidentiality were included in the survey. These instructions and assurances were presented to participants prior to survey administration by survey staff. Trained school personnel conducted surveys for students absent on the day of the survey, and a small percentage of surveys were completed by mail or by telephone.

Student response accuracy

Drawn from early studies of the development and validity of the *Communities That Care* youth survey (Arthur, et al., 2002), the survey contained items to determine the accuracy of participants' self-reports. Participant responses were classified as being questionable if they reported any of the following: (1) that they were not honest at all when filling out the survey; (2) that they had used a fake drug in their lifetime or in the past 30 days; or (3) that they had used illicit drugs on more than 120 occasions in the past 30 days. A single, dichotomous measure of accuracy was calculated using these items. Questionable responses were removed from the analysis. Twenty-three participants at T1, 41 participants at T2, and 27 participants at T3 met the criteria for questionable responses and were excluded from the analyses.

Statistical Analyses

All analyses were conducted using Stata IC software for Windows (StataCorp, 2017), version 15.1. First, *t* tests and chi-square analyses were conducted to compare the means and frequencies of predictor variables for the full sample and by gender. Next, correlations between antisocial behavior (T1-T3), depressive symptoms (T1-T3) and predictors (T1) were examined to identify pairs or sets of highly correlated variables that may result in collinearity in the negative binomial regression analyses. Last, as depressive symptoms and antisocial behavior are distributed as an elongated Poisson distribution, a series of negative binomial longitudinal regression analyses were conducted to examine associations between antisocial behavior and depressive symptoms, and depressive symptoms and antisocial behavior, controlling for predictor variables. Predictors were grouped by domain and entered into each analysis hierarchically. This approach is in accordance with prior studies examining developmental trajectories of influences on behavior (Loeber & Farrington, 2000).

The first set of analyses predicted depressive symptoms from antisocial behavior using the following steps: (1) T1 antisocial behavior predicting T2 depressive symptoms, controlling for T1 predictors; (2) T2 antisocial behavior predicting T3 depressive symptoms, controlling for T2 predictors; and (3) T1 antisocial behavior predicting T3 depressive symptoms, controlling for T1 predictors. The second set of analyses predicted antisocial behavior from depressive symptoms using the following steps: (1) T1 depressive symptoms predicting T2 antisocial behavior, controlling for T1 predictors; (2) T2 depressive symptoms predicting T3

antisocial behavior, controlling for T2 predictors; and (3) T1 depressive symptoms predicting T3 antisocial behavior, controlling for T1 predictors. Each set of analyses controlled for age, gender and the clustering of participants in schools (using robust ‘information-sandwich’ estimates of standard errors, with adjustment for participant clustering within schools).

The final step in the negative binomial longitudinal regression analyses examined the moderating role of gender, using gender-predictor interaction terms. The final fully adjusted negative binomial longitudinal analysis included the addition of gender-predictor interaction terms. The final hierarchical negative binomial longitudinal model included the addition of statistically significant gender-predictor interaction terms, as this approach presents the most parsimonious model with least assumptions.

Results

Correlations between depressive symptoms, antisocial behavior and risk and protective factors

Results in Table 2 showed correlations were generally low to moderate, ranging from $-.38$ to $.68$. Problems with multicollinearity between the analyzed variables were not indicated, with no correlation $\Rightarrow .80$. The correlation between antisocial behavior and depressive symptoms at T1 was positive ($.22$). Correlations between T2 antisocial behavior and T1 predictors ranged between $-.13$ and $.34$ and were statistically significant at $p < .05$. Correlations between T2 depressive symptoms and T1 predictors were significant at $p < .05$, ranging from $-.25$ to $.33$ (Refer Table 2).

Antisocial behavior as a predictor of depressive symptoms

The results for negative binomial multivariate regression models longitudinally associating antisocial behavior and depressive symptoms are presented in Table 3. The bivariate models showed T1 antisocial behavior significantly increased the incidence of T2 depressive symptoms by (incident rate ratio [IRR]) 1.37 , however after adjusting for school clustering no significant effect was evident from T2 to T3 or T1 to T3. Results of final adjusted hierarchical multivariate analyses showed T1 antisocial behavior was not associated with depressive symptoms 1-year later (Model 1) when school clustering, prior depressive symptoms and common risk and protective factors were controlled. Results showed female gender was the strongest predictor of T2 depressive symptoms; with the incidence of T2 depressive symptoms increasing by a factor of (IRR) 1.70 , after adjusting for all predictors. Other statistically significant T1 multivariate predictors included prior depressive symptoms (IRR = 1.06^{***}), past month alcohol use (IRR = 1.11^{**}), family conflict (IRR = 1.13^{**}), interaction with antisocial peers (IRR = 1.08^{*}) and bullying victimization (IRR = 1.06^{***}). Peer recognition for prosocial involvement and family opportunities for prosocial involvement emerged as statistically significant protective predictors. The final fully adjusted model showed several statistically significant gender interactions; the incidence of T2 depressive symptoms was decreased by $.89$ when females reported alcohol use or family conflict, compared to males who reported these risks. Online supplemental material Table 2 presents all stages of the hierarchical modelling for Model 1.

Results showed antisocial behavior (T2) did not predict later depressive symptoms (T3; refer Table 3, Model 2). Two T2 predictors remained statistically significant in the final model. The incidence of depressive symptoms (T3) was increased by a factor of 1.03 when prior depressive symptoms (T2) were reported. The incidence of depressive symptoms was also increased by past month alcohol use ($IRR = 1.24^{**}$). Results showed peer recognition for prosocial involvement emerged as a protective predictor ($IRR = .93^{*}$). Two statistically significant gender interaction terms displayed statistically significant effects; the incidence of T3 depressive symptoms were decreased by 0.81 when females reported accommodation transitions or alcohol use, compared to males who reported these risk factors.

Results showed T1 antisocial behavior was not a significant predictor of T3 depressive symptoms (refer Table 3, Model 3) when school clustering, T1 depressive symptoms and other predictors were controlled. The incidence of T3 depressive symptoms was increased 3.42 among female participants. Prior depressive symptoms ($IRR = 1.03^{***}$), bullying victimization ($IRR = 1.05^{*}$) and community disorganization ($IRR = 1.09^{*}$) were significant predictors in the final multivariate model. School opportunities for prosocial behavior showed a multivariate risk effect ($IRR = 1.20^{*}$). Tests of gender interaction terms showed several statistically significant interactions. The incidence of T3 depressive symptoms were decreased when females reported poor family management practices ($IRR = .77^{**}$) or peer rewards for antisocial behavior ($IRR = .91^{*}$), compared to males exposed to these risks. Differential multivariate effects for depression were also observed for females exposed to school opportunities ($IRR = .69^{*}$) and recognition for prosocial involvement ($IRR = 1.26^{*}$), compared to males exposed to these factors.

Depressive symptoms as a predictor of antisocial behavior

Table 4 presents the results for negative binomial multivariate regression models longitudinally associating depressive symptoms and later antisocial behavior. The bivariate model showed T1 depressive symptoms predicted T2 antisocial behavior (Model 1, $IRR = 1.01^{***}$). However, this association did not maintain statistical significance in the fully adjusted multivariate model controlling for school clustering and all T1 predictors. Results of the multivariate analysis showed T1 antisocial behavior was the strongest predictor of T2 antisocial behavior ($IRR = 1.32^{***}$). Younger age ($IRR = .97^{**}$), female gender ($IRR = .96^{**}$), alcohol use ($IRR = 1.04^{*}$), interaction with antisocial peers ($IRR = 1.11^{**}$) and academic failure ($IRR = 1.03^{*}$) also emerged as statistically significant predictors in the final adjusted model. The final model showed gender had no moderating effects. Online supplemental material Table 3 presents all stages of the hierarchical modelling for Model 1.

Depressive symptoms at T2 did not predict antisocial behavior at T3 (refer Table 4, Model 2). Results for Model 2 showed the incidence of antisocial behavior at T3 was significantly predicted by female gender ($IRR = .96^{*}$), more frequent past year accommodation transitions ($IRR = 1.08^{**}$), past month cannabis use ($IRR = 1.11^{*}$), family conflict ($IRR = 1.03^{*}$) and interaction with antisocial peers ($IRR = 1.08^{*}$). Model 2 showed gender had no moderating effects.

Model 3 shows T1 depressive symptoms predicted T3 antisocial behavior at the bivariate level ($IRR = 1.00^{*}$), however this result was not maintained after controlling for school

clustering and all T1 predictors. Results of the multivariate analysis showed the incidence of antisocial behavior was significantly predicted by participant reported cannabis use (IRR = .89*) and academic failure (IRR = 1.08*). The incidence of antisocial behavior at T3 was increased by (IRR) 1.17 times for females who reported past month tobacco use, compared to males who reported tobacco use. Online supplemental material Table 4 presents all stages of the hierarchical modelling for Model 3.

Discussion

The current longitudinal study has provided an opportunity to examine reciprocal prospective associations between antisocial behavior and depressive symptoms among adolescents, controlling for a broad range of predictors known to influence the development of both adolescent depressive symptoms and antisocial behavior. Results showed females reported higher levels of depressive symptoms, compared to males. Levels of antisocial behavior were significantly higher for males compared to females.

Reciprocal associations between antisocial behavior and depressive symptoms

The present study showed no longitudinal associations between antisocial behavior and depressive symptoms, after adjusting for school clustering and predictors. Although significant associations existed at the bivariate level, these associations were not maintained following adjustment for prior depressive symptoms or antisocial behavior and other predictors. These findings may be interpreted as being in contrast to prior research suggesting early adolescent antisocial behaviors are prospective predictors of internalizing (e.g. depression) behaviors (e.g. Angold, et al., 1999; Caspi, et al., 1995; Moffitt, 1993) and depressive symptoms are prospective predictors of antisocial behavior (Loeber, et al., 1999; Measelle, et al., 2006). There are several possible explanations for these differences.

First, the present study has adjusted for school clustering and a wide range of early adolescent predictors of antisocial behavior and depressive symptoms. It is possible that school clustering and psychosocial factors in midadolescence may contribute to reciprocal associations between antisocial behavior and depression. That is, the association between depressive symptoms and antisocial behavior in adolescence may be caused by "third variables" that are causally related to both. Second, during this developmental period, the experience of depressive symptoms may be more predicted by school context, prior depression, alcohol and social events, rather than antisocial behavior per se. Particularly for females, rates of depression are known to increase during adolescence, and depression is affected by social context such as peer and other relationships (Oldehinkel, Verhulst, & Ormel, 2011; Patton, et al., 2008).

Third, the age at which antisocial behavior begins to emerge may be important in how antisocial behavior is associated with depressive symptoms (Lewinsohn, Gotlib, & Seeley, 1995). Prior research has identified differing trajectories of antisocial behavior onset (e.g. child-onset and adolescent-onset) (Caspi, et al., 1995; Smart, et al., 2004), which may have differential implications for depressive symptomatology (Barker, Oliver, & Maughan, 2010). Barker, et al. (2010) reported depressive symptoms were common amongst adolescents within child-onset and adolescent-onset conduct problem trajectory groups, compared to

those in low trajectory groups. The present findings showed T1 depressive symptoms and antisocial behavior were slightly stronger reciprocal predictors than at T2, in the bivariate models. The continuity of depressive symptoms and antisocial behavior suggested that associations between antisocial behavior and depressive symptoms may have been already established in the early adolescent age period examined in this study.

In the present study, female gender and prior experience of the outcome were the only consistent risk factors predictive of later depressive symptoms and antisocial behaviors, respectively, in the multivariate analysis. The findings suggest that young people who demonstrate prior depressive symptoms or antisocial behavior may be at greater risk for persistent depressive symptoms and antisocial behaviors and other morbidities and psychopathology related to depression (e.g. anxiety, self-harm, substance use) (Fergusson & Woodward, 2002; Heerde, et al., 2015; Kiesner, 2002; Moffitt, 1993). This finding underscores the importance of intervening with adolescents who are exhibiting depressive symptoms or antisocial behavior. Future analyses using the IYDS sample are planned to examine whether prospective reciprocal associations exist between adolescent antisocial behavior and depressive symptoms and young adult antisocial behavior and depressive symptoms.

The role of risk and protective factors

The finding that, at the multivariate level, heightened risk for depressive symptoms and antisocial behaviors arose from various individual, family, peer and school predictors is consistent with prior studies. The current findings are consistent with prior work on predictors of depressive symptoms, which has pointed to the importance of adolescent alcohol use, family conflict, bullying victimization, and peer rewards for antisocial behavior (Bond, et al., 2005; Shortt & Spence, 2006). Similarly, peer recognition of prosocial involvement has been associated with reduced depressive symptoms both in the current study and elsewhere (Bond, et al., 2005; Seiffge-Krenke, et al., 2001). Regarding predictors of antisocial behavior, interacting with antisocial peers (Hawkins, et al., 2000; Hemphill, et al., 2009; Herrenkohl, et al., 2003; Smart, et al., 2004) is a commonly cited predictor. Findings of the present study also showed at the school and family levels recognition of prosocial behavior and accommodation transitions at the community level are potentially important predictors to consider in future studies.

The influence of gender

Prior studies have suggested gender may be a potentially important moderator of associations between antisocial behavior and depressive symptoms (Costello, et al., 2003; Flannery, et al., 2001; Maughan, et al., 2004; Measelle, et al., 2006; Obeidallah & Earls, 1999). The findings of the present study are consistent with prior work showing significant differences in rates of antisocial behavior and depressive symptoms for males and females. A significant overall effect of gender was apparent in the majority of fully adjusted multivariate models, such that being female was positively related to depressive symptoms and negatively related to antisocial behavior. Several gender by predictor interactions emerged. In multivariate models predicting depressive symptoms, having changed homes in the past year (accommodation transitions), alcohol use, family conflict, poor family

management, peer rewards for antisocial behavior and school opportunities were less strongly related to depressive symptoms for females compared to males; recognition for prosocial involvement in school was more strongly related to depressive symptoms for females compared to males. In multivariate models predicting antisocial behavior, past month tobacco use was more predictive of antisocial behavior for females compared to males.

The findings reported here are congruent with prior studies reporting a moderating role of gender for the effect of risk and protective factors as predictors of depressive symptoms, with fewer gender moderating effects on antisocial behavior (Costello, et al., 2003; Flannery, et al., 2001; Maughan, et al., 2004; Measelle, et al., 2006; Obeidallah & Earls, 1999). Our findings of generally lower effects for risk and protective effects for females are incongruent with the view that females may be particularly sensitive to social changes across the adolescent period, including those changes associated with family and peer relationships (Oldehinkel, et al., 2011; Patton, et al., 2008). Our finding of a generally lower effect of risk factors on female depression may be explained by distinct features of our study including the multivariate adjustment for school clustering, a large number of risk and protective factors, and multiple gender interactions in the same model.

Strengths and Limitations of the Current Study

Several strengths of the current study are noted. At the time of study commencement in 2002 the recruited sample was state-representative, demonstrated high response rates, and included approximately equal numbers of female and male participants. In later years, the study has achieved strong participant retention. The comprehensive nature of the IYDS measures and the use of multivariate analyses presents a unique opportunity to examine detailed data across a wide range of risk and protective factors known to influence the development of healthy and problematic behaviors in adolescents.

Despite these notable strengths, several limitations to the study are acknowledged. The study results are generalizable only to states with similar school contexts and grade levels to those examined here. Each of the regression models explained only a minor portion of the outcome variance (e.g., *Pseudo R*² range 0.004 to 0.060). This suggests that a range of predictive influences were unaccounted in our regression models. The analyses were exclusively conducted on participant self-report data; however, the measures utilized have demonstrated good reliability and validity in large samples (Arthur, et al., 2002; Glaser, et al., 2005; Pollard, et al., 1999) and longitudinal validity (Hemphill, et al., 2011). Additionally, confirmatory factor analyses have demonstrated validity in the factor structure of all measures (Glaser, et al., 2005). It is acknowledged that debate exists concerning whether risk and protective factors are opposite ends of the continuum or whether there are qualitative differences between the two. The modelling of protective factors in the present study did not explore whether the protective factors were moderators or mediators of the effect of antisocial behavior on depression. These analyses were not conducted as there were non-significant multivariate effects of antisocial behavior in predicting depression and depression in predicting antisocial behavior. Hence, the present study has only modelled whether protective factors were direct predictors of lower rates of depression or antisocial

behavior. Given female gender was a consistent predictor, we comprehensively examined gender moderation for the effects of risk and protective factors.

Implications of the Findings for Future Research

The current study investigated the reciprocal predictive effects of antisocial behavior and depressive symptoms among adolescents, controlling for a range of predictors. Antisocial behavior showed small significant predictive associations in unadjusted correlation analyses (Table 2) but was not predictive of later depressive symptoms, after controlling for prior levels of depressive symptoms and other factors. Similar findings were observed for the predictive effect of depressive symptoms on antisocial behavior. These findings suggest that reciprocal predictive associations between depressive symptoms and antisocial behavior arise indirectly due to common underlying influences. Congruent with previous research, the current findings confirm predictors from individual, family, school and peer domains influence the development of depressive symptoms (Bond, et al., 2005; Shore, Toumbourou, Lewis, & Kremer, 2018; Shortt & Spence, 2006), and in a number of cases (e.g., alcohol, family conflict, peer interactions) were similar influences for antisocial behavior. Findings support the use of school and family interventions in the adolescent period to reduce common risk and protective factors for depressive symptoms (Buttigieg, et al., 2015) and antisocial behavior (Shaykhi, Ghayour-Minaie, & Toumbourou, 2018).

The finding that predictive associations (Table 2) were reduced after adjusting for school clustering (bivariate analyses Tables 3 and 4) supports the view that common exposure to school context partly explains reciprocal associations between depressive symptoms and antisocial behavior. Future research could further explore school context effects using analytic techniques such as trajectory analysis to identify sub-groups with common developmental patterns (Shore, et al., 2018). In the present study we conducted between-individual (where prediction is inferred from variations between individuals) rather than within-individual (where prediction is inferred from variations within individuals [e.g., in changing exposure to risk and protective factors]) analyses (Farrington, 2014; Hemphill, et al., 2015) to examine predictors of antisocial behavior and depressive symptoms. It has been suggested that predictors of antisocial behavior may be better studied using within-individual analytic techniques that investigate prospective change in risk and protective factors (Farrington, Loeber, Yin, & Anderson, 2002; Hemphill, et al., 2015). One approach to further elucidating associations between antisocial behavior and mental health (including depressive symptoms) and the influence of associated predictors could be to compare differences in within- and between-individual predictors of antisocial behavior and depressive symptoms. The use of person-oriented analytic approaches, such as cluster analysis, as opposed to the variable-oriented analytic approach used in this study may also be beneficial. The present analysis contributes insights into adolescent influences that can inform the development and refinement of prevention and early intervention approaches to identify models that are more likely to be effective in reducing both antisocial behavior and mental health problems.

Conclusions

The current study sought to contribute to extant literature by examining reciprocal associations between adolescent antisocial behavior and depressive symptoms, controlling for a range of predictors. Antisocial behavior and depressive symptoms were not prospectively or reciprocally associated in multivariate analyses. Rather, reciprocal associations between depressive symptoms and antisocial behaviors were identified to arise through common influences in school context and individual, family, peer and school-level predictors. The moderating role of gender was also considered. Results suggest that some predictors are differentially important for females, with gender moderators more common in predictors of depressive symptoms. The present findings suggest that prevention and intervention strategies may be able to reduce adolescent depressive symptoms and antisocial behaviors by targeting common predictors in school systems, family conflict, peer interactions, alcohol use and early symptoms of depression and antisocial behaviors.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- Adolescence is a peak period for the development of depression and antisocial behaviors.
- Depression and antisocial behaviors showed predictive stability but were not reciprocally related.
- Individual, family, peer and school factors predicted depressive symptoms and antisocial behavior.

Table 1

Descriptive statistics for depressive symptoms and antisocial behavior at T1, T2 and T3 and predictors at T1.

Depressive symptoms, Antisocial behavior/ Predictors	No. of scale items	Response options	Combined sample		Female sample		Male sample		Cronbach's Alpha (α)	Mean (SD)	Cronbach's Alpha (α)	Mean (SD)	Cronbach's Alpha (α)
			Mean (SD)	Cronbach's Alpha (α)	Mean (SD)	Cronbach's Alpha (α)	Mean (SD)	Cronbach's Alpha (α)					
			(N = 2906)		(n = 1490)		(n = 1416)						
Depressive symptoms/Antisocial behavior													
Depressive symptoms (T1)	13	0–26 (Recoded; see text)	7.31 (5.55)	0.88	8.15 (6.05) ***	0.89	6.42 (4.80)	0.85					
Depressive symptoms (T2)	13	0–26 (Recoded; see text)	7.44 (6.30)	0.91	8.78 (6.90) ***	0.92	6.02 (5.23)	0.89					
Depressive symptoms (T3)	13	0–26 (Recoded; see text)	7.68 (6.48)	0.92	9.28 (7.03) ***	0.93	5.98 (5.34)	0.89					
Antisocial behavior (T1)	9	1–8 (Never to 40+ times)	1.11 (0.27)	0.70	1.07 (0.20)	0.67	1.15 (0.32) ***	0.72					
Antisocial behavior (T2)	9	1–8 (Never to 40+ times)	1.15 (0.49)	0.91	1.09 (0.32)	0.88	1.22 (0.62) ***	0.92					
Antisocial behavior (T2)	9	1–8 (Never to 40+ times)	1.17 (0.50)	0.89	1.13 (0.38)	0.88	1.21 ** (0.60)	0.92					
Predictors (T1)													
<i>Individual factors</i>													
Favorable attitudes towards antisocial behavior	5	1–4 (Very wrong to Not wrong at all)	1.51 (0.56)	0.84	1.46 (0.51)	0.83	1.56 *** (0.59)	0.85					
Impulsivity	3	1–4 (Definitely no to Definitely yes)	1.96 (0.57)	0.56	1.92 (0.58)	0.58	1.99 ** (0.56)	0.53					
Recognition for prosocial involvement (P)	2	1–5 (No or very little chance to Very good chance)	3.38 (0.95)	0.63	3.37 (0.99)	0.70	3.39 (0.92)	0.55					
<i>Family factors</i>													
Family conflict	3	1–4 (Definitely no to Definitely yes)	2.24 (0.79)	0.80	2.29 *** (0.84)	0.82	2.18 (0.73)	0.77					
Low parent attachment	4	1–4 (Definitely yes to Definitely no)	3.03 (0.70)	0.76	2.96 (0.72)	0.76	3.10 *** (0.66)	0.76					
Poor family management	9	1–4 (Definitely no to Definitely yes)	1.69 (0.51)	0.81	1.63 (0.51)	0.82	1.74 *** (0.51)	0.80					

Depressive symptoms, Antisocial behavior/ Predictors	No. of scale items	Response options	Combined sample (N = 2906)		Female sample (n = 1490)		Male sample (n = 1416)		Cronbach's Alpha (α)
			Mean (SD)	Cronbach's Alpha (α)	Mean (SD)	Cronbach's Alpha (α)	Mean (SD)	Cronbach's Alpha (α)	
Family opportunities for prosocial involvement (P)	3	1-4 (Definitely no to Definitely yes)	3.09 (0.71)	0.73	3.09 (0.75)	0.76	3.10 (0.67)	0.69	
<i>Peer factors</i>									
Interaction with antisocial peers	8	0-4 (None of my friends to 4 of my friends)	0.29 (0.49)	0.84	0.23 (0.44)	0.84	0.34 *** (0.53)	0.84	
Peer rewards for antisocial involvement	4	1-5 (No or very little chance to Very good chance)	2.22 (1.20)	0.91	2.21 (1.19)	0.91	2.23 (1.21)	0.91	
Interaction with prosocial peers (P)	2	0-4 (None of my friends to 4 of my friends)	3.15 (0.91)	0.46	3.15 (0.90)	0.50	3.15 (0.92)	0.44	
Bullying victimization	1	1-4 (No to Yes, most days)	1.69 (0.95)	n/a	1.68 (0.92)	n/a	1.70 (0.98)	n/a	
<i>School factors</i>									
Academic failure	2	1-4 (Definitely yes to Definitely no)	2.04 (0.67)	0.69	1.99 (0.65)	0.68	2.09 *** (0.68)	0.72	
Low commitment to school	7	1-5 (Almost always to Never)	2.23 (0.62)	0.77	2.17 (0.61)	0.78	2.30 *** (0.63)	0.77	
School opportunities for prosocial involvement (P)	5	1-4 (Definitely no to Definitely yes)	3.00 (0.44)	0.57	3.03 *** (0.43)	0.56	2.97 (0.45)	0.57	
School recognition for prosocial involvement (P)	4	1-4 (Definitely no to Definitely yes)	2.88 (0.57)	0.69	2.90 (0.56)	0.69	2.86 (0.58)	0.69	
<i>Community factors</i>									
Low neighborhood attachment	3	1-4 (Definitely no to Definitely yes)	1.91 (0.81)	0.82	1.91 (0.83)	0.83	1.91 (0.78)	0.81	
Community disorganization	5	1-4 (Definitely no to Definitely yes)	1.50 (0.56)	0.79	1.47 (0.54)	0.79	1.53 * (0.57)	0.80	
Community opportunities for prosocial involvement (P)	5	1-4 (Definitely no to Definitely yes)	2.94 (0.73)	0.66	2.94 (0.72)	0.64	2.94 (0.74)	0.67	
Community recognition for prosocial involvement (P)	3	1-4 (Definitely no to Definitely yes)	2.39 (0.90)	0.88	2.38 (0.92)	0.89	2.41 (0.87)	0.87	
<i>Accommodation/ substance use</i>									
Past year accommodation transitions	1	0-1 (No, Yes)	23.53	n/a	22.53	n/a	24.59	n/a	

Depressive symptoms, Antisocial behavior/ Predictors	No. of scale items	Response options	Combined sample		Female sample		Male sample	
			(N = 2906)		(n = 1490)		(n = 1416)	
			Mean (SD)	Cronbach's Alpha (α)	Mean (SD)	Cronbach's Alpha (α)	Mean (SD)	Cronbach's Alpha (α)
Past month alcohol use	1	Recoded (see text)	32.89	n/a	31.50	n/a	34.36	n/a
Past month tobacco use	1	Recoded (see text)	11.34	n/a	12.60*	n/a	10.01	n/a
Past month cannabis use	1	Recoded (see text)	4.88	n/a	4.33	n/a	5.46	n/a

Note. (P) Protective factor. N=sample size, SD=standard deviation. % =percent. n/a refers to scales with one item and therefore a Cronbach's alpha could not be calculated. Gender coded 0=male, 1=female. Past month alcohol use (coded 0=no use, 1=recent use). Past month tobacco use (coded 0=no use, 1=recent use). Past month cannabis use (coded 0=no use, 1=recent use). Mean age T1 (combined sample) =13.63 years; Mean age T1 (females) =13.58 years; Mean age T1 (males) =13.67 years.

Statistically significant gender differences for continuous risk and protective factors calculated using independent *t*-tests. Statistically significant gender differences for dichotomous risk and protective factors calculated using chi-square tests. Statistically significant gender differences shown in bold and indicated with asterisks attached to the significantly higher value;

* $p < .05$

** $p < .01$

*** $p < .001$

Table 2

Correlation matrix for T1 and T2 antisocial behavior, T1, T2 and T3 depressive symptoms and demographics and risk factors at T1.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1. Antisocial behavior (T1)	-	0.40	0.22	0.10	0.05	0.13	-0.15	-0.11	0.08	0.42	0.24	0.33	0.43	0.26	0.20	-0.18	0.29	0.61	0.16	0.07	0.24	0.33	0.13	0.23
2. Antisocial behavior (T2)		-	0.14	0.18	0.01	0.03	-0.13	0.02	0.06	0.25	0.18	0.19	0.22	0.17	0.11	-0.12	0.20	0.34	0.10	0.04	0.19	0.21	0.10	0.12
3. Depressive symptoms (T1)			-	0.56	0.24	0.06	0.16	-0.03	0.05	0.22	0.18	0.22	0.13	0.34	0.44	-0.35	0.24	0.26	0.18	0.34	0.26	0.32	0.25	0.21
4. Depressive symptoms (T2)				-	0.27	0.01	0.22	0.02	0.05	0.11	0.14	0.15	0.05	0.22	0.33	-0.25	0.14	0.17	0.10	0.24	0.16	0.19	0.17	0.15
5. Depressive symptoms (T3)					-	-0.04	0.12	0.04	0.01	0.02	0.02	0.06	0.01	0.06	0.11	-0.10	0.02	0.05	0.04	0.12	0.07	0.04	0.07	0.08
Demographic factors and predictors (T1)																								
6. Age					-		-0.04	-0.51	-0.07	0.24	0.30	0.21	0.11	0.13	0.12	-0.11	0.26	0.16	0.32	-0.02	0.05	0.18	0.05	0.05
7. Female							-	-0.01	-0.04	-0.09	-0.05	0.08	-0.07	-0.06	0.07	-0.11	-0.11	-0.11	-0.01	-0.01	-0.08	-0.10	-0.00	-0.05
8. Victoria								-	0.04	-0.07	-0.04	-0.15	-0.36	-0.05	-0.08	0.10	-0.09	-0.13	0.01	0.01	-0.10	-0.10	-0.09	-0.07
9. Past year accommodation transitions								-	-	-0.01	-0.004	0.07	0.06	0.05	0.03	-0.05	0.001	0.10	-0.06	0.05	0.11	0.01	0.10	0.05
10. Favorable attitudes towards antisocial behavior									-		0.34	0.31	0.25	0.41	0.28	-0.30	0.50	0.41	0.33	0.01	0.19	0.47	0.19	0.22
11. Past month alcohol use											-	0.68	0.58	0.23	0.18	-0.16	0.35	0.29	0.25	0.04	0.15	0.29	0.12	0.12
12. Past month tobacco use												-	0.71	0.22	0.20	-0.17	0.31	0.37	0.20	0.06	0.23	0.28	0.12	0.12
13. Past month cannabis use													-	0.14	0.16	-0.15	0.23	0.40	0.12	0.01	0.18	0.22	0.10	0.14
14. Impulsivity														-	0.34	-0.30	0.36	0.29	0.21	0.10	0.26	0.38	0.18	0.21
15. Family conflict															-	-0.38	0.29	0.25	0.17	0.19	0.17	0.30	0.25	0.28
16. Low parent attachment																-	0.43	-0.21	-0.15	-0.09	-0.21	-0.36	-0.32	-0.18
17. Poor family management																	-	0.35	0.27	0.01	0.23	0.44	0.23	0.21
18. Interaction with antisocial peers																		-	0.20	0.08	0.26	0.35	0.17	0.28
19. Peer rewards for antisocial involvement																			-	0.09	0.03	0.24	0.09	0.10
20. Bullying victimization																				-	0.07	0.06	0.12	0.10
21. Academic failure																					-	0.43	0.16	0.15
22. Low commitment to school																						-	0.26	0.19
23. Low neighborhood attachment																							-	0.40
24. Community disorganization																								-

Note. Statistically significant associations in **bold** ($p < .05$), (P) Protective factor. Female gender (coded 0=male, 1=female); Victoria (coded 0=Washington State, 1=Victoria); Past month alcohol, tobacco and cannabis use (coded 0=no use, 1=recent use).

Point biserial correlations were performed between dichotomous variables (female, Victoria, accommodation transitions, and past month alcohol, tobacco and cannabis use) and continuous risk and protective factors. *Tetrachoric correlations* were performed between dichotomous variables: female, Victoria, accommodation transitions, past month alcohol, tobacco and cannabis use. *Pearson correlations* were performed between continuous risk and protective factors. Correlations for protective factors are available from the lead author.

Table 3

Adjusted negative binomial regression analyses predicting T2 and T3 depressive symptoms from T1 and T2 antisocial behavior and other predictors.

	Model 1			Model 2			Model 3		
	T1 antisocial behavior to T2 depressive symptoms (n=2314)	p-value	IRR (SE)	T2 antisocial behavior to T3 depressive symptoms (n=1641)	p-value	IRR (SE)	T1 antisocial behavior to T3 depressive symptoms (n=1572)	p-value	
Outcome: depressive symptoms	13.63 (0.98)			14.63 (0.97)			15.03 (0.42)		
Female (%)	51.27			51.27			50.85		
Predictors									
Antisocial behavior (bivariate)	1.37*** (0.09)	<0.0001		1.02 (0.05)	0.598	1.15 (0.09)	1.15 (0.09)	[0.99, 1.33]	0.066
Antisocial behavior	0.96 (0.07)	0.562		0.95 (0.07)	0.459	1.10 (0.13)	1.10 (0.13)	[0.87, 1.38]	0.438
Female (referent: male)	1.70*** (0.18)	<0.0001		1.50 (0.34)	0.071	3.42** (1.52)	3.42** (1.52)	[1.44, 8.17]	0.005
Age	0.97 (0.02)	0.184		1.03 (0.06)	0.650	1.04 (0.06)	1.04 (0.06)	[0.94, 1.16]	0.431
Victoria (referent: Washington State)	1.04 (0.04)	0.426		1.02 (0.11)	0.880	1.15 (0.12)	1.15 (0.12)	[0.93, 1.42]	0.196
Past year accommodation transitions	1.01 (0.04)	0.780		1.08 (0.09)	0.339	0.96 (0.05)	0.96 (0.05)	[0.87, 1.06]	0.436
^a Female*past year accommodation transitions	–	–		0.81* (0.08)	0.039	–	–	–	–
Prior depressive symptoms	1.06*** (0.004)	<0.0001		1.03*** (0.005)	<0.0001	1.03*** (0.004)	1.03*** (0.004)	[1.02, 1.04]	<0.0001
<i>Individual factors</i>									
Favorable attitudes towards antisocial behavior	0.95 (0.03)	0.092		0.92 (0.05)	0.147	0.94 (0.05)	0.94 (0.05)	[0.85, 1.04]	0.245
Past month alcohol use (referent: no use)	1.11** (0.04)	0.004		1.24** (0.09)	0.031	0.98 (0.05)	0.98 (0.05)	[0.89, 1.08]	0.715
Past month tobacco use (referent: no use)	1.00 (0.06)	0.993		0.93 (0.05)	0.229	1.05 (0.07)	1.05 (0.07)	[0.93, 1.19]	0.427
Past month cannabis use (referent: no use)	0.92 (0.08)	0.321		1.01 (0.08)	0.887	0.94 (0.10)	0.94 (0.10)	[0.76, 1.16]	0.554
Impulsivity	1.05 (0.04)	0.173		1.07 (0.05)	0.109	0.97 (0.05)	0.97 (0.05)	[0.88, 1.07]	0.539
Peer recognition for prosocial involvement (P)	0.95* (0.02)	0.011		0.93* (0.03)	0.015	0.96 (0.03)	0.96 (0.03)	[0.90, 1.01]	0.118
^b Female*past month alcohol use	0.89** (0.03)	0.005		0.81* (0.08)	0.031	–	–	–	–
<i>Family factors</i>									
Family conflict	1.13** (0.04)	0.001		1.02 (0.03)	0.488	1.02 (0.03)	1.02 (0.03)	[0.95, 1.09]	0.571
Low parent attachment	1.00 (0.03)	0.896		0.97 (0.04)	0.520	0.95 (0.04)	0.95 (0.04)	[0.87, 1.03]	0.241
Poor family management	0.99 (0.04)	0.745		1.00 (0.05)	0.947	1.11 (0.09)	1.11 (0.09)	[0.94, 1.31]	0.204

Outcome: depressive symptoms	Model 1		Model 2		Model 3	
	T1 antisocial behavior to T2 depressive symptoms (n=2314)		T2 antisocial behavior to T3 depressive symptoms (n=1641)		T1 antisocial behavior to T3 depressive symptoms (n=1572)	
Family opportunities for prosocial involvement (P)	0.92[*] (0.02)	[0.87, 0.98]	0.011		0.98 (0.05)	[0.90, 1.08] 0.728
<i>c</i> _{Female*family conflict}	0.89^{**} (0.03)	[0.82, 0.97]	0.005		–	–
<i>d</i> _{Female*poor family management}	–	–	–		0.77^{**} (0.07)	[0.64, 0.93] 0.007
<i>Peer factors</i>						
Interaction with antisocial peers	1.08[*] (0.04)	[1.01, 1.16]	0.028		1.01 (0.06)	[0.90, 1.12] 0.908
Peer rewards for antisocial involvement	0.96[*] (0.01)	[0.94, 0.99]	0.017		1.06 (0.03)	[1.00, 1.12] 0.061
Interaction with prosocial peers (P)	0.99 (0.02)	[0.95, 1.03]	0.668		1.01 (0.02)	[0.97, 1.06] 0.662
Bullying victimization	1.06^{***} (0.02)	[1.03, 1.10]	<0.0001		1.05[*] (0.02)	[1.01, 1.10] 0.027
<i>e</i> _{Female*peer rewards for antisocial involvement}	–	–	–		0.91[*] (0.03)	[0.85, 0.98] 0.012
<i>School factors</i>						
Academic failure	1.01 (0.03)	[0.95, 1.07]	0.755		1.04 (0.04)	[0.95, 1.12] 0.402
Low commitment to school	1.01 (0.04)	[0.94, 1.09]	0.734		0.98 (0.05)	[0.89, 1.07] 0.686
School opportunities for prosocial involvement (P)	1.06 (0.05)	[0.96, 1.18]	0.232		1.20[*] (0.11)	[1.01, 1.44] 0.038
School recognition for prosocial involvement (P)	0.97 (0.03)	[0.91, 1.03]	0.354		0.92 (0.07)	[0.79, 1.06] 0.258
<i>f</i> _{Female*school opportunities for prosocial involvement}	–	–	–		0.69^{**} (0.10)	[0.53, 0.91] 0.008
<i>g</i> _{Female*school recognition for prosocial involvement}	–	–	–		1.26[*] (0.13)	[1.03, 1.54] 0.023
<i>Community factors</i>						
Low neighborhood attachment	1.01 (0.02)	[0.97, 1.05]	0.563		1.0 (0.03)	[0.95, 1.06] 0.859
Community disorganization	1.02 (0.03)	[0.96, 1.08]	0.480		1.09[*] (0.05)	[1.00, 1.19] 0.045
Community opportunities for prosocial involvement (P)	0.97 (0.03)	[0.92, 1.02]	0.186		1.03 (0.04)	[0.96, 1.10] 0.466
Community recognition for prosocial involvement (P)	0.98 (0.02)	[0.94, 1.03]	0.454		1.01 (0.03)	[0.95, 1.07] 0.745
<i>h</i> _{Female*community recognition for prosocial involvement}	–	–	–		–	–

	Model 1	Model 2	Model 3
Outcome: depressive symptoms	T1 antisocial behavior to T2 depressive symptoms (n=2314)	T2 antisocial behavior to T3 depressive symptoms (n=1641)	T1 antisocial behavior to T3 depressive symptoms (n=1572)
<i>Pseudo R²</i>	0.060	0.013	0.013
<i>Adjusted R²</i>	0.056	0.006	0.006

Note. The fully adjusted analyses (Models 1-3) control for gender, age, state, the clustering of students in schools, T1 depressive symptoms and all T1 predictors in the table. The final negative binomial regression models are presented here. Online supplemental material Table 2 contains all stages of the hierarchical modelling, including gender*risk and protective factors interactions for Model 1. Results from all stages of the hierarchical modelling for Models 2 and 3 are available from the lead author.

(P)=Protective factor. Female gender (coded 0=male, 1=female); Victoria (coded 0=Washington State, 1=Victoria); Past month alcohol, tobacco and cannabis use (coded 0=no use, 1=recent use).

IRR=incidence rate ratio; SE=robust standard error; CI=confidence interval. Pseudo R^2 =McFadden's R^2 ; Adjusted R^2 =McFadden's Adjusted R^2 .

Statistically significant results shown in **bold** and indicated with asterisks

* $p < .05$

** $p < .01$

*** $p < .001$.

^aFemale*past year accommodation transitions: IRR corresponds to the interaction between the dichotomous gender variable (coded "0" for males and "1" for females) and the continuous risk factor past year accommodation transitions.

^bFemale*pst month alcohol use: IRR corresponds to the interaction between the dichotomous gender variable (coded "0" for males and "1" for females) and the dichotomous risk factor past month alcohol use.

^cFemale*family conflict: IRR corresponds to the interaction between the dichotomous gender variable (coded "0" for males and "1" for females) and the continuous risk factor family conflict.

^dFemale*poor family management: IRR corresponds to the interaction between the dichotomous gender variable (coded "0" for males and "1" for females) and the continuous risk factor poor family management.

^eFemale*peer rewards for antisocial involvement: IRR corresponds to the interaction between the dichotomous gender variable (coded "0" for males and "1" for females) and the continuous risk factor peer protective rewards for antisocial involvement.

^fFemale*school opportunities for prosocial involvement: IRR corresponds to the interaction between the dichotomous gender variable (coded "0" for males and "1" for females) and the continuous protective factor school opportunities for prosocial involvement.

^gFemale*school recognition for prosocial involvement: IRR corresponds to the interaction between the dichotomous gender variable (coded "0" for males and "1" for females) and the continuous protective factor school recognition for prosocial involvement.

^hFemale*community recognition for prosocial involvement: IRR corresponds to the interaction between the dichotomous gender variable (coded "0" for males and "1" for females) and the continuous protective factor community recognition for prosocial involvement.

Table 4

Adjusted negative binomial regression analyses predicting T2 and T3 antisocial behavior from T1 and T2 depressive symptoms and other predictors.

	Model 1			Model 2			Model 3		
Outcome: antisocial behavior	T1 depressive symptoms to T2 antisocial behavior (<i>n</i> =2348)			T2 depressive symptoms to T3 antisocial behavior (<i>n</i> =1678)			T1 depressive symptoms to T3 antisocial behavior (<i>n</i> =1610)		
Mean age at outcome (yrs.; SD)	13.63 (0.98)			14.63 (0.97)			15.03 (0.42)		
Female (%)	51.27			51.27			50.85		
Predictors	IRR (SE)	95% CI	<i>p</i> -value	IRR (SE)	95% CI	<i>p</i> -value	IRR (SE)	95% CI	<i>p</i> -value
Depressive symptoms (bivariate)	1.01 *** (0.001)	[1.01, 1.02]	<0.0001	1.00 (0.002)	[1.00, 1.01]	0.203	1.00 * (0.002)	[1.00, 1.01]	0.046
Depressive symptoms	1.00 (0.002)	[1.00, 1.01]	0.074	1.00 (0.001)	[1.00, 1.02]	0.348	1.00 (0.002)	[1.00, 1.01]	0.755
Female (referent: male)	0.96 ** (0.01)	[0.93, 0.98]	0.003	0.96 * (0.02)	[0.91, 1.00]	0.049	1.09 (0.09)	[0.92, 1.29]	0.299
Age	0.97 ** (0.01)	[0.96, 0.99]	0.009	0.98 (0.03)	[0.93, 1.04]	0.480	0.98 (0.05)	[0.93, 1.02]	0.325
Victoria (referent: Washington State)	1.04 (0.02)	[0.99, 1.08]	0.097	0.98 (0.06)	[0.86, 1.11]	0.753	0.99 (0.05)	[0.90, 1.10]	0.895
Past year accommodation transitions	1.00 (0.02)	[0.96, 1.05]	0.967	1.08 ** (0.03)	[1.03, 1.13]	0.001	0.99 (0.02)	[0.95, 1.04]	0.793
Prior antisocial behavior	1.32 *** (0.10)	[1.15, 1.53]	<0.0001	1.05 (0.07)	[0.92, 1.20]	0.470	1.06 (0.08)	[0.91, 1.24]	0.433
<i>Individual factors</i>									
Favorable attitudes towards antisocial behavior	1.06 (0.03)	[1.00, 1.13]	0.068	1.04 (0.04)	[0.96, 1.12]	0.325	1.02 (0.03)	[0.96, 1.08]	0.519
Past month alcohol use (referent: no use)	1.04 * (0.02)	[1.00, 1.09]	0.049	0.99 (0.02)	[0.94, 1.04]	0.712	1.03 (0.03)	[0.98, 1.08]	0.268
Past month tobacco use (referent: no use)	1.03 (0.05)	[0.93, 1.13]	0.581	1.00 (0.03)	[0.95, 1.05]	0.897	0.97 (0.05)	[0.88, 1.06]	0.475
Past month cannabis use (referent: no use)	1.05 (0.09)	[0.89, 1.24]	0.579	1.11 * (0.05)	[1.01, 1.21]	0.025	0.89 * (0.05)	[0.81, 0.99]	0.029
Impulsivity	1.00 (0.02)	[0.97, 1.04]	0.888	1.00 (0.02)	[0.96, 1.03]	0.823	0.99 (0.03)	[0.95, 1.05]	0.835
Peer rewards for prosocial involvement (P)	1.02 (0.01)	[1.00, 1.04]	0.101	1.02 (0.01)	[0.99, 1.04]	0.250	0.99 (0.01)	[0.97, 1.02]	0.552
^a Female*past month tobacco use	–	–	–	–	–	–	1.17 * (0.08)	[1.03, 1.34]	0.015
<i>Family factors</i>									
Family conflict	1.00 (0.01)	[0.97, 1.02]	0.824	1.03 * (0.02)	[1.00, 1.07]	0.040	1.03 (0.02)	[1.00, 1.07]	0.056
Low parent attachment	0.98 (0.01)	[0.95, 1.00]	0.094	0.98 (0.02)	[0.95, 1.01]	0.256	0.99 (0.03)	[0.94, 1.04]	0.674
Poor family management	1.02 (0.02)	[0.98, 1.06]	0.356	1.01 (0.03)	[0.95, 1.07]	0.813	1.05 (0.04)	[0.98, 1.14]	0.157
Family opportunities for prosocial involvement (P)	1.03 (0.02)	[0.99, 1.06]	0.168	1.00 (0.03)	[0.95, 1.05]	0.884	1.03 (0.02)	[0.98, 1.07]	0.238
<i>Peer factors</i>									
Interaction with antisocial peers	1.11 ** (0.04)	[1.04, 1.18]	0.002	1.08 * (0.04)	[1.02, 1.15]	0.015	1.02 (0.03)	[0.95, 1.09]	0.597
Peer rewards for antisocial involvement	1.00 (0.01)	[0.99, 1.02]	0.633	1.00 (0.01)	[0.98, 1.02]	0.933	1.00 (0.01)	[0.98, 1.02]	0.999
Interaction with prosocial peers (P)	1.00 (0.01)	[0.98, 1.03]	0.777	1.00 (0.01)	[0.98, 1.03]	0.839	0.99 (0.01)	[0.97, 1.01]	0.265
Bullying victimization	1.00 (0.01)	[0.98, 1.02]	0.974	0.99 (0.01)	[0.97, 1.02]	0.633	0.99 (0.01)	[0.96, 1.01]	0.295

	Model 1			Model 2			Model 3		
^b Female*interaction with antisocial peers	0.93 (0.04)	[0.85, 1.01]	0.068	–	–	–	–	–	–
<i>School factors</i>									
Academic failure	1.03 * (0.02)	[1.00, 1.07]	0.040	1.00 (0.02)	[0.97, 1.03]	0.920	1.08 * (0.04)	[1.00, 1.16]	0.046
Low commitment to school	1.02 (0.02)	[0.98, 1.06]	0.428	0.98 (0.02)	[0.93, 1.03]	0.424	0.97 (0.02)	[0.93, 1.02]	0.289
School opportunities for prosocial involvement (P)	0.95 (0.03)	[0.90, 1.00]	0.072	1.00 (0.03)	[0.94, 1.06]	0.912	0.96 (0.03)	[0.90, 1.02]	0.201
School recognition for prosocial involvement (P)	1.04 (0.03)	[0.99, 1.10]	0.116	1.01 (0.03)	[0.96, 1.06]	0.668	1.04 (0.02)	[0.99, 1.09]	0.089
^c Female*academic failure	0.93 (0.04)	[0.85, 1.01]	0.068	–	–	–	0.92 (0.04)	[0.84, 1.01]	0.067
<i>Community factors</i>									
Low neighborhood attachment	1.01 (0.01)	[0.99, 1.03]	0.437	1.01 (0.01)	[0.99, 1.04]	0.316	1.00 (0.02)	[0.96, 1.04]	0.985
Community disorganization	1.00 (0.02)	[0.97, 1.03]	0.910	0.96 (0.02)	[0.93, 1.00]	0.052	1.03 (0.03)	[0.98, 1.10]	0.262
Community opportunities for prosocial involvement (P)	0.99 (0.01)	[0.97, 1.02]	0.545	0.99 (0.02)	[0.95, 1.03]	0.518	1.00 (0.02)	[0.97, 1.04]	0.905
Community recognition for prosocial involvement (P)	1.01 (0.01)	[0.99, 1.03]	0.398	1.00 (0.02)	[0.97, 1.03]	0.920	1.00 (0.01)	[0.97, 1.02]	0.834
<i>Pseudo R²</i>	<i>0.018</i>			<i>0.006</i>			<i>0.004</i>		
<i>Adjusted R²</i>	<i>0.006</i>			<i>0.010</i>			<i>0.014</i>		

Note. The fully adjusted analyses (Models 1–3) control for gender, age, state, the clustering of students in schools, baseline (T1 or T2) antisocial behavior and all baseline predictors in the table. The final negative binomial regression models are presented here. Online supplemental material Tables 3 and 4 contain all stages of the hierarchical modelling, including gender*risk and protective factors interactions for Models 1 and 3. Results from all stages of the hierarchical modelling for Models 2 and 3 are available from the lead author.

(P)=Protective factor. Female gender (coded 0=male, 1=female); Victoria (coded 0=Washington State, 1=Victoria); Past month alcohol, tobacco and cannabis use (coded 0=no use, 1=recent use). IRR=incidence rate ratio; SE=robust standard error; CI=confidence interval. Pseudo R²=McFadden's R²; Adjusted R²=McFadden's Adjusted R².

Statistically significant results shown in **bold** and indicated with asterisks

*
 $p < .05$

**
 $p < .01$

 $p < .001$.

^aFemale*past month tobacco use: IRR corresponds to the interaction between the dichotomous gender variable (coded "0" for males and "1" for females) and the dichotomous risk factor past month tobacco use (coded 0=no use, 1=recent use).

^bFemale*interaction with antisocial peers: IRR corresponds to the interaction between the dichotomous gender variable (coded "0" for males and "1" for females) and the continuous risk factor interaction with antisocial peers.

^cFemale*academic failure: IRR corresponds to the interaction between the dichotomous gender variable (coded "0" for males and "1" for females) and the continuous risk factor academic failure.