Adolescent Illicit Drug Use and Subsequent Academic and Psychosocial Adjustment:

An Examination of Socially-Mediated Pathways

* Frédéric N. Brière, [a,c] Jean-Sébastien, Fallu, [b,c,d] Julien Morizot, [b,d] Michel Janosz,. [b,c,d]

[a] Université de Montréal, C.P. 6128, succursale Centre-Ville, Montréal (Québec), H3C 3J7, Canada (frederic.nault-briere@umontreal.ca)

[b] École de Psychoéducation, Université de Montréal, C.P. 6128, succursale Centre-Ville, Montréal (Québec), H3C 3J7, Canada (jean-sebastien.fallu@umontreal.ca; Julien.morizot@umontreal.ca; michel.janosz@umontreal.ca)

[c] School Environment Research Group (SERG), 7077 Avenue du Parc, 5[e] étage, Montréal, (Québec), H3N 1X7, Canada

[d] Institut de Recherche en Santé Publique de l'Université de Montréal (IRSPUM), Pavillon 1420, boul. Mont-Royal, C.P. 6128, Succ. Centre-Ville, Montréal (Québec), H3C 3J7, Canada

Corresponding author. Frédéric N. Brière; Tel: 1-514-452-0332 (Canada); Fax: 514-343-6951. frederic.nault-briere@umontreal.ca

Word Count : 4308

Abstract

Background. Questions remain regarding the consequences of illicit drug use on adolescent adjustment and the nature of mechanisms that may explain these consequences. In this study, we examined whether early-onset illicit drug use predicts subsequent academic and psychosocial adjustment and whether associations are socially-mediated by decreased school engagement and increased peer deviancy.

Method. 4885 adolescents were followed throughout secondary school. We used regressions to determine whether illicit drug use in grade 7 predicted academic achievement, school dropout, depressive symptoms, and conduct problems in grades 10-11, adjusting for potential confounders. We used path analysis to test whether significant associations were mediated by school engagement and peer deviancy in grade 8.

Results. Illicit drug use predicted conduct problems and school dropout, but not academic achievement and depressive symptoms. The association between illicit drug use and conduct problems was fully mediated by increased peer deviancy. The association between illicit drug use and school dropout was partially mediated by increased peer deviancy, but remained mostly direct. No indirect association via decreased school engagement was found. Examination of reverse pathways revealed that conduct problems and academic achievement in grade 7 predicted drug use in grades 10-11. These associations were mediated by peer deviancy and school engagement (conduct problems only).

Conclusion. Adolescent illicit drug use influences the risk of school dropout and conduct problems in part by contributing to deviant peer affiliation. Reciprocal social mediation characterizes the association between drug use and conduct problems. A reverse mechanism best explains the association with academic achievement.

Key words: Drug use, academic achievement, school dropout, depressive symptoms, conduct problems, adolescence.

1. Introduction

Adolescent illicit drug use is widespread and has been associated with a wide range of long-term negative outcomes (Fergusson et al., 2002; Johnston, 2013). Prospective studies show associations between illicit drug use and academic difficulties during adolescence, including poorer academic achievement and school dropout (Bachman et al., 2007; Townsend et al., 2007), as well as reduced educational and occupational attainment in adulthood (Fergusson et al., 2002; Horwood et al., 2010). Other studies found illicit drug use in youth to be associated with poorer psychosocial functioning, including externalizing and internalizing symptoms (D'Amico et al., 2008; Fergusson et al., 2002). Earlier onset of drug use is particularly predictive of long-term impairments (Brook et al., 2002; Horwood et al., 2010).

However, findings from prospective studies have not been completely consistent. The directionality of the association between drug use and externalizing symptomatology remains debated (Bui et al., 2000; D'Amico et al., 2008) and inconsistent associations have been reported between drug use and internalizing symptoms (e.g., Macleod et al., 2004; Rogers et al., 2009). Prospective evidence regarding drug use consequences on academic adjustment (achievement, engagement, etc.) during secondary school (Bachman et al., 2007) is scarce, although longer-term effects on dropout and educational attainment are better documented (Townsend et al., 2007).

Apart from inconsistent findings, an issue that remains largely unclear is *how* adolescent illicit drug use increases the risk of poor outcomes over the lifespan. One possibility is that illicit drug use influences individual adjustment directly, presumably via a neurobiological effect involving active drug ingredients (e.g., THC, MDMA, etc.). A second possibility is that illicit drug use influences individual adjustment via social mediation mechanisms, that is via indirect relationships mediated by social factors that increase the risk of academic and psychosocial problems. Several authors have argued that such mechanisms are likely to largely account for

drug use consequences on individual adjustment (Fergusson and Horwood, 1997; Ford, 2005), but limited research has tested this proposition empirically.

A social mediation mechanism that has been proposed is that illicit drug use could contribute to academic and psychosocial difficulties via an indirect influence on the social bonds of adolescents (Ford, 2005; Townsend et al., 2007), which have been consistently emphasized as key determinants of prosocial and deviant pathways (Catalano and Hawkins, 1996; Hirschi, 2002). Drug use may draw adolescents toward delinquent and drug-using peers who can influence academic and psychosocial adjustment via social learning mechanisms (e.g., direct peer pressure; Bandura, 1977) or group norms and sanctions (Kandel, 1985). At the same time, drug use may push adolescent illicit drug users away from normative social ties, as drug use generates 'role incompatibility' with expected roles such as school engagement (Yamaguchi and Kandel, 1985).

Very few studies have tested social mediation of drug-related consequences. Peer deviancy/drug use was found to mediate consequences of cannabis use on subsequent criminality (Fergusson and Horwood, 1997), but not consequences on school dropout (Haller et al., 2010). One study found academic motivation to mediate the consequences of drug use on school dropout (Kaplan and Liu, 1994). On the other hand, another study did not find school bonding to mediate the association between drug use and delinquency (Ford, 2005). The extant evidence is thus limited and somewhat mixed.

Common limitations of previous studies may explain inconsistent findings regarding the nature and mechanisms of drug use consequences. These include limited adjustment for potential confounders, lack of consideration of reverse mechanisms (e.g., prospective links from academic and psychosocial adjustment to drug use), and a focus on specific outcomes and potential mediators that precluded the test of general, overarching mechanisms. To our knowledge, no well-controlled prospective study has yet examined whether the associations between illicit drug

use and academic and psychosocial adjustment are socially-mediated by both peer deviancy and school engagement, taking into account the possibility of reverse mechanisms.

In this study, we used a large prospective sample to examine the repercussions of early-onset illicit drug use during adolescence. Our first objective was to determine whether illicit drug use in early secondary school (grade 7) was predictive of subsequent academic (academic achievement, school dropout) and psychosocial outcomes (conduct problems, depressive symptoms) in grades 10-11 after accounting for relevant potential confounders. We considered common risk factors (sex, family adversity, difficult relationships with parents) that can have a ubiquitous impact on adjustment (Sameroff et al., 2003) and modeled each association adjusting for other adjustment problems, as adjustment difficulties tend to influence each other (Cichetti, 2006). Our second objective was to determine whether the associations between illicit drug use and subsequent adjustment were mediated by a negative shift in social bonds reflected by (1) decreased school engagement and (2) increased peer deviancy in grade 8. We also examined associations and social mediation in the opposite direction in order to determine whether associations between illicit drug use and academic and psychosocial outcomes were better explained by a reverse or bidirectional mechanism.

2. Method

2.1 Participants

Participants were followed annually throughout secondary school (2003/2004-2007/2008) as part of the evaluation of a dropout prevention program in disadvantaged areas of Quebec, Canada (Janosz et al., 2010). Seventy-one schools were sampled via a stratified random sampling procedure to be representative of the 200 secondary schools located in disadvantaged communities in Quebec in terms of geographical location, size, and language. In this study, we used participants who were aged 12 or 13 in Grade 7 and did not officially dropout of school

before grade 10. The final sample comprised 4885 participants. The sample included slightly more girls (53.1%) than boys and the majority of participants were Quebec-born Caucasians (88.8%). Minority participants were of diverse origins (Native=1.0%; Caribbean=1.8%; Latin American=1.8%; African=1.4%; Asian=1.3% Middle Eastern=1.2%; South Asian=0.5%; European=2.2%).

2.2. Procedure

Data were collected via self-reported questionnaires administered in class by teachers and trained research assistants. All students and parents provided informed active consent (23% refusals/no answers). Study procedures were approved by the Institutional Review Board of the University of Montreal. Illicit drug use was measured in the winter of Grade 7. Psychosocial and academic outcomes were assessed in the Spring of grades 10 and 11. Potential mediators (school engagement and peer deviancy) were measured in the Spring of Grade 8. Baseline levels of the outcomes and potential mediators, as well as potential confounders were measured in the winter of grade 7. Rates of missing data on conduct problems and depressive symptoms in grades 10-11 were 28.7% and 27.8% respectively. Only 4 (0.1%) participants did not have official information on school dropout. Excluding participants who dropped out of school, 22.8% of participants had missing data on academic achievement in grades 10-11. Rates of missing data on school engagement and peer deviancy in Grade 8 were 25.6% and 29.2% respectively. Missingness on potential mediators and outcomes was mostly related to attrition due to participants (1) moving to different schools (at least once=14%), (2) being absent from school on the day of the survey for various reasons, and (3) dropping out of school (10% - this applied only to conduct problems and depressive symptoms in grades 10-11, as dropouts were excluded from analyses examining academic achievement). Missingness related to the non-completion of scales within a survey was low for potential mediators (0%-3.6%) and outcomes (0%-2.9%). Missing data on potential

confounders in grade 7 ranged from 0% to 14.1%. Analysis of missing data bias is presented in Appendix A.

2.3 Measures

2.3.1 Illicit Drug Use (Grade 7).

Participants were asked to report whether they used three types of illicit drugs: cannabis (marihuana, hasch, a joint, pot?), stimulants (speed, pep pills, etc.) or hallucinogens (LSD, STP, PCP, etc.), and hard drugs (heroin, morphine, opium, crack, etc.) in the past 12 months (4-point frequency items: 0="no use"; 3="very often"). This scale was validated in a sample of Quebec adolescents (alpha=.79) (Le Blanc, 1996). Participants who reported using any of the three types of illicit drugs were coded as 1 (no use=0).

2.3.2 Psychosocial and academic adjustment (Grades 10-11).

Conduct problems were measured using a 16-item scale (alpha=.95) assessing the occurrence of various delinquent behaviors in the past 12 months (e.g., did you take and keep something in a shop without paying?) (Le Blanc, 1994). (4-point frequency items: 1="never"; 4="very often"). We recoded items dichotomously (0="never"; 1="at least once") to obtain a count variable indexing the number of delinquent acts committed in the past year (min 0; max 16).

Depressive symptoms were assessed using the Center for Epidemiologic Studies-Depression (CES-D) scale (20 items; alpha=.90) which inquires about feelings and behaviors in the past week (Radloff, 1977). The CES-D includes items such as "I felt that everything I did was an effort" (4-point frequency items: 0="rarely or none of the time"; 3="most or all the time") (min 0; max 60). The CES-D has been validated in adolescent and in French. (Radloff, 1991; Riddle et al., 2002)

Academic achievement was assessed using the average of self-reported grades in Mathematics and Language Arts (French) rated on typical report card scales (min 0%; max 100%). Achievement in Mathematics and Language Arts are the two core subjects and key requirements for secondary school completion in Quebec. This proxy of achievement has been proven to be an excellent predictor of later academic success (Archambault et al., 2009; Janosz et al., 1997). Furthermore, focusing on specific topics has been shown to increase the accuracy of self-reported grades among high school students (Kuncel, Credé, & Thomas, 2005).

School dropout was assessed using official records obtained from the Quebec Ministry of Education, Leisure, and Sports (MELS). Participants were coded as dropouts in grade 10 or 11 if (1) they were not registered in school that year, (2) had not obtained a diploma and (3) had been officially registered the year before. Psychosocial and academic measures were combined over grades 10 and 11 to reduce missingness and capture more stable constructs of adjustment. Mean scores were used for all outcomes, except dropout, which was coded as 0=non occurrence in grade 10 or grade 11 and 1= occurrence in either grade.

2.3.3 Potential mediators: school engagement and peer deviancy (Grade 8)

School engagement was assessed using a tridimensional measure including behavioral, affective, and cognitive dimensions (Archambault et al., 2009). The behavioral dimension (alpha=.73) assessed school attendance and compliance with rules with items (e.g., ''have you disrupted class on purpose?'') (4-point frequency items: 1=never; 4=quite often). The affective dimension (alpha=.82) assessed how students liked and were interested in school tasks with statements (e.g., ''I like school'') (7-point Likert items: 1=strongly disagree; 7=strongly agree). The cognitive dimension (alpha=.88) assessed the degree to which students were willing to learn language arts (French) and mathematics (e.g., ''How much effort are you ready to spend in mathematics?'') (7-point items: 1=not at all to 7 =a lot). The three dimensions were combined

using weights from the original confirmatory factor analysis (min 0; max 3.67) (Archambault et al., 2009).

Peer deviancy was measured using a 3-item scale (alpha=.68) (Le Blanc, 1994), derived from a longer scale used in longitudinal studies on adolescent deviancy (Elliott et al., 1985). The items were dichotomized and summed up (min=0; max=3): "my best friends take drugs" (0=never; 1=a few times to always), "my best friends could have had trouble with the police because of their misbehavior" (0=strongly disagree / disagree / undecided; 1 =agree / strongly agree), and "how many of your friends were arrested by the police because of their misbehavior" (0=none; 1=one or two to many).

2.3.4 Controls (Grade 7).

We used identical measures in grade 7 to control for baseline values of outcomes and potential mediators. However, because preliminary analyses pointed to multicollinearity issues (e.g., regression coefficient reversals due to very high correlations) in models involving measures of conduct problems, peer deviancy, and illicit drug use in grade 7, we dichotomized conduct problems (0=no conduct problem; 1=any conduct problem) and peer deviancy (0=no peer deviancy; 1=any peer deviancy) at baseline. As a baseline control for school dropout, we included an 11-item measure (alpha=.89) of perceived advantages of dropping out asking participants to rate potential benefits of dropping out of school, such as "I would be happier if I dropped out of school" (4-point Likert items: 1=totally disagree 4=totally agree). Potential confounders included sex (0=females; 1=males), family adversity (a cumulative index of risk factors : low parental education and occupational prestige, material and educational resources, number of family movings, having a single parent, school dropout by siblings) and conflict with parents, a 3-item scale (alpha=.73) including questions such as "do you have arguments with your parents?" (4-point frequency items: 0=never; 3=continuously) (Le Blanc, 1996).

2.4 Data Analysis

We first examined the associations between illicit drug use in grade 7 and psychosocial and academic outcomes in grades 10-11. For each outcome, we evaluated an unadjusted model, a model adjusted for baseline outcome values, and a fully adjusted model including all potential confounders. We used linear regression for depressive symptoms and academic achievement (continuous outcomes), logistic regression for school dropout (dichotomous outcome), and Poisson regression for conduct problems (count outcome). We only evaluated associations between illicit drug use and academic achievement in participants who did not drop out of school in grade 10 or 11. When a predictive association remained after full adjustment, we pursued the examination of direct and indirect pathways via decreased school engagement and increased peer deviancy using path analysis. We designed models with (1) illicit drug use predicting the outcome and the two potential mediators, (2) the two potential mediators predicting the outcome, and (3) all control variables predicting the outcome and the two potential mediators. We computed indirect associations using product of coefficients, paired with bootstrapping (2500 draws) to estimate standard errors (MacKinnon, 2008). Bootstrapping was unavailable for models involving numerical integration (logistic and Poisson models). In order to strengthen our conclusions about the direction of the relationships, we tested reverse direct and indirect associations by specifying identical models with academic and psychosocial outcome variables in grade 7 and illicit drug use in grades 10-11. In order to retain all available participants and reduce potential bias associated with attrition, we used Full Information Maximum Likelihood (FIML) estimation in all models (Graham, 2009). We conducted all analyses with Mplus 6.12 (Muthén and Muthén, 2010).

3. Results

3.1 Descriptives

Table 1 presents the means or rates for the main study variables in males, females, and the total sample. Approximately one participant out of five reported using illicit drug in Grade 7. Among illicit drug users, 87% reported using cannabis (once or twice =48%; times or more =39%), 41% reported using stimulants/hallucinogens (once or twice =25%; 3 times or more =16%), and 42% reported using hard drugs (once or twice =24%; 3 times or more =18%).

3.2 Unadjusted and adjusted associations

Table 2 presents unadjusted and adjusted associations between illicit drug use in Grade 7 and subsequent psychosocial and academic adjustment in Grades 10-11. Participants who reported using illicit drugs tended to have poorer adjustment on all outcomes. However, illicit drug use did not predict academic achievement and depressive symptoms after adjusting for baseline outcomes and potential confounders. Illicit drug use remained predictive of conduct problems and school dropout after full adjustment, although the strength of both associations was diminished. None of the associations between illicit drug use and subsequent academic and psychosocial outcomes differed by sex.

3.3 Mediation analyses

We next examined whether associations between illicit drug use in grade 7 and subsequent conduct problems and school dropout in grades 10-11 were mediated by decreased school engagement and increased peer deviancy in Grade 8. The association between illicit drug use and school dropout was partly mediated by an indirect pathway via increased peer deviancy, but the largest share of the association remained in a residual direct pathway (Figure 1). The association between illicit drug use and conduct problems was fully mediated by an indirect pathway via increased peer deviancy (Figure 2). No indirect pathway via decreased school engagement was found in either case.

3.3 Reverse direct and indirect associations

The examination of reverse associations showed that conduct problems and academic achievement in grade 7 independently predicted illicit drug use in grades 10-11. As shown in the bottom part of Figure 2, conduct problems were predictive of subsequent drug use via decreased school engagement and peer deviancy in grade 8. A significant direct pathway also remained. Higher academic achievement in grade 7 was associated with a lower risk of subsequent illicit drug use in grades 10-11. This association was fully mediated by lower peer deviancy in grade 8 (Figure 3). We found no reverse direct or indirect associations for depressive symptoms and school dropout (with perceived advantages of dropping out as predictor).

3.4 Ancillary analyses

Finally, we conducted a series of ancillary analyses to test the robustness of results and explore additional hypotheses. First, we examined whether considering drug use frequency rather than illicit drug use (yes/no) modified results of our main analyses. We found identical results, suggesting that intensity of drug use had no substantive impact on study conclusions. Second, we investigated the possibility that effects of illicit drug use on academic achievement (in grade 8) might mediate associations with subsequent conduct problems (Patterson et al., 1989) and especially school dropout (Townsend et al., 2007). We found no indirect pathway for any of the two outcomes. Third, we tested a model with inverted outcomes and mediator to determine whether the association between illicit drug use and peer deviancy or school engagement was mediated by academic and psychosocial adjustment. Illicit drug use in grade 7 predicted increased peer deviancy (B=.33, 95%CI=.20–.45), but not school engagement in grades 10-11. This association was partly mediated by increased conduct problems in grade 8 (indirect=.14, 95%CI=.09–.19).

4. Discussion

In this study, we used a large prospective sample of adolescents to examine the developmental repercussions of early-onset illicit drug use during the secondary school. Our first objective was to assess the association between illicit drug use in grade 7 and subsequent academic and psychosocial adjustment in grades 10-11. We found illicit drug use to independently predict school dropout and conduct problems, but not academic achievement and depressive symptoms. Our study adds to the evidence implicating illicit drug use as a risk factor of both school dropout and conduct problems (D'Amico et al., 2008; Fergusson et al., 2002; Townsend et al., 2007).

Our second objective was to examine whether associations between illicit drug use and subsequent adjustment were socially mediated by a negative shift in social bonds reflected in (1) increased peer deviancy and (2) decreased school engagement. Consistent with a previous study (Fergusson and Horwood, 1997), we found peer deviancy to fully mediate the association between illicit drug use and subsequent conduct problems and to partially mediate the association between illicit drug use and school dropout. Drug use may contribute to bringing users closer to delinquent and drug-using peers, possibly via selection effects (i.e., users affiliate with individuals who behave like them) or because drug use is incompatible with affiliation with prosocial peers. Ancillary analyses also suggested that illicit drug use may lead to deviant peer affiliation via increases in conduct problems, suggesting that drug-induced facilitation of deviant behavior may play a role in the process of deviant peer affiliation. In turn, increased peer deviancy is likely to contribute to the risk of conduct problems via social learning mechanisms such as direct peer pressure and vicariant learning (e.g., observing other drug users) (Bandura and McClelland, 1977) and group-based processes, such as norms and sanctions that define a standard for non-conventional behavior and provide penalties or rewards to promote conformity to this standard (Kandel, 1985).

Contrary to our hypothesis, school engagement did not mediate the association between illicit drug use and conduct problems or school dropout. This result is consistent with a previous study showing no mediation for delinquency (Ford, 2005), although supporting evidence exists for school dropout (Kaplan & Liu, 1994). Closer examination of models suggests that we found no indirect effect primarily because illicit drug use in grade 7 was not predictive of subsequent school engagement in grade 8. The stability of engagement from grade 7 to grade 8 was very high (r=.58) and may have precluded detecting modest associations with illicit drug use.

Most of the association between illicit drug use and subsequent dropout was not explained by the two potential mediators (93% of attributable increased odds). The nature and importance of this residual association is intriguing. Our ancillary analyses ruled out the possibility that illicit drug use affects dropout via school failure, as suggested elsewhere (Townsend et al., 2007). Other possibilities include that illicit drug use influence the risk of dropout via decreased parental involvement (quality relationships, supervision, etc.), adverse neurobiological effects or a negative impacts on student achievement and engagement that become more pronounced and discernible after grade 8. Finally, since our measure of academic achievement was self-reported and focused solely on grades in Language Arts and Mathematics, we cannot rule out the possibility that different results would have been found observed with an independent and more global measure.

An interesting complementary contribution of this study was the identification of two reverse mechanisms. First, in addition to prospective association from illicit drug use to conduct problems, we found conduct problems in grade 7 to predict illicit drug use in grades 10-11. Furthermore, this reverse association was partly mediated by increased peer deviancy and decreased school engagement in grade 8. Taken together, our findings thus imply that the association between illicit drug use and conduct problems is best characterized by reciprocal social mediation. Illicit drug use and conduct problems appear to represent two interconnected

problem behaviors, influencing each other in part by drawing adolescents toward social deviant peers and eroding prosocial attachment to school (Catalano and Hawkins, 1996; Jessor and Jessor, 1977). Second, we found a reverse association from academic achievement in grade 7 to illicit drug use in grades 10-11. Considering that we did not find the expected association from illicit drug use to academic achievement, this finding suggests that illicit drug use is more likely to represent a consequence rather than a cause of low academic achievement. This result is consistent with previous studies (Ellickson et al., 2005; Fothergill and Ensminger, 2006; Haller et al., 2010). A more novel contribution from our analyses is that this reverse prospective association was fully mediated by increased peer deviancy in grade 8, suggesting that academic difficulties contribute to drawing adolescents toward the drug-promoting influence of deviant peers, possibly by eliciting rejection from networks of prosocial, academically-oriented peers.

Depressive symptoms was not prospectively associated with illicit drug use in one direction or the other after adjustment, suggesting that the association is best explained by common risk factors. Several studies similarly found no association between drug use and depressive symptoms (Arseneault et al., 2002; Harder et al., 2006), although significant associations have also been reported, especially from drug use to depressive symptoms (Degenhardt et al., 2003; Fergusson et al., 2002). One element which may explain differences with previous studies is the short time frame of the CES-D items (past week symptoms only). Longer-term measurement of symptoms (e.g., past year) may have been required to detect the influence of more distal risk factors.

Several limitations need to be noted. First, we used an index of illicit drug use without making distinctions between different types of drugs. Although this strategy did not provide information on specific drug effects, the typical co-occurrence of multiple drug use limited our capacity to examine drugs separately and socially-mediated mechanisms are not theoretically expected to be drug-specific. Second, multicollinearity between illicit drug use and other

variables in grade 7 made it necessary for us to transform measures of conduct problems and peer deviancy at baseline, which created less stringent controlling. Third, the presence of missing data may have affected results, although FIML estimation correct for bias associated with observed variables. Fourth, our sample mostly contained schools located in disadvantaged areas. Our results may not generalize to other school settings and students (e.g., private schools). However, as a note regarding external validity, unfamiliar readers should know that the social and legal context surrounding drug use in Quebec compares to most Western countries, as do correlates of illicit drug use among adolescents (Dubé and et al., 2009). Rates of illicit drug use tend to be slightly above those observed in countries like USA (Johnston et al., 2013), but it is reasonable to assume that our findings generalize to other Western countries.

Future studies should explore other potential mediators that could explain the association between illicit drug use and school dropout. These include other social aspects, such as parenting practices and peer relationships, or neurobiological effects of drugs. Future studies are also needed to examine how heterogeneity in drug use profiles influences the outcomes of illicit drug use, as well as the social mechanisms that may explain these outcomes.

Our findings reinforce the notion that effectively intervening on early-onset drug use may reduce the risk of dropout and conduct problems in students. The role of peer deviancy in the consequences of drug use also has important clinical implications. One concern expressed by clinicians and researchers is that interventions that focus on zero-tolerance and criminalization may contribute to alienating users and unintentionally push them toward increased marginality and criminality (Kleinig, 2004). Although we do not provide direct support for this hypothesis, our results suggest that interventions should be designed with a special care to avoid potential negative social consequences for users. Strategies that focus on providing appealing and non-judgmental opportunities to build and/or maintain bonds between users and normative influences (e.g., involvement in activities designed to require collaboration with prosocial peers and adults)

are likely to provide a promising avenue to offset the negative social repercussions of illicit drug use (Dishon, Dodge, & Lansford, 2006). Finally, our results suggest that educational interventions that seek to improve academic achievement may help to reduce early illicit drug use, which in turn may have a positive impact on multiple aspects of adjustment.

5. References

Archambault, I., Janosz, M., Morizot, J., Pagani, L., 2009. Adolescent behavioral, affective, and cognitive engagement in school: relationship to dropout. J. Sch. Health 79, 408-415.

Arseneault, L., Cannon, M., Poulton, R., Murray, R., Caspi, A., Moffitt, T.E., 2002. Cannabis use in adolescence and risk for adult psychosis: longitudinal prospective study. B. M. J. 325, 1212 1213.

Bachman, J.G., O'Malley, P.M., Schulenberg, J.E., Johnston, L.D., Freedman-Doan, P., Messersmith, E.E., 2007. The education-drug use connection: How successes and failures in school relate to adolescent smoking, drinking, drug use, and delinquency. Psychology Press.

Bandura, A., 1977. Social Learning Theory. Prentice-Hall, Englewood Cliffs.

Brook, D.W., Brook, J.S., Zhang, C., Cohen, P., Whiteman, M., 2002. Drug use and the risk of major depressive disorder, alcohol dependence, and substance use disorders. Arch. Gen. Psychiatry 59, 1039.

Bui, K.V.T., Ellickson, P.L., Bell, R.M., 2000. Cross-lagged relationships among adolescent problem drug use, delinquent behavior, and emotional distress. J. Drug Issues 30, 283-303.

Catalano, R.F., Hawkins, J.D., 1996. The social development model: A theory of antisocial behavior. In: Hawkins, J.D. (ed.) Delinquency and Crime. Cambridge University Press, Cambridge, pp.149-197.

Cichetti, D., 2006. Development and psychopathology. In: Cichetti, D., Cohen, D.J. (Eds.). Developmental psychopathology (volume I: Theory and method). Wiley & Sons., Hoboken, NJ.

D'Amico, E.J., Edelen, M.O., Miles, J.N., Morral, A.R., 2008. The longitudinal association between substance use and delinquency among high-risk youth. Drug Alcohol Depend. 93, 85-92.

Degenhardt, L., Hall, W., Lynskey, M., 2003. Exploring the association between cannabis use and depression. Addiction 98, 1493-1504.

Dishion, T.J., Dodge, K.A., Lansford, J.E., 2006. Findings and recommendations: A blueprint To minimize deviant peer influence in youth interventions and programs. In : Dodge, K.A., Dishion, T.J., Lansford, J.E. (Eds), Deviant peer influences in programs for youth: Problems and solutions, Guilford Press, New York, pp. 366-394.

Dubé, G., et al., 2009. Enquête québécoise sur le tabac, l'alcool, la drogue et le jeu chez les élèves du secondaire, 2008. Institut de la Statistique du Québec (ISQ), Québec.

Ellickson, P., Tucker, J., Klein, D., Saner, H. 2004. Antecedents and outcomes of marijuana use initiation during adolescence. Prev. Med. 39, 976–984.

Elliott, D.S., Huizinga, D., Ageton, S.S., 1985. Explaining delinquency and drug use. Sage Publications, Beverly Hills, CA.

Fergusson, D.M., Horwood, L., 1997. Early onset cannabis use and psychosocial adjustment in young adults. Addiction 92, 279-296.

Fergusson, D.M., Horwood, L.J., Swain- Campbell, N., 2002. Cannabis use and psychosocial adjustment in adolescence and young adulthood. Addiction 97, 1123-1135.

Fothergill, K., Ensminger, M. 2006. Childhood and adolescent antecedents of drug and alcohol problems: A longitudinal study. Drug Alcohol Depend., 82, 61–76.

Ford, J.A., 2005. Substance Use, the Social Bond, and Delinquency. Sociol. Inq. 75, 109-128.

Graham, J.W., 2009. Missing data analysis: making it work in the real world. Annu. Rev. Psychol. 60, 549-576.

Haller, M., Handley, E., Chassin, L., Bountress, K., 2010. Developmental cascades: Linking adolescent substance use, affiliation with substance use promoting peers, and academic achievement to adult substance use disorders. Dev. Psychopathol. 22, 899.

Harder, V.S., Morral, A.R., Arkes, J., 2006. Marijuana use and depression among adults: Testing for causal associations. Addiction 101, 1463-1472.

Hirschi, T., 1969. Causes of delinquency. University of California Press, Berkeley.

Horwood, L.J., Fergusson, D.M., Hayatbakhsh, M.R., Najman, J.M., Coffey, C., Patton, G.C., Silins, E., Hutchinson, D.M., 2010. Cannabis use and educational achievement: Findings from three Australasian cohort studies. Drug Alcohol Depend. 110, 247-253.

Janosz, M., Bélanger, J., Dagenais, C., Bowen, F., Abrami, P.C., Cartier, S.C., Chouinard, R., Fallu, J.-S., Desbiens, N., Roy, G., Pascal, S., Lysenko, L., Turcotte, L., 2010. Aller plus loin,

ensemble : synthèse du rapport final d'évaluation de la stratégie d'intervention Agir autrement. Groupe de recherche sur les environnements scolaires, Université de Montréal, Montréal

Janosz, M., LeBlanc, M., Boulerice, B., Tremblay, R., 1997. Disentangling the weight of school dropout predictors: a test on two longitudinal samples. J. Youth Adolesc. 26, 733-762.

Jessor, R., Donovan, J.E., Costa, F.M., 1991. Beyond adolescence: Problem behavior and young adult development. Cambridge University Press, New York.

Johnston, L., 2013. Monitoring the future: National results on adolescent drug use: Overview of key findings, 2012. DIANE Publishing, Institute for Social Research, The University of Michigan, Ann Arbor.

Kandel, D.B., 1985. On processes of peer influences in adolescent drug use: A developmental perspective. Adv. Alcohol Subst. Abuse 4, 139-162.

Kaplan, H.B., Liu, X., 1994. A longitudinal analysis of mediating variables in the drug use-dropping out relationship. Criminol. 32, 415-439.

Kleinig, J., 2004. Ethical issues in substance use intervention. Subst. Use Misuse 39, 369-398.

Kuncel, N.R., Credé, M., Thomas, L., 2005. The validity of self-reported grade point averages, class ranks, and test scores: A meta-analysis and review of the literature. Rev. Educ. Res. 75, 63-82

Le Blanc, M., 1996. MASPAQ: Mesures de l'adaptation personnelle et sociale pour les adolescents québécois: Manuel et guide d'utilisation [Measures of Quebec Adolescent' Social and Personal Adjustment: User Guide (3rd ed.)]. Research Group on Problem Adolescents, School of Psychoeducation, University of Montreal, Montreal.

Macleod, J., Oakes, R., Copello, A., Crome, I., Egger, M., Hickman, M., Oppenkowski, T., Stokes-Lampard, H., Davey Smith, G., 2004. Psychological and social sequelae of cannabis and other illicit drug use by young people: a systematic review of longitudinal, general population studies. Lancet 363, 1579-1588.

MacKinnon, D. P., 2008. Introduction to Statistical Mediation Analysis. Erlbaum, New York.

Muthén, L.K., Muthén, B.O., 2010. Mplus User's Guide [version 6; computer program]. Muthén & Muthén, Los Angeles.

Patterson, G.R., DeBaryshe, B.D., Ramsey, E., 1989. A developmental perspective on antisocial behavior. Am. Psychol. 44, 329-335.

Radloff, L.S., 1977. The CES-D Scale: a self-report depression scale for research in the general population. Appl. Psychol. Meas. 1, 385-401.

Radloff, L.S., 1991. The use of the Center for Epidemiologic Studies Depression Scale in adolescents and young adults. J. Youth Adolesc. 20, 149-166.

Riddle, A.S., Blais, M.R., Hess, U., 2002. A Multi-Group Investigation of the CES-D's Measurement Structure Across Adolescents, Young Adults and Middle-Aged Adults. Centre interuniversitaire de recherche en analyse des organisations (CIRANO), Montreal.

Rogers, G., Elston, J., Garside, R., Roome, C., Taylor, R., Younger, P., Zawada, A., Somerville, M., 2009. The harmful health effects of recreational ecstasy: a systematic review of observational evidence. Health Technol. Assess. 13, xii-338.

Sameroff, A.J., Gutman, L.M., Peck, S.C., 2003. Adaptation among youth facing multiple risks: Prospective research findings. In: Luthar, S.S. (Ed.), Resilience and vulnerability: adaptation in the context of childhood adversities. Cambridge University Press, Cambridge. pp. 364-391.

Townsend, L., Flisher, A.J., King, G., 2007. A systematic review of the relationship between high school dropout and substance use. Clin. Child Fam. Psychol. Rev. 10, 295-317.

Yamaguchi, K., Kandel, D.B., 1985. On the resolution of role incompatibility: A life event history analysis of family roles and marijuana use. Am. J. of Sociol. 90, 1284-1325.

Table 1

Table 1. Descriptive statistics for main study variables

	Males (N = 2290)		Females (N = 2595)		Total (N = 4885)	
	Mean (SD)	No (%)	Mean (SD)	No (%)	Mean (SD)	No (%)
Main Predictor (Grade 7)						
Illicit drug use		432 (18.9)		430 (16.6)		862 (17.6)
Outcomes (Grades 10-11)						
Conduct problems	3.53 (4.42)		1.17 (2.24)		2.27 (3.57)	
Academic achievement	69.86 (9.68)		73.34 (8.92)		71.70 (9.43)	
Depressive symptoms	12.12 (9.36)		13.48 (9.80)		12.80 (9.63)	
Dropout		304 (13.3)		171 (6.6)		475 (9.7)
Mediators (Grade 8)						
Peer deviancy	1.01 (1.12)		0.79 (1.01)		0.89 (1.07)	
School engagement	2.17 (0.59)		2.34 (0.56)		2.26 (0.58)	
Outcomes and mediators at baseline[a] (Grade 7)						
Conduct problems	2.52 (3.56)		1.28 (2.39)		1.85 (3.03)	
Academic achievement	74.38 (11.00		75.79 (10.73)		75.12 (10.88)	
Depressive symptoms	11.94 (8.92)		14.56 (11.04)		13.34 (10.20)	
Perceived advantages of dropout	0.65 (0.61)		0.54 (0.56)		0.59 (0.58)	
Peer deviancy	0.75 (1.01)		0.62 (0.96)		0.68 (0.99)	
Academic engagement	2.32 (0.59)		2.46 (0.56)		2.40 (0.58)	

Notes. [a] Baseline outcomes and mediators were collected in the Winter of grade 7, concurrently with illicit drug use.
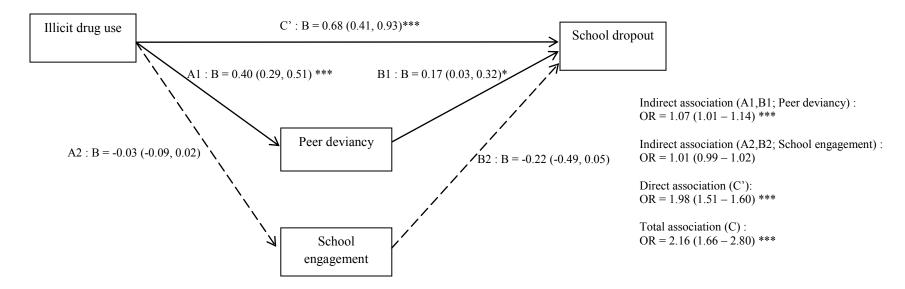
Item scales: conduct problems (min=0; max=16); depressive symptoms (min=0; max=60); peer deviancy (min=0; max=3); academic achievement (min=0; max=100); school engagement in grade 8 (min=0; max=3.87);

Table 2

Table 2. Association between Substance Use in Grade 7 and Psychosocial and Academic Adjustment in Grades 10-11

	Psychosocial Adjustment		Academic Adjustment	
	Conduct problems	Depressive symptoms	Achievement	Dropout
	IRR (95%CI)	B (95%CI)	B (95%CI)	OR (95%CI)
Illicit Drug Use (1=yes)				
Total Association				
Unadjusted	2.24 (1.97, 2.51) ***	3.34 (2.23, 4.46) ***	-2.41 (-3.13, -1.69) ***	3.50 (2.83, 4.33) ***
Adjusted for outcome at baseline	1.40 (1.22, 1.57) ***	0.94 (-0.16, 2.03) [t]	-0.53 (-1.18, 0.12)	2.97 (2.33, 3.79) ***
Fully adjusted [a]	1.16 (1.01, 1.30) *	0.32 (-0.85, 1.49)		2.16 (1.66, 2.80) ***

IRR = Incidence Rate Ratio, B = unstandardised linear regression coefficient, OR= Odds ratio, CI = Confidence Interval
*** $p < .001$; ** $p < .01$; *; $p < .05$; [t] $p < .10$
a Adjusted for: Sex, family adversity, conflict with parents, academic achievement, peer deviancy, conduct problems, academic engagement, depressive symptoms, and intent to dropout.

Figure 1

GRADE 7   **GRADE 8**   **GRADES 10-11**

Illicit drug use

C' : B = 0.68 (0.41, 0.93)***

School dropout

A1 : B = 0.40 (0.29, 0.51) ***   B1 : B = 0.17 (0.03, 0.32)*

A2 : B = -0.03 (-0.09, 0.02)

Peer deviancy

B2 : B = -0.22 (-0.49, 0.05)

School engagement

Indirect association (A1,B1; Peer deviancy) :
OR = 1.07 (1.01 – 1.14) ***

Indirect association (A2,B2; School engagement) :
OR = 1.01 (0.99 – 1.02)

Direct association (C'):
OR = 1.98 (1.51 – 1.60) ***

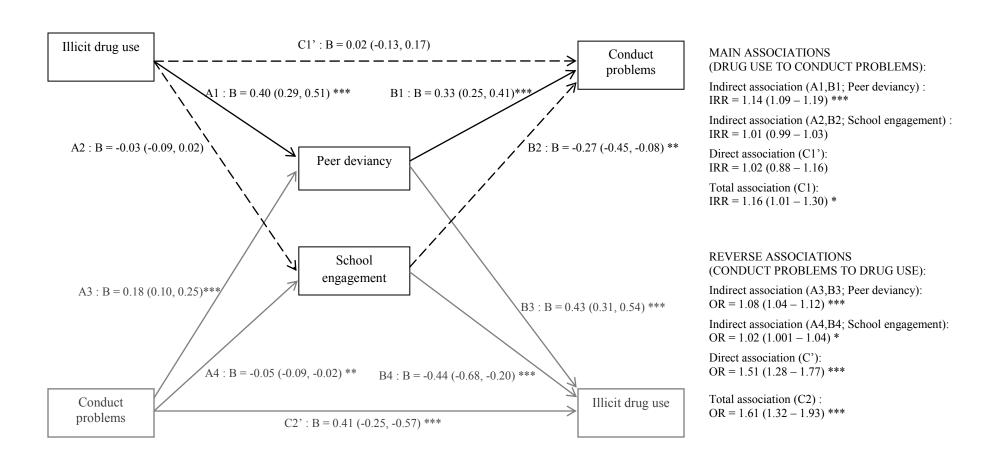Total association (C) :
OR = 2.16 (1.66 – 2.80) ***

Notes:
Full lines = significant associations; dashed lines = non significant associations.
B = Unstandardized regression coefficient (B1, B2, C' = logistic regression; A1, A2 = linear regression); OR = Odds ratio.
*** $p < .001$; ** $p < .01$; * $p < .05$.
Controls (not shown): depressive symptoms, perceived advantages of dropping out, academic achievement, peer deviancy, school engagement, and conflict with parents in grade 7, as well as sex and family adversity.

Figure 1. Direct and indirect pathways linking illicit drug use in grade 7 to school dropout in grades 10-11

Figure 2

GRADE 7　　　　　　　**GRADE 8**　　　　　　　**GRADES 10-11**

Illicit drug use

Conduct problems

C1' : B = 0.02 (-0.13, 0.17)

A1 : B = 0.40 (0.29, 0.51) ***

B1 : B = 0.33 (0.25, 0.41)***

A2 : B = -0.03 (-0.09, 0.02)

Peer deviancy

B2 : B = -0.27 (-0.45, -0.08) **

School engagement

A3 : B = 0.18 (0.10, 0.25)***

B3 : B = 0.43 (0.31, 0.54) ***

Conduct problems

A4 : B = -0.05 (-0.09, -0.02) **

B4 : B = -0.44 (-0.68, -0.20) ***

Illicit drug use

C2' : B = 0.41 (-0.25, -0.57) ***

MAIN ASSOCIATIONS
(DRUG USE TO CONDUCT PROBLEMS):

Indirect association (A1,B1; Peer deviancy) :
IRR = 1.14 (1.09 – 1.19) ***

Indirect association (A2,B2; School engagement) :
IRR = 1.01 (0.99 – 1.03)

Direct association (C1'):
IRR = 1.02 (0.88 – 1.16)

Total association (C1):
IRR = 1.16 (1.01 – 1.30) *

REVERSE ASSOCIATIONS
(CONDUCT PROBLEMS TO DRUG USE):

Indirect association (A3,B3; Peer deviancy):
OR = 1.08 (1.04 – 1.12) ***

Indirect association (A4,B4; School engagement):
OR = 1.02 (1.001 – 1.04) *

Direct association (C'):
OR = 1.51 (1.28 – 1.77) ***

Total association (C2) :
OR = 1.61 (1.32 – 1.93) ***

Notes:
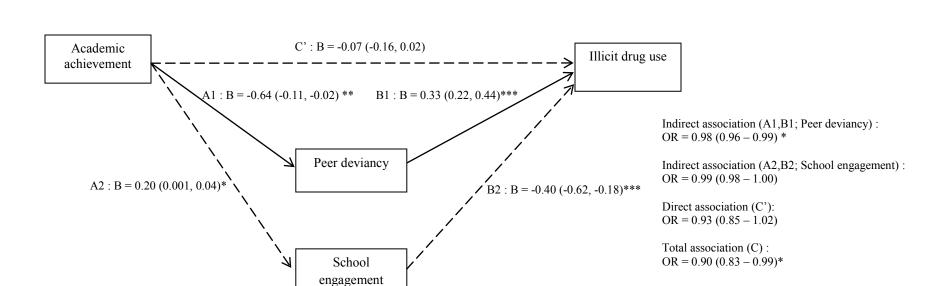Full lines = significant associations; dashed lines = non significant associations.
B = Unstandardized regression coefficient (C1', B1, B2 = *Poisson* regression; A1, A2, A3, A4 = linear regression; B3, B4, C2' = logistic regression); IRR = Incidence Rate Ratio; OR = Odds ratio.
*** $p < .001$; ** $p < .01$; * $p < .05$.
Controls (not shown): depressive symptoms, perceived advantages of dropping out, academic achievement, peer deviancy, school engagement, and conflict with parents in grade 7, as well as sex and family adversity.

Figure 2. Main and reverse pathways linking illicit drug use and conduct problems between grade 7 and grades 10-11

Figure 3

GRADE 7   **GRADE 8**   **GRADES 10-11**

Academic achievement

C' : B = -0.07 (-0.16, 0.02)

Illicit drug use

A1 : B = -0.64 (-0.11, -0.02) **   B1 : B = 0.33 (0.22, 0.44)***

Peer deviancy

A2 : B = 0.20 (0.001, 0.04)*

B2 : B = -0.40 (-0.62, -0.18)***

School engagement

Indirect association (A1,B1; Peer deviancy) :
OR = 0.98 (0.96 – 0.99) *

Indirect association (A2,B2; School engagement) :
OR = 0.99 (0.98 – 1.00)

Direct association (C'):
OR = 0.93 (0.85 – 1.02)

Total association (C) :
OR = 0.90 (0.83 – 0.99)*

Notes:
Unit for academic achievement: 1 = SD.
Full lines = significant associations; dashed lines = non significant associations.
B = Unstandardized regression coefficient (B1, B2, C' = logistic regression; A1, A2 = linear regression); OR = Odds ratio.
*** $p < .001$; ** $p < .01$; * $p < .05$.
Controls (not shown): depressive symptoms, perceived advantages of dropping out, academic achievement, peer deviancy, school engagement, and conflict with parents in grade 7, as well as sex and family adversity.

Figure 3. Reverse indirect pathway linking academic achievement in grade 7 to illicit drug use in grades 10-11