Do Marijuana Use and Externalizing Behaviours Mediate the Association between Academic Aptitude and Academic Performance?

by

Clea Moutrie Beale Sturgess
B.A. (Hons), University of Victoria, 2015

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Supervisory Committee

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Abstract

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Past research has explored the concurrent and longitudinal associations between externalizing behaviours, marijuana use, and academic outcomes and has found that externalizing behaviours and marijuana use negatively affect academic performance. However, precursors to these pathways are not well understood. Early evidence of academic aptitude is an important predictor of academic performance in high school. Performance at a young age does not guarantee results in high school and low early academic aptitude does not necessarily result in low later performance. It is important to understand the factors that may impact students' academic performance as they proceed through middle school and high school, and how early academic aptitude can influence risk factors that impact later academic performance. This project examined the role that marijuana use and externalizing behaviours play in the association between early academic aptitude and later academic performance. The project used six waves of data from the Victoria Healthy Youth Survey (V-HYS), a 10-year prospective longitudinal study. A community-based sample of youth (N = 662; 48% male; ages 12 to 18) were surveyed biannually from 2003 (W1) to 2014 (W6). Frequency of marijuana use over the past year and externalizing behaviours were assessed at each time point. To assess academic aptitude, participants' British Columbia Foundation Skills Assessment (FSA) percentile scores in numeracy, reading, and writing were measured in grades 7 and/or 10. Academic performance was assessed using participants' provincially reported grade 12 English and Math course percentage grades as well as self-reported grade 12 grades. Structural equation modeling (SEM) was used to test the possible mediating and moderating effect of marijuana frequency and externalizing behaviours in the association between academic aptitude and academic performance. Academic aptitude was positively associated with academic performance ($\beta = .59$, SE = .04, $p < .001$) and negatively associated with marijuana use ($\beta = -.21$, SE = .04, $p < .001$). Marijuana use was

negatively associated with academic performance (β = -.25, SE = .04, p < .001). The indirect effect of marijuana use was significant (b = .04, SE = .01, 95% CI = .018, .068). In terms of moderation, for the High Externalizing group (*n* = 75, 47% males), no paths were significant. For the Low Externalizing group (*n* = 445, 49% males), all paths were significant, and the indirect effect was significant (*β* = .05, *SE* = .02, *CI* = 0.01, 0.08). Marijuana use mediates the association between early academic aptitude and later academic performance, indicating the importance of early prevention and intervention. Externalizing behaviours moderated this association. While youth with externalizing behaviours are at high risk for marijuana use and should be targeted for intervention, youth who do not exhibit externalizing behaviours should also be included for prevention and intervention and may require different strategies.

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Chapter 1: Introduction

Adolescence is a critical period when academic performance begins to have serious implications for post-secondary education which in turn can affect career prospects (Bound, Schoenbaum, & Waidmann 1995; Caspi, Wright, Moffitt, & Silva, 1998; Chen & Kaplan, 2003). Adolescence is also a time of exploration and experimentation and many adolescents engage in externalizing behaviours and substance use including marijuana. Past research has explored the concurrent and longitudinal associations between externalizing behaviours, marijuana use and academic outcomes, and has found that these behaviours negatively affect academic performance (e.g., Ehrenreich, Nahapetyan, Orpinas, & Song, 2015; Kremer, Flower, Huang, & Vaughn, 2016; Patte, Qian, & Leatherdale, 2017; Van der Ende, & Tiemeier, 2016). However, precursors to these pathways are not well understood.

An important predictor of academic performance in high school is earlier evidence of academic aptitude. Most youth who perform well at early ages tend to continue to perform well and most of those who do not tend to continue to perform poorly throughout their academic careers (Bowers, 2010). However, this is not true for everyone. Good or great performance at a young age does not guarantee good results in high school, and low early academic aptitude does not necessarily result in low later performance. Research is needed in order to further understand the factors that may impact students' academic performance as they proceed through middle school and high school, and how early academic aptitude can influence risk factors that impact later academic performance. The purpose of the present research was to examine the role that marijuana use and externalizing behaviours play in the association between early academic aptitude and later academic performance.

I first review research relating academic aptitude and academic performance in adolescence and then examine research on how risk factors impact academic performance. I then review literature that examines how academic performance is affected by marijuana use and externalizing behaviours. Next, I discuss the gaps in the literature, showing that academic aptitude has not been examined as a precursor to marijuana use or externalizing behaviours, the lack of information on sex differences in the literature, the scarcity of research using Canadian samples, and the infrequency of research examining academic aptitude and academic performance longitudinally. Finally, I describe the present study and how it addresses these gaps.

Overview

Though low academic performance in high school is associated with earlier externalizing behaviours and marijuana use (Homel, Thompson, & Leadbeater, 2014; Kremer, Flower, Huang, & Vaughn, 2016; McLeod, Uemura, & Rohrman, 2012; Meier, Hill, Small, & Luthar, 2015; Patte, Qian, & Leatherdale, 2017), not everyone who experiments with these behaviours performs poorly. Therefore, it is important to identify who is most at risk. In other words, are there early identifiers of those who are on a path towards the levels of marijuana use and externalizing behaviour that are likely to result in poor academic performance? High levels of externalizing behaviour are associated with poor academic outcomes (e.g., Kremer, Flower, Huang, & Vaughn, 2016), however current research is mixed on how marijuana use may influence future academic performance. Higher frequency of use and earlier age of onset appear to be important factors in the latter association (e.g., Maggs et al., 2015; Stiby et al, 2015), but some longitudinal studies have found that using even a small amount of marijuana increases the risk of high school dropout (Ehrenreich, Nahapetyan, Orpinas, & Song, 2015) or

is associated with poor academic performance (Patte, Qian, & Leatherdale, 2017). We need to better understand the circumstances under which marijuana use and externalizing, considered together, associate with later academic performance. We also do not know if early academic aptitude is an indicator of who engages in externalizing behaviour or marijuana use. This study examines whether early academic aptitude impacts later externalizing behaviours and marijuana use, and how marijuana use and externalizing behaviours are associated with subsequent academic performance (see Figure 1).

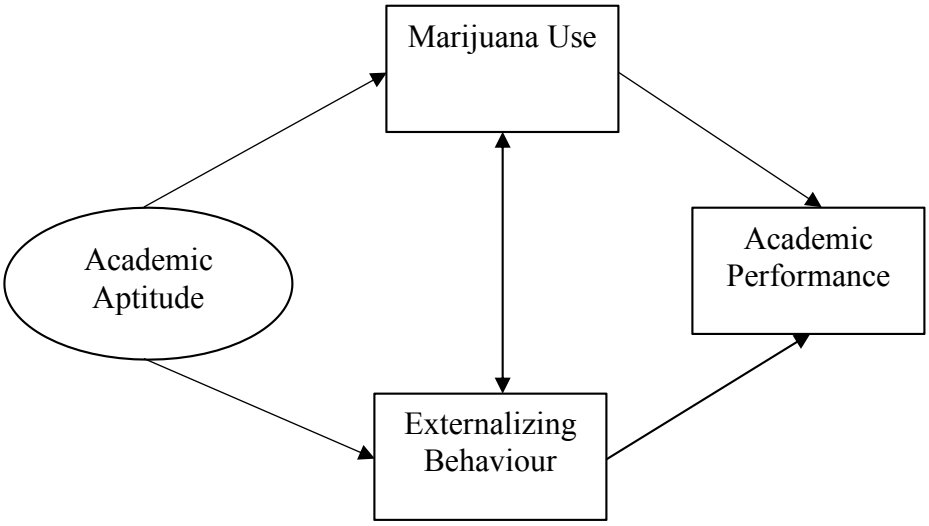


Figure 1. Theoretical path model of the associations between academic aptitude, externalizing behaviours, marijuana use, and academic performance.

Academic Aptitude and Academic Performance in Adolescence

Weiner's attributional theory of achievement motivation (1972, 1974) asserts that causal attributions for success and failure, namely ability (i.e., academic aptitude) and effort (i.e., academic performance), facilitate achievement behaviour. Academic aptitude reflects abilities or the capacity to learn, while academic performance is indicative of level of effort

combined with ability (Nicholls, 1978). Academic aptitude and academic performance are interdependent concepts, in that aptitude can influence the strength of performance**,** and a high level of performance may be required for aptitude to be recognized (e.g., when testing IQ, participants are asked to make their best effort at each task in order to get the most accurate measure). Operational definitions of aptitude vary in the literature, as it is typically measured using standardized tests like IQ tests, SAT scores, or provincial aptitude tests. For the purposes of the current study and reflecting Weiner's theory of achievement motivation (1972, 1974), *academic aptitude* is conceptualized as ability in core academic subjects like reading, writing, and math. Academic aptitude is associated with academic performance in high school and university (Hansen, 2010; Heckman, Stixrud, & Urzua, 2006) and level of education attained (Hansen, 2010).

Academic performance typically refers to an individual's achievement in school subjects. While academic performance is influenced by aptitude, it is also affected by other factors such as behaviour and effort (Bowers, 2011), and is typically measured by teacher-assigned course grades or grade point average (GPA). Academic performance is associated with high school drop-out and graduation (Allensworth & Easton, 2007, Balfanz, Herzog, & Mac Iver, 2007, Rumberger & Palardy, 2005) and college entrance and performance (Burton & Ramist, 2001, Zwick & Greif Green, 2007).

Academic aptitude is typically stable from elementary school to high school (Jimerson, Egeland, and Teo, 1999), but research is mixed for academic performance across this period. For example, Scales, Benson, Roehlkepartain, Sesma, and van Dulmen (2006) found that academic performance in middle school predicts academic performance in high school, whereas Gutman, Sameroff, and Cole (2003) found that academic performance declines from

middle school to high school. Using hierarchical cluster analysis, Bowers (2010) found four clusters of GPA trends from elementary to high school: a high-high group who showed a stable high GPA from elementary to high school, a low-high group who had a lower GPA in elementary but increased in middle school and remained stable through high school, a high-low group who had a high GPA in elementary but declined steadily over time, and a low-low group with a stable low GPA over time. Although Bowers did not report percentages of students within each cluster, he showed the clusters distinguished between those who were more likely to drop out (i.e., the low-low group) and those who were more likely to graduate (i.e., the high-high group)

Past research assessing academic ability often uses GPA and standardized test scores interchangeably (Meier, Hill, Small, & Luthar, 2015; Scales, Benson, Roehlkepartain, Sesma, & van Dulmen, 2006) or uses a combined score of GPA and standardized tests (Masten et al., 2005). However, aptitude and performance are separate but interrelated aspects of academic achievement, and may each contribute to a better understanding of academic pathways and the mechanisms that influence success or failure. Standardized test scores (e.g., SAT scores, IQ test scores) typically correlate moderately at about $r = .5$ to .6 with GPA (Bowers, 2011; Brennan, Kim, Wenz-Gross, & Siperstein, 2001; Willingham, Pollack, & Lewis, 2002), suggesting that about 25–35% of academic performance (grades) is explained by academic aptitude (standardized test scores) and vice-versa. Standardized tests do not necessarily test the curriculum that students learn (Willingham, Pollock, & Lewis, 2002), so grades reflect not only course content, but also likely include participation, behaviour in class, and effort (Bowers, 2011). Sex differences in aptitude and performance have been found. For example, girls and boys show similar scores on IQ tests (academic aptitude), but girls tend to earn higher grades

(academic performance) than boys in elementary, middle, and high school (Duckworth & Seligman, 2006; Pomerantz, Altermatt, & Saxon, 2002).

Past research has investigated some factors linking aptitude and performance. For example, Duckworth and Seligman (2005) examined the association between a standardized measure of academic aptitude (IQ) and academic performance (report-card grades, achievement test scores, attendance) and found that self-discipline (defined as the ability to inhibit behaviour, follow rules, and control impulsive reactions) was a more robust predictor of academic performance than IQ in eighth grade students. In the first of two studies ($N = 140$), they created a composite self-discipline score with questionnaire data from children, parents, and teachers, and found that these scores predicted academic performance seven months later. In the second study ($N = 164$), they added measures of IQ and a delay of gratification task, and found that self-discipline accounted for more than twice the variance as IQ in final grades seven months later, controlling for earlier grades and achievement test scores. Students with higher self-discipline scores also performed better on every measure of academic performance than students with higher impulsivity. Girls showed higher levels of both self-discipline and academic performance than boys. Another study (Gutman, Sameroff, & Cole, 2002) examined the effects of risks (including minority group status, SES, family size, stressful life events, and parent mental health) on academic performance using academic growth trajectories from elementary school to high school. They measured GPA at every grade (1 to 12), verbal IQ at age four, and mental health at age four (measured with scores on the Rochester Adaptive Behavior Inventory scale indicating level of socio-emotional functioning). Higher IQ (i.e., academic aptitude) had a positive association with GPA (i.e., academic performance), but not for students with multiple risks. For low-risk students, poorer mental health was associated

with lower GPA. This research shows that increased risks and fewer assets can influence the positive association between academic aptitude and academic performance in adolescence. In the proposed study, I will examine the effects of externalizing behaviours and marijuana use on this association.

Externalizing Behaviours and Marijuana Use in Adolescence

Both externalizing behaviours and marijuana use are associated with lower academic performance (e.g., Kremer, Flower, Huang, & Vaughn, 2016; Masten et al., 2005; Patte, Qian, & Leatherdale, 2017; Stiby et al., 2015). However, it is not known whether youth with higher academic aptitude are protected from the negative effects of these risk factors or whether low aptitude predicts greater involvement in these risks, which is in turn associated with poor performance.

Definitions of externalizing behaviour vary in the literature, but generally consist of combinations of delinquent behaviours (e.g., defiance, disruptiveness, aggressiveness, impulsivity, antisocial behaviour, and over-activity) (Defoe, Farrington, & Loeber, 2013). When studying the association between externalizing behaviour and academic performance, externalizing behaviour is most often measured with a questionnaire checklist endorsing various delinquent behaviours typically based on the child behaviour checklist (CBCL) (Achenbach, 1994), answered by teachers and/or parents when participants are in middle school or younger, or self-report when participants are in high school (Ansary & Luthar, 2009; Englund & Siebenbruner, 2012; Kremer, Flower, Huang, & Vaughn, 2016; McLeod, Uemura, & Rohrman, 2012). Measures may or may not include substance use. Questionnaires include items such as frequency of carrying a weapon, vandalism, breaking and entering, shoplifting, forcing someone to have sex, and selling drugs (Defoe, Farrington, & Loeber, 2013). Within

the present study, self-reported measures of symptoms of Oppositional Defiance Disorder (ODD) and Attention Deficit Hyperactivity Disorder (ADHD) created the externalizing symptoms index (see Method). Externalizing symptoms are linked with marijuana use in adolescence (Bryant, Schulenberg, O'Malley, & Johnston, 2003; Ehrenreich, Nahapetyan, Orpinas, & Song, 2015; Meier, Hill, Small, & Luthar, 2015). The impending legalization of marijuana in Canada necessitates further investigation into its contribution to youth risk.

Canadian youth use more marijuana than in any other country (UNICEF Office of Research, 2013); 28% of adolescents ages 11 to 15, 22% of adolescents ages 15 to 19, and 26% of young adults ages 20 to 24 used marijuana over the past year (Statistics Canada, 2013). Although males and females typically report similar rates (21% and 20% respectively) of use between ages 15 to 17, males report more use than females at ages 18 to 24 (41% and 25% respectively; Statistics Canada, 2013). The average age of initiation for marijuana use is in Canada is 16 years old (Health Canada, 2013), though 25% of youth report using marijuana in or before grade nine (2012-2013 Youth Smoking Survey).

Canadian youth commonly perceive marijuana use as safe and healthy compared with alcohol and prescription drugs (McKiernan & Fleming, 2017), believe it is not really a drug (Porath-Waller, Brown, Frigon, & Clark, 2013), improves focus and concentration (Porath-Waller, Brown, Frigon, & Clark, 2013) and consider it an acceptable treatment for pain, seizures, mental illness, cancer, stress, sleep problems, and arthritis (McKiernan & Fleming, 2017). Marijuana use will become legal in Canada in 2018, which may further reduce adolescents' perception of risk (Wall et al., 2011). As legalization of marijuana becomes increasingly prevalent in North America, it is important to understand the short- and long-term

risks associated with adolescent marijuana use to aid with informed consumption, prevention, and intervention.

Adolescent marijuana use is typically assessed by self-report questionnaires, with measures such as age of first use (Horwood et al., 2010; Melchior et al., 2017; Verweij et al., 2013), current frequency of use (i.e., daily, weekly, occasionally, never used; Henry, 2010; Horwood et al., 2010; Stiby et al., 2015), number of occasions used in a given period of time (Bryant et al., 2003; Degenhardt et al., 2010; Ehrenreich, Nahapetyan, Orpinas, & Song, 2015; Maggs et al., 2015; Meier, Hill, Small, & Luthar, 2015; Melchior et al., 2017; Patte, Qian, & Leatherdale, 2017), and the Cannabis Abuse Screening Test (Stiby et al., 2015) which categorizes users into those who use abusively and those who do not.

Marijuana use and externalizing behaviour are moderately associated in adolescence (e.g., King, Iacono, & McGue, 2004; Kohornen, 2010; Schulenberg et al., 2005). Griffith-Lendering, Huijbregts, Mooijaart, Vollebergh, and Swaab (2011) examined the association between externalizing symptoms, internalizing symptoms, and marijuana use in 1449 adolescents who were age 11 at baseline and followed until age 16. They found no associations between marijuana use and internalizing problems. However, marijuana use and externalizing problems were significantly correlated (r = .19–.58), and externalizing problems in early adolescence preceded marijuana use in later adolescence (marijuana use did not precede externalizing problems). In a large-scale Australian longitudinal study, adolescents (age 14 at baseline) with both persistent and adolescent-onset externalizing behaviours were at increased risk for marijuana use disorders at age 21 (Hayatbakhsh et al., 2008). However, not all studies have found a direct association between externalizing behaviour and marijuana use over time. For example, Korhonen (2010) examined the longitudinal association between externalizing

behaviour and initiation of marijuana use in adolescence, and found that early onset cigarette smoking mediated their association.

Academic Problems Associated with Marijuana Use

Adolescent marijuana use is associated with many factors that directly affect academic performance including poor study skills, poor attention, learning problems (Ehrenreich, Nahapetyan, Orpinas, & Song, 2015), fewer academic goals, lower school engagement and truancy (Bryant, Schulenberg, O'Malley, & Johnston, 2003; Patte, Qian, & Leatherdale, 2017), difficulty with peers (Bryant, Schulenberg, O'Malley, & Johnston, 2003) and lower grades or standardized test scores (Homel, Thompson, & Leadbeater, 2014; Meier, Hill, Small, & Luthar, 2015; Patte, Qian, & Leatherdale, 2017; Stiby et al, 2015). Marijuana use is also associated with long-term academic consequences, including increased risk of high-school dropout (Ehrenreich, Nahapetyan, Orpinas, & Song, 2015, Horwood et al., 2010; Stiby et al, 2015), reduced post-secondary educational attainment (Homel, Thompson, & Leadbeater, 2014; Lynskey & Hall, 2000, Maggs et al., 2015; Melchior et al., 2017; Stiby et al., 2015), and a lower likelihood of attaining post-secondary education (Degenhardt et al., 2010; Homel, Thompson, & Leadbeater, 2014; Horwood et al., 2010).

Higher frequency of marijuana use may be associated with poorer academic outcomes. Maggs et al. (2015) studied 4925 participants who were age 18 at baseline and followed for eight years, and found that frequent use (using marijuana six or more times in a month) predicted lower college degree attainment than infrequent or non-users. Similarly, with a sample of 1155 adolescents, Stiby and colleagues (2015) showed that higher frequency of marijuana at age 15 is associated with both poorer academic performance at age 16 and higher likelihood of school dropout than infrequent or non-users. Using the first five waves (eight

years) of the current sample (N = 632), Homel, Thompson, and Leadbeater (2014) identified three trajectories of marijuana use in ages 15 to 25: abstainers (31%) (never used), occasional users (44%) (using a few times a year at baseline, peaking at a few times per month at age 20), and frequent users (25%) (using a few times per month at baseline, increasing to more than once per week by age 18). Occasional users were more likely than abstainers to drop out of post-secondary education. Frequent users were less likely to enrol in post-secondary education than both abstainers and occasional users, and had 15 times more risk of high school drop-out than abstainers.

While these studies show that higher frequency of marijuana use is associated with poorer academic outcomes, other studies have shown that any amount of marijuana use is associated with poor academic outcomes. Ehrenreich, Nahapetyan, Orpinas, and Song (2015) modelled marijuana trajectories and their associations with concurrent teacher-rated academic skills in 619 students who were in grade six at baseline, and followed for six years. They found four trajectories of marijuana use: *Increasing* (9%; steadily increasing from smoking twice per month in grade six to twice per week in grade twelve), *Experimental* (12%; initiating use in grade seven, but only using twice per month in grade twelve), *Sporadic* (14%; infrequent users), and *Abstaining* (65%; never used). Girls were less likely to be in the Increasing group than boys. The Increasing group had more attention and learning problems, and the lowest scores on academic skills, which worsened over time. Compared with Abstainers, youth who were members of any of the marijuana using groups had more academic problems and were at higher risk of dropping out of high school. A recent Canadian study found that any amount of marijuana use impacted academic performance whereas more frequent use was the most detrimental to post-secondary ambitions (Patte, Qian, & Leatherdale, 2017). The authors

examined adolescents who were 13 to 18 years old at baseline (N = 26,475), with data collected annually over three years. Initiating regular marijuana use (monthly, weekly, or daily) was associated with decreased ambitions to attend university. Those who used sporadically showed increased aspirations to continue their education after high school (trade school, college, or university). Youth who started using any amount of marijuana within one or two years after baseline were at greater risk for academic disengagement and poor performance, and were less likely to attend class regularly, complete homework, or value good grades. Sex differences were not reported.

Research examining how age of initiation of marijuana use is associated with academic outcomes finds that earlier initiation typically precedes worse academic outcomes. Horwood and colleagues (2010) analysed three Australian longitudinal studies and found that early onset marijuana use (before age 15) resulted in significantly lower odds of educational achievement (measured as completing high school, enrolling in university, or attaining a university degree), compared with those who began using between ages 15 and 17. For those who had abstained until age 18, the odds of educational achievement were significantly higher than the late onset group. The study also found that for males, age of onset of marijuana use had a greater impact on university enrolment than for females. Melchior et al. (2017) found similar results, comparing early marijuana initiation (before age 16) and late initiators (after age 16) with non-users. They found that early initiators were less likely than non-users to attain a high school degree, but that late initiators did not differ from non-users. These results were more strongly associated in females than in males.

These studies assume a direction of effect from marijuana use to impairments in academic performance; however, it is also possible that poor academic performance is related

to greater subsequent marijuana use. In one of the only studies to examine early academic performance as a predictor of later drug use (including alcohol, tobacco, and marijuana), Henry (2010) found that youth (a sample of 201 rural adolescents) with higher academic performance in grade six (self-report average letter grade) showed less increase in drug use (self-report frequency of alcohol, cigarette, and marijuana use) than their peers over the following three years. Growth in drug use was also significantly negatively correlated with academic performance (r = -.52). However, in contrast to the literature, Henry (2010) did not find a significant association between drug use in grade six and subsequent deterioration in academic performance. This suggests that higher levels of academic performance may be a protective factor against drug use, whereas lower levels of academic performance are also a risk for marijuana use (Bryant et al., 2003). These studies use various measures of academic achievement, and performance and aptitude are not examined independently. It is likely that higher frequency of use and earlier onset will be associated with poorer academic performance, though it is also possible that occasional marijuana use will be associated with poor academic outcomes. Boys will likely be more frequent users and use at an earlier age, and may have lower academic performance than girls. There is no research on whether higher academic aptitude is protective, nor whether lower academic aptitude is a risk for marijuana use. The proposed research will test the pathway from academic aptitude to marijuana use.

Academic Problems Associated with Externalizing Behaviours

Research has also found evidence for a longitudinal association between early externalizing problems and poorer later academic outcomes. For example, Kremer, Flower, Huang, and Vaughn (2016) examined externalizing behaviour and academic aptitude in a large U.S. sample of children who were followed from birth to age 18. Externalizing was measured

at ages three and older by parent report on whether a list of problem behaviours occurred. Academic aptitude was measured with scores on three subtests of the Woodcock-Johnson Revised Tests of Achievement (WJ-R) at three waves. Higher externalizing was associated with lower subsequent academic aptitude scores, and associations were stronger for girls. Masten and colleagues (2005) found cascading links from childhood externalizing problems to later poor academic outcomes and future internalizing problems. Data were collected four times over 20 years in a sample of 220 children aged 8 to 12 at baseline. Academic competence was measured with scores on achievement tests, GPA, and teacher and parent ratings of academic ability. Externalizing problems were measured with parent reports of aggression and delinquency at younger ages, and with self and parent reports when participants were older. Childhood externalizing problems were associated with reduced academic competence in adolescence, which in turn was associated with higher internalizing problems in adulthood. Similarly, in a sample of 816 Dutch children ages 6 to 10 at baseline, followed biannually for eight years, Van Der Ende, Verhulst, and Tiemeier (2016) found that parent-reported externalizing behaviour consistently predicted poor teacher-reported academic performance over time, but teacher-reported academic performance did not predict parent-reported externalizing behaviour. However, when the sources of the reports were reversed, the association was bi-directional; teacher-reported externalizing behaviour predicted poor parent-reported academic performance, and parent-reported poor academic performance predicted higher levels of teacher-reported externalizing behaviour.

There is some evidence that poor academic aptitude precedes externalizing behaviour. Suldo, Thalji, and Ferron (2011) found that students with externalizing behaviours (measured by teacher ratings) were at high risk for decreased academic performance (measured with GPA

and attendance) the following year. However, externalizing behaviours did not predict decreases in standardized test scores (i.e. academic aptitude). Also, in a study of 503 adolescent boys who were age 11 at baseline and followed every year until age 15, Defoe, Farrington, and Loeber (2013) showed that low SES and hyperactivity predicted externalizing behaviour, which in turn predicted low academic achievement (measured by teacher, parent, and self-report). To summarize, externalizing behaviour appears to precede problems with academic performance. However, the prior effects of academic aptitude have not been taken into account. It is not clear whether lower levels of academic aptitude precede externalizing behaviour, and this will be tested in the proposed study.

The Compound Risks of Marijuana Use and Externalizing Behaviour

Compounding risks can impact academic outcomes. Youth with co-occurring problems can experience worse outcomes compared with peers with only one or no problems (Evans, Li, & Whipple, 2013; Sameroff, 2006; Sameroff, Seifer, Zax, & Barocas, 1987). Research suggests that when externalizing behaviour is combined with substance use, academic performance may be more strongly impacted than when exposed to only one of these risks (e.g., McLeod, Uemura, & Rohrman, 2012). McLeod, Uemura, and Rohrman (2012) collected four waves of data annually from a sample of 6315 students who were in grades seven to twelve at baseline. Low academic performance (measured with GPA and highest degree achieved) was predicted by attention problems, delinquency, and substance use (including cigarette smoking, alcohol use, marijuana use, and other illicit drug use). Youth with both delinquency and substance use problems had lower subsequent GPA than those with one problem (either delinquency or substance use). Ansary and Luthar (2009) followed 256 adolescents who were in grade 10 at baseline for three years. They measured marijuana use and externalizing behaviours with self-

reports, and used a combination of GPA and teacher report of learning problems and externalizing behaviours. The authors found that participants who used marijuana and had multiple other problems, including externalizing behaviours, had the worst academic outcomes. In addition, low academic achievement was associated with the highest levels of externalizing behaviours over time.

Some research has attempted to disentangle directional effects between marijuana use, externalizing behaviours, and academic outcomes; however, findings are mixed. For example, one study (Bryant et al., 2003) examined how academic achievement and school misbehaviour at baseline impacted marijuana use over time. They collected biennial data from a large sample of adolescents who were age 14 at baseline, and followed for six years. Their measures included academic achievement (self-report of grades), school misbehaviour (standardized reports of school suspensions and detentions, and self-report of skipped classes), and marijuana use (self-report of frequency of use over the past 30 days). Those who reported low academic achievement at baseline were compared with those who reported high academic achievement. Both groups increased in their marijuana use over the following six years, but low achievers used more and increased more marijuana than their higher achieving peers. The same comparison was made between groups with high and low levels of school misbehaviour, and those with higher levels of misbehaviour showed greater increases in marijuana use. This study shows that academic performance may precede marijuana use, but does not examine whether it precedes externalizing behaviours. Englund and Siebenbruner (2012) examined whether externalizing symptoms and academic competence predict marijuana use in middle adolescence in 191 children who were age 7 at baseline and followed to age 16. Externalizing was measured with teacher report at ages 7, 9, and 12, and with self-report at age 16. Academic competence

was assessed with teacher ratings. Marijuana use was assessed by self-report of frequency at age 16. Higher levels of academic competence in childhood predicted lower levels of externalizing symptoms in adolescence, but did not significantly predict marijuana use. Early externalizing behaviour did not predict later academic competence (controlling for early levels). Externalizing behaviour at age 16 was associated with concurrent marijuana use. This study's findings contradict other research showing a directional association between externalizing behaviour and academic outcomes, and suggests that early academic competence may predict lower levels of later externalizing behaviour.

Finally, Meier, Hill, Small, and Luthar (2015) studied the effect of persistent marijuana use (approximately monthly over four years of high school) on externalizing behaviours, and on both academic aptitude (measured with SAT scores) and performance (measured with GPA) in 254 adolescents who were in grade nine at baseline and followed until grade twelve. When controlling for grade nine GPA, persistent users had lower GPA and higher externalizing symptoms in grade twelve than their less-frequent and non-using peers. However, externalizing behaviour was not significantly associated with grade twelve SAT scores.

In summary, most research on marijuana use, externalizing behaviours, and academic performance show paths from marijuana use or externalizing behaviours to poor academic outcomes. It is more likely that youth with higher levels of externalizing behaviour will use marijuana. The current study will examine the compounding risks of externalizing behaviours and marijuana use, and consistent with the literature, expects that together they will be associated with poor academic performance. The current study will also address a gap in the literature by examining whether earlier academic aptitude is associated with later marijuana use or externalizing behaviours.

Gaps in Research

1. The majority of the current research examines the concurrent or later academic outcomes of marijuana use in adolescence, but none examine whether early academic aptitude scores predict subsequent marijuana use or later externalizing behaviours.
2. Few studies examine standardized measures of academic achievement (i.e., academic aptitude) as outcomes (with the exception of Maggs et al., 2015; Meier, Hill, Small, & Luthar, 2015; Stiby et al., 2015; and Suldo, Thalji, and Ferron, 2011). No studies use standardized measures of academic achievement as predictors of either marijuana use or externalizing behaviours.
3. Few studies examine sex differences. Some studies indicate that early marijuana use may have more severe consequences for females (Melchior et al., 2017), while later use may be riskier for males (Horwood et al., 2010).
4. Only one study uses a Canadian sample (Patte, Qian, & Leatherdale, 2017). It is important to study Canadian adolescents specifically, as they are the heaviest marijuana users in the world, and may have different academic outcomes than their counterparts in the United States, Australia, and the United Kingdom. They may also require different types of interventions due to differences in cultural norms around expectation of use and risk.
5. Academic aptitude and academic performance are typically not examined separately. Though these measures are correlated, aptitude is intended to provide a standardized measure of ability or intelligence, while performance likely represents a combination of subject knowledge and effort. Since academic performance predicts later success, it is important to examine how it is impacted by risk factors.

The Present Study

Research Questions. The current study extends the literature by assessing how early academic aptitude affects later marijuana use and externalizing behaviour, and, in turn, how these are associated with academic performance at the end of high school. This presents three key research questions related to the theoretical model presented in Figure 1:

1. Is academic aptitude associated with early marijuana use and externalizing behaviour?
2. Do marijuana use and externalizing behaviour mediate the association between prior academic aptitude and academic performance at the end of high school (Grade 12)?
3. Are there sex differences in these associations?

Hypotheses.

1. Adolescents with higher scores on standardized tests (assessed in grades seven or ten) will be less likely to use marijuana or to exhibit externalizing behaviours. Conversely, adolescents with lower scores on standardized tests in grades seven or ten will be more likely to use marijuana and to have externalizing behaviours at age 16 or 17.
2. Marijuana use and externalizing behaviours at age 16 or 17 will mediate the association between academic aptitude in grades seven or ten and academic performance in grade 12.
3. Since boys typically show higher levels of externalizing behaviours and more frequent use of marijuana use than girls, the association between these behaviours and academic performance will be stronger for boys than for girls.

Chapter 2: Method

Participants

The present study uses secondary data from the Victoria Healthy Youth Survey (V-HYS; Leadbeater, Thompson, & Gruppuso, 2012), a 10-year prospective longitudinal study, surveyed a community-based sample of youth (N = 662; 48% male; ages 12 to 18) biannually from 2003 (T1) to 2014 (T6) in a medium-sized urban community. Participants were recruited from a random sample of 9,500 telephone listings; 1,036 households with an eligible youth (aged 12 to 18 years; mean age = 15.52, SD = 1.96) were identified. Those who agreed to participate were 662 parents and youth (342 females) at Time 1 (T1), 578 (87%; 306 females) at Time 2 (T2), 539 (81%; 294 females) at Time 3 (T3), 459 (69%; 254 females) at Time 4 (T4), 463 (70%; 249 females) at Time 5 (T5), and 478 (72%; 264 females) at Time 6 (T6). Table 1 shows the sample distribution by age and sex across time points.

Ethnicity and socioeconomic status (SES) reported by participating adolescents were almost identical to that of the population from which the sample was drawn. Most were European Canadian (85%), 4% were Asian, 3% were Aboriginal, and the remaining 8% were from other ethnic backgrounds (e.g., Black, Hispanic, bi-racial, or other). The sample was economically diverse: 19% of both fathers and mothers had no education beyond high school, whereas 43% of fathers and 49% of mothers had college or university training.

Procedure

V-HYS. Youth and one parent or guardian (for youth under 18 years of age) gave written consent for participation at each wave. Youth received a gift certificate for their participation at each interview. A trained interviewer administered the V-HYS interviews in the youth's home or another private place. To enhance privacy and increase responding, a portion of the repeated

measures V-HYS questions was strictly self-report. These items dealt with private topics and emotional issues where youth are the best sources of data (e.g., sexual experiences, depression, and substance use). This portion of the interview was self-administered and placed in a sealed envelope not accessible to the interviewer. In addition, Skype or phone interviews were used in later waves to follow youth across moves and absences owing to traveling and helped to reduce selective attrition at each wave. The V-HYS was approved by the University of Victoria's Research Ethics Board.

Table 1

Distribution of Sample (N) by Age and Sex across Study Times

	T1		T2		T3		T4		T5		T6	
Age	M	F	M	F	M	F	M	F	M	F	M	F
12	44	39										
13	36	54	1									
14	57	47	32	31								
15	41	57	30	48								
16	62	42	53	41	33	31						
17	54	58	31	53	29	48						
18	26	45	52	37	48	38	6	4				
19			41	56	31	49	25	34				
20			27	39	43	41	39	37	11	6		
21			5	1	34	50	29	40	23	38		
22					22	36	23	39	34	31	12	4
23					5	1	38	41	32	32	21	39
24							37	34	29	43	30	33
25							17	25	40	36	33	37
26								1	31	39	31	43
27									14	24	38	42
28											33	43
29											15	20
30											1	3
Subtotal	320	342	272	306	245	294	204	255	214	249	214	264
Total	662		578		539		459		463		478	

Note: M = male; F = female; T1-T6 = Time 1 to Time 6.

Provincial education data. The Province of British Columbia Ministry of Education provided data for V-HYS participants' grade 7 and 10 Foundation Skills Assessment scores in Numeracy, Reading and Writing, and grade 12 English and Math course grades. Data were securely linked to participants by the ministry in order to protect participant privacy. Table 2 shows proportion of provincial data available for V-HYS participants.

Table 2

Proportion of Available Provincial Education Data for V-HYS Participants by Sex

	Valid *N* (%)	Valid *N* (%) Male	Valid *N* (%) Female
Provincial Education Data			
Grade 7 Numeracy FSA Score	297 (45%)	145 (45%)	152 (44%)
Grade 7 Reading FSA Score	297 (45%)	145 (45%)	152 (44%)
Grade 7 Writing FSA Score	297 (45%)	145 (45%)	152 (44%)
Grade 10 Numeracy FSA Score	269 (41%)	136 (43%)	133 (39%)
Grade 10 Reading FSA Score	270 (41%)	136 (43%)	134 (39%)
Grade 10 Writing FSA Score	268 (40%)	135 (42%)	133 (39%)
Either Grade 7 or 10 FSA data*	523 (79%)	255 (80%)	268 (78%)
Grade 12 English Course Grade	498 (75%)	243 (76%)	255 (75%)
Grade 12 Math Course Grade	241 (36%)	126 (40%)	115 (34%)

*Note: Shows the number of participants with either grade seven or ten FSA scores. Some participants had both grade seven and ten scores. See section on missing data (p. 26) for an explanation of how Full Information Maximum Likelihood (FIML) was used.

Measures

Academic aptitude. To assess academic aptitude, participants' British Columbia Foundation Skills Assessment (FSA) percentile scores in numeracy, reading, and writing were measured in grades seven and ten. The FSA is a standardized province-wide assessment of

academic skills in British Columbia (Government of the Province of British Columbia, 2018). Given the limited availability of measures (see Table 2), if participants had scores for either grade seven or ten, these scores were used. If participants had scores for both grades seven and ten, scores were combined. A confirmatory factor analysis validated this measure (see Results).

Academic performance. Measures of academic performance included participants' grade 12 English (either English or Communications) course percentage grades and grade 12 Math (either Applications of Mathematics or Essentials of Mathematics) course percentage grades. Applications of Mathematics emphasizes concrete activities and modelling, while Essentials of Mathematics focuses on symbolic manipulation (British Columbia Ministry of Education, 2006). Course percentage grades are a combination of teacher-assigned grades and provincial examination scores. In addition, academic performance was measured in the V-HYS by asking participants "in general, what are your grades right now?" Responses were given on a five-point scale: 0 = *mostly F's*, 1 = *mostly D's*, 2 = *mostly C's,* 3 = *mostly B's*, and 4 = *mostly A's*. In order to match V-HYS scores to education data provided by the province, participants responses from either grade 11 or 12 were used. The above measures of academic performance were combined, and a confirmatory factor analysis validated the measure (see Results).

Marijuana use. The frequency of marijuana use was assessed by asking participants "how often marijuana (pot, hash) was used in the past 12 months?" Responses were given on a five-point scale: 0 = *never*, 1 = *a few times a year*, 2 = *a few times a month,* 3 = *once a week*, and 4 = *more than once a week*. Data from the first three waves were used to create a measure of marijuana use frequency at ages 16 or 17.

Externalizing behaviours. Externalizing behaviours comprised oppositional defiant disorder (ODD) and ADHD symptoms. ODD and ADHD symptoms were each assessed with a six-item scale from the Brief Child and Family Phone Interview (BCFPI; Cunningham, Boyle, Hong, Pettingill, and Bohaychuk, 2009). Items for the ADHD subscale included "do you notice that you…jump from one activity to the other; fail to finish things you start; fidget; have difficulty following directions or instructions; are impulsive, or that you act without stopping to think?" Items for the ODD subscale included: "do you notice that you… are defiant, or that you talk back to people; are easily annoyed by others; are cranky; argue a lot with adults; are angry and resentful; blame others for your own mistakes?" Items for each domain were rated on a three-point Likert scale (0 = *never*, 1 = *sometimes*, or 2 = *often*). Scores were summed for each subscale and the subsequently averaged to create an externalizing behaviour score (range = 0 – 12). Data from the first three waves were used to create a measure of externalizing behaviours at ages 16 or 17.

Socioeconomic status (SES). Participant-reported mothers' highest level of education was coded on a five-point scale: 0 = *did not finish high school*, 1 = *finished high school*, 2 = *vocational training,* 3 = *some college/university courses*, and 4 = *finished college/university*.

Planned Analyses

As a first step, confirmatory factor analysis (CFA) was used to investigate how well hypothesized models fit the data. The latent variable *academic aptitude* consisted of grade 7 and 10 BC FSA scores for Numeracy, Reading, and Writing. The latent variable *academic performance* consisted of grade 12 Math and English course grades, and self-reported grades in grade 11 or 12. Secondly, structural equation modeling (SEM; Little, 2013) was used to first testing the direct effect of academic aptitude on academic performance, and then tested the

mediating influences of marijuana use and externalizing behaviours on the association between academic aptitude and academic performance. Sex differences were examined using multiple group modelling; a model wherein all pathways were equal across sex was tested against a model with unconstrained pathways.

Revised hypotheses and analyses. Due to multicollinearity between marijuana use and externalizing behaviours, the mediation model did not fit the data. It was hypothesized that while marijuana use would likely mediate the association between academic aptitude and academic performance, externalizing behaviours would moderate the mediation model. SEM was subsequently used to test the mediating effect of marijuana on the direct path between academic aptitude and academic performance, as noted above. Then, participants were divided into low and high externalizing behaviours groups based on a cut-off score of seven indicating behaviours elevated relative to normed values for 6- to 18-year-olds (Cunningham, Boyle, Hong, Pettingill, & Bohaychuk, 2009). The mediation models were then re-run for each externalizing behaviours group.

Missing data. Little's (2013) missing completely at random (MCAR) test was used to examine missing data mechanisms. The test was significant (χ^2 (453, N = 662) = 658.38, p < .001), which indicated that the data were not missing at random (Enders, 2010; Little, 1988). When the values of the missing dependent variable (i.e., marijuana use frequency, academic manifest variables) are not known, there is no explicit method to formally test the missing at random (MAR) assumption. The MAR assumption is that any bias due to missing data is attributable to a study variable. Therefore, we took various steps to examine the missing data patterns (Enders, 2010). First, there was a large percentage of missing data for academic

variables ranging from 17% (self-reported grade 11 and 12 grades) to 64% (grade 12 Math course grades). For marijuana use frequency and externalizing behaviours, missing data were 21% and 22%, respectively. Compared to females, males had significantly more missing data on only one academic variable: self-reported grade 11 and 12 grades (χ^2 (1, N = 662) = 6.00, p = .01). Additionally, individuals with higher SES had a larger proportion of missing data on grade 7 Numeracy, Reading, and Writing FSA scores (χ^2 (4, N = 657) = 10.26, p = .04), while those with lower SES had a larger proportion of missing data for grade 12 English course grades (χ^2 (4, N = 657) = 18.72, p = .001) and grade 12 Math course grades (χ^2 (4, N = 657) = 18.00, p = .001).

Second, various demographic variables (i.e., sex, SES,) and individual centered variables (i.e., academic variables) that were the primary source of missingness in the data were included in the imputation model in order to adjust for bias. For example, because males and individuals with both lower and higher SES had greater proportions of missing data for certain variables, sex and SES were included in the imputation model to adjust for the potential bias due to these variables. Accordingly, the data can be considered MAR. Under the MAR assumption, the imputation model using the expectation maximization algorithm provides unbiased estimates (Allison, 2002; McLachlan, Krishnan, & Ng, 2004). Therefore, all 662 participants were included in the final results.

To further reduce potential bias due to missing data and non-normality, all models were run using Full Information Maximum Likelihood (FIML) with the robust Maximum Likelihood estimator (MLR) in Mplus 7.4 (Muthén & Muthén, 1998-2012). In SEM, all observed indicators are treated as latent factors. This allows for the contribution of all available data to the likelihood function, with adjustments to the standard errors made by the MLR estimator.

Chapter 3: Results

Descriptive Statistics

Descriptive statistics for the full sample, as well as for the two externalizing groups (i.e., low and high) are shown in Table 3. There were similar proportions of males and females in both groups, and SES did not significantly differ across groups. One measure of *academic aptitude* (i.e., Grade 10 numeracy) and one measure of *academic performance* significantly differed between groups (i.e., self-report grades 11 or 12), with the low externalizing group performing better than the high group. Frequency of marijuana use also significantly differed between groups, with the low externalizing group using less marijuana than the high externalizing group. Table 4 shows sex differences for the same variables. Females had significantly better scores than males for some measures of *academic aptitude* (i.e., Grade 10 Reading, Grade 7 Writing, and Grade 10 Writing) and all measures of *academic performance* (i.e., Grade 12 English, Grade 12 Math, and self-report grades 11 or 12).

Table 5 shows sex differences in frequency of marijuana use at ages 16 or 17. Males and females were distributed equally in categories of frequency of use (i.e., never, a few times per year, a few times per month, once a week, more than once a week), except the 'once a week' category, which had significantly more males than females. There were no sex differences in categories of use in the high externalizing group, and in the low externalizing group the 'once a week' category had significantly more males than females. Table 6 shows differences in frequency of marijuana use by externalizing group. Those in the high externalizing group had significantly more people in the 'more than once a week' category compared with those in the low externalizing group.

Table 3

Means (or n) and Standard Deviations (or %) of all Variables by Externalizing Group

Variables	Mean or *n* (SD or %)	Low Externalizing Mean or *n* (SD or %)	High Externalizing Mean or *n* (SD or %)	*t*	Range
Sex					
Female	342 (52%)	225 (51%)	40 (53%)		
Male	320 (48%)	220 (49%)	35 (47%)		
Socioeconomic Status (SES)	2.88 (1.38)	2.89 (1.34)	2.93 (1.48)	-0.22	0 – 4
Academic Aptitude					
Grade 7 Numeracy	57.66 (19.37)	58.68 (18.90)	54.60 (20.70)	1.17	2 – 100
Grade 10 Numeracy	53.64 (21.25)	55.22 (20.61)	46.88 (21.65)	**2.15***	8 – 98
Grade 7 Reading	68.16 (15.93)	69.95 (15.00)	70.83 (14.88)	-0.69	0 – 96
Grade 10 Reading	69.18 (18.72)	70.19 (18.21)	63.71 (19.04)	1.92	10 – 98
Grade 7 Writing	52.54 (13.68)	53.67 (14.39)	49.86 (13.14)	1.47	0 – 100
Grade 10 Writing	59.92 (15.32)	59.92 (15.13)	59.26 (17.23)	0.23	17 – 100
Academic Performance					
Grade 12 English	74.99 (13.65)	75.67 (13.46)	73.67 (12.45)	1.02	31 – 99
Grade 12 Math	76.78 (13.61)	76.68 (13.88)	74.86 (9.96)	0.58	34 – 100
Self-Report Grades (11 or 12)	3.09 (.80)	3.15 (.77)	2.75 (0.87)	**3.86*****	0 – 4
Marijuana Use Frequency	1.19 (1.40)	1.08 (1.32)	1.83 (1.66)	**-3.70*****	0 – 4
Externalizing Behaviours	4.50 (2.08)	3.93 (1.62)	7.90 (0.94)	**-29.90*****	0 – 11
Age of First Marijuana Use	15.58 (2.50)	15.74 (2.43)	15.06 (2.79)	**2.01***	6 – 26

* p < .05, ** p < .01, *** p < .001

Table 4

Means (or n) and Standard Deviations (or %) of all Variables by Sex

Variables	Mean or *n* (SD or %)		*t*	Range
	Males	Females		
Socioeconomic Status (SES)	2.87 (1.36)	2.89 (1.39)	-0.23	0 – 4
Academic Aptitude				
Grade 7 Numeracy	57.90 (20.22)	57.43 (18.58)	0.21	2 – 100
Grade 10 Numeracy	55.38 (22.22)	51.86 (20.13)	1.36	8 – 98
Grade 7 Reading	66.46 (16.10)	69.78 (15.64)	-1.81	0 – 96
Grade 10 Reading	66.22 (19.30)	72.18 (17.67)	**-2.65****	10 – 98
Grade 7 Writing	49.98 (13.33)	54.99 (13.61)	**-3.30****	0 – 100
Grade 10 Writing	56.55 (14.45)	63.35 (15.46)	**-3.72*****	17 – 100
Academic Performance				
Grade 12 English	71.51 (13.97)	78.31 (12.50)	**-5.72*****	31 – 99
Grade 12 Math	75.11 (13.31)	78.62 (13.75)	**-2.01***	34 – 100
Self-Report Grades (11 or 12)	2.91 (0.79)	3.24 (0.77)	**-5.01*****	0 – 4
Marijuana Use Frequency	1.24 (1.40)	1.14 (1.40)	0.78	0 – 4
Externalizing Behaviours	4.51 (1.95)	4.49 (2.20)	0.11	0 – 11
Age of First Marijuana Use	15.62 (2.56)	15.64 (2.44)	0.19	6 – 26

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 5

Differences in Frequency of Marijuana Use in the Past Year by Sex and Externalizing Group

	Full Sample		Low Externalizing		High Externalizing		Total
Marijuana Use Frequency	M	F	M	F	M	F	
Never	110 (43%)	126 (47%)	94 (42%)	116 (51%)	16 (46%)	10 (25%)	236 (45%)
A few times per year	60 (23%)	58 (22%)	55 (25%)	52 (23%)	4 (11%)	5 (13%)	118 (23%)
A few times per month	37 (15%)	39 (14%)	33 (15%)	29 (13%)	4 (11%)	10 (25%)	76 (14%)
Once a week	16 (6%)[a]	7 (3%)[b]	14 (7%)[a]	5 (2%)[b]	2 (6%)	2 (5%)	23 (4%)
More than once a week	34 (13%)	37 (14%)	25 (11%)	24 (11%)	9 (26%)	13 (32%)	71 (14%)
Subtotal	257	267	221	227	35	40	524
Total	524		448		75		
χ^2	4.63 (p = .32)		6.80 (p = .15)		4.48 (p = .35)		

Table 6

Frequency of Marijuana Use in the Past Year by Externalizing Group

Marijuana Use Frequency	Full Sample	Low Externalizing	High Externalizing
Never	236 (45%)	210 (47%)[a]	26 (35%)[b]
A few times per year	118 (23%)	108 (24%)[a]	9 (12%)[b]
A few times per month	76 (14%)	62 (14%)	14 (19%)
Once a week	23 (4%)	19 (4%)	4 (5%)
More than once a week	71 (14%)	49 (11%)[a]	22 (30%)[b]
Total	524	448	75
χ^2	23.55 (p < .001)		

Note: superscripts show significant differences in frequency

Those in the low externalizing group had significantly more people in the ‘never’ and ‘a few times per year’ categories than those in the high externalizing group.

Table 7 shows correlations between the manifest variables for academic aptitude (i.e., Grade 7 and Grade 10 numeracy, Grade 7 and Grade 10 reading, and Grade 7 and Grade 10 writing FSA scores) and academic performance (i.e., Grade 12 English and Grade 12 Math course grades and Grade 11/12 self-report grades) latent variables. All were significantly positively correlated, except for Grade 7 reading FSA scores and Grade 12 Math course grades ($r = .11$, $p = .21$).

Table 8 shows the correlations among study variables for all participants, and by externalizing group. Academic aptitude was significantly positively correlated with academic performance ($r = .67$, $p < .001$), sex ($r = .13$, $p = .01$; male = 0, female = 1), and SES ($r = .20$, $p < .001$). Aptitude was significantly negatively correlated with marijuana use frequency ($r = -.21$, $p < .001$) and externalizing behaviours ($r = -.20$, $p < .001$). Academic performance was significantly positively correlated with SES ($r = .20$, $p < .001$), and sex ($r = .28$, $p < .001$), and was negatively correlated with marijuana use frequency ($r = -.38$, $p < .001$) and externalizing behaviours ($r = -.31$, $p < .001$). Marijuana use and externalizing behaviours were significantly positively correlated ($r = .31$, $p < .001$). Age of first marijuana use was significantly positively correlated with SES ($r = .09$, $p = .048$), academic aptitude ($r = .22$, $p < .001$), and academic performance ($r = .24$, $p < .001$). Age of first marijuana use was significantly negatively correlated with marijuana use ($r = -.57$, $p < .001$), and with externalizing behaviours ($r = -.15$, $p = .003$). *For the low externalizing group*, academic aptitude was significantly positively correlated with academic performance ($r = .67$, $p < .001$) and SES ($r = .27$, $p < .001$), and was significantly negatively correlated with marijuana use frequency ($r = -.18$, $p = .003$) and with

externalizing behaviours (r = -.19, p = .001). Academic performance was significantly positively correlated with sex (r = .30, p < .001) and with SES (r = .18, p = .001). Marijuana use and externalizing behaviours were significantly positively correlated (r = .29, p < .001). Age of first marijuana use was significantly positively correlated with SES (r = .14, p = .01), academic aptitude (r = .18, p = .001), and academic performance (r = .23, p < .001). Age of first marijuana use was significantly negatively correlated with marijuana use (r = -.53, p < .001), and with externalizing behaviours (r = -.14, p = .01). *For the high externalizing group,* academic aptitude was significantly positively correlated with academic performance (r = .40, p = .02) and SES (r = .29, p = .04), and was significantly negatively correlated with externalizing behaviours (r = -.29, p = .04). Academic performance was significantly positively correlated with SES (r = .37, p = .005). Age of first marijuana use was significantly positively correlated with academic aptitude (r = .39, p = .001), and academic performance (r = .28, p = .02). Age of first marijuana use was significantly negatively correlated with marijuana use (r = -.69, p < .001).

Table 7

Correlations of Manifest Variables for Academic Aptitude and Academic Performance

	NU7	NU10	RE7	RE10	WR7	WR10	ENG12	MATH12	SRGR
Grade 7 Numeracy (NU7)	1								
Grade 10 Numeracy (NU10)	**.69****	1							
Grade 7 Reading (RE7)	**.50****	**.45****	1						
Grade 10 Reading (RE10)	**.46****	**.61****	**.49****	1					
Grade 7 Writing (WR7)	**.36****	**.24***	**.46****	**.29***	1				
Grade 10 Writing (WR10)	**.41****	**.45****	**.46****	**.55****	**.26***	1			
Grade 12 English (ENG12)	**.36*****	**.45*****	**.33*****	**.45*****	**.31*****	**.40*****	1		
Grade 12 Math (MATH12)	**.44*****	**.57*****	.11	**.35*****	**.18***	**.34*****	**.60*****	**1**	
Self-Report Grades (11 or 12) (SRGR)	**.33*****	**.52*****	**.31*****	**.53*****	**.28*****	**.37*****	**.66*****	**.60*****	1

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 8

Correlations of Dependent and Independent Variables

	Full Sample						Low Externalizing						High Externalizing					
	Sex	SES	AA	AP	MJ	EXT	Sex	SES	AA	AP	MJ	EXT	Sex	SES	AA	AP	MJ	EXT
Sex (Male = 0)	1						1						1					
Socioeconomic Status (SES)	.01	1					.03	1					.01	1				
Academic Aptitude (AA)	**.13***	**.27*****	1				.10	**.27*****	1				.09	**.29***	1			
Academic Performance (AP)	**.28*****	**.20*****	**.67*****	1			**.30*****	**.18****	**.67*****	1			-.24	**.37****	**.40***	1		
Marijuana Use Frequency (MJ)	-.03	-.04	**-.21*****	**-.38*****	1		-.08	-.07	**-.18****	**-.39*****	1		.16	.05	-.24	-.20	1	
Externalizing Behaviours (EXT)	-.01	-.05	**-.20*****	**-.31*****	**.31*****	1	-.05	-.08	**-.19****	**-.31*****	**.29*****	1	.22	-.01	**-.29***	.01	-.07	1
Age of First Marijuana Use	-.01	**.09***	**.22*****	**.24*****	**-.57*****	**-.15****	.02	**.14***	**.18****	**.23*****	**-.53*****	**-.14***	-.03	.06	**.39****	**.28***	**-.69*****	.08

* $p < .05$, ** $p < .01$, *** $p < .001$

Mediation Path Model

To test the mediating effects of marijuana use on the association between academic aptitude and academic performance, an academic aptitude latent variable was created using CFA. Fit indices are shown in Table 9. The model fit was acceptable as determined by comparative fit index (CFI) values ≥ .90, Tucker-Lewis index (TLI) values ≥ .90, root mean square error of approximation (RMSEA) values ≤ .08, and standardized root mean square residual ≤ .08 (Byrne, 2010; Hu & Bentler, 1999). CFA was also used to create the academic performance latent variable from grade 12 English course grades, grade 12 Math course grades, and self-reported grades in grades 11 or 12. Fit indices are not available for this model as it is fully saturated, given there are only three variables; however the latent variable improves the model by reducing error associated with each variable and allowing for each participant to contribute available information.

Figure 2 shows the results of the mediation analysis for the full sample. This was computed by estimating paths from academic aptitude to marijuana use, as well as academic aptitude and marijuana use to academic performance. This model controlled for sex and SES. In support of my hypothesis, higher academic aptitude was associated with lower marijuana use (β = -.21, *SE* = .04, $p < .001$) and greater marijuana use was associated with lower academic performance (β = -.25, *SE* = .04, $p < .001$). The direct path between academic aptitude and academic performance was significant (β = .59, *SE* = .06, $p < .001$). The indirect effect of marijuana use was also significant (β = .04, *SE* = .01, *95% CI* = 0.018, 0.068), showing that marijuana use significantly reduces the effect of academic aptitude on academic performance.

Table 10 shows estimates for the control variables. For the full sample path model, there were significant effects for SES on academic aptitude, and for sex on academic performance.

Table 9

CFA Model Fit Indices for Academic Aptitude

Indices	
χ^2	315.86
	15
CFI	0.974
TLI	0.956
RMSEA	0.042
SRMR	0.064

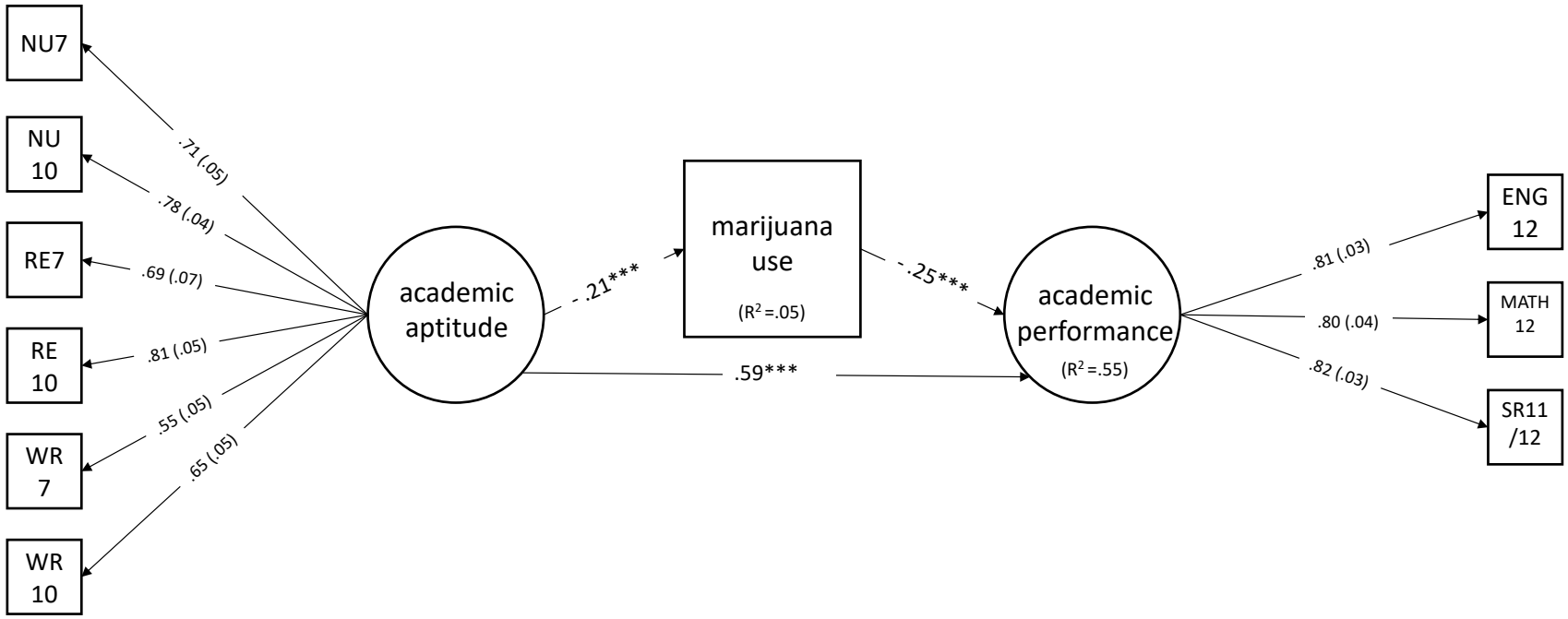


Figure 2. SEM Path Analysis

Table 10

Estimates for Control Variables in SEM Path Models

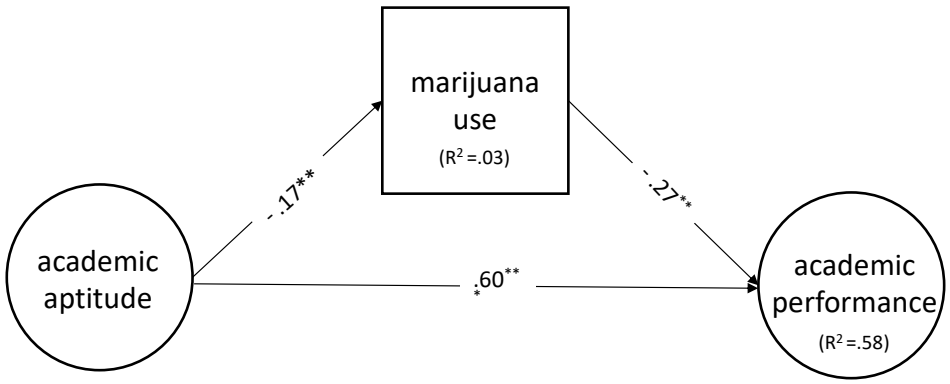
	Full Sample			Low Externalizing			High Externalizing		
Variable	ß	SE	*p*	ß	SE	*p*	ß	SE	*p*
Academic Aptitude									
SES	**.28**	**.05**	**< .001**	**.27**	**.06**	**< .001**	**.29**	**.14**	**.03**
Sex	.20	.12	.10	.16	.11	.16	.12	.29	.67
Academic Performance									
SES	.02	.05	.65	.001	.05	.99	.27	.14	.05
Sex	**.40**	**.09**	**< .001**	**.45**	**.08**	**< .001**	-.47	.27	.08

Moderation

In order to test the moderating effect of externalizing symptoms, models were computed using the multiple group function in MPlus 7.4 (Muthén & Muthén, 1998-2017). Again, models controlled for sex and SES. Results for each path model by group are shown in Figures 3 and 4.

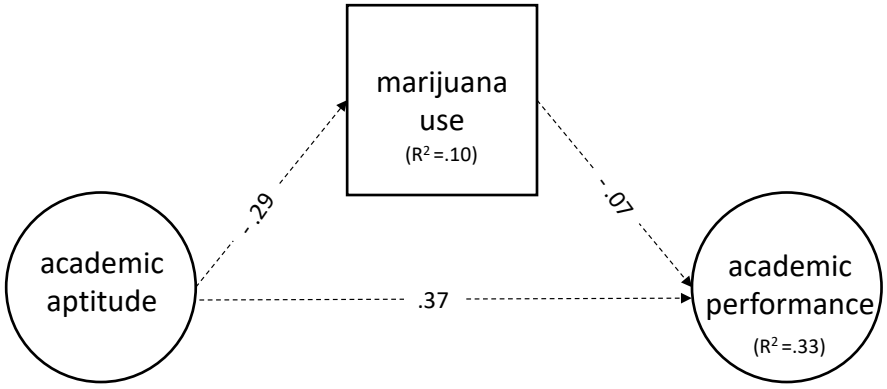
Low externalizing. Figure 3 shows the mediation analysis for the low externalizing group. Higher academic aptitude was associated with lower marijuana use (β = -.18, *SE* = .07, *p* = .01) and more frequent marijuana use was associated with lower academic performance (β = -.27, *SE* = .06, *p* < .001). The direct path between academic aptitude and academic performance was significant (β = .60, *SE* = .07, *p* < .001). The indirect effect of marijuana use was significant (β = .05, *SE* = .02, *CI* = 0.01, 0.08). Table 10 shows estimates for the control variables. There were significant effects for SES on academic aptitude, and for sex on academic performance.

High externalizing. Figure 4 shows the mediation analysis for the high externalizing group. None of the paths were significant. Table 10 shows estimates for the control variables. There were significant effects for SES on academic aptitude.



Indirect Effect
B =.05, SE = .02, 95% CI = .01, .08

Figure 3. SEM Path Analysis: Low Externalizing Group



Indirect Effect
B =.02, SE = .33, 95% CI = -.10, .14

Figure 4: SEM Path Analysis: High Externalizing Group

Academic Aptitude and Academic Performance Groups

Participants were divided into low and high academic aptitude and academic performance groups (i.e., either below or above the median factor scores) in order to understand more about youth's academic aptitude and academic performance, and how they are associated with the variables in the study. Table 11 shows mean differences for all study variables by academic groups. Those in the high academic aptitude and academic performance groups had significantly higher SES than those in the low academic aptitude and academic performance groups. Marijuana use frequency and externalizing behaviours were significantly higher for those in the low academic aptitude and academic performance groups, compared to those in the high academic aptitude and high academic performance groups. For the low academic aptitude and low academic performance groups, mean age of first marijuana use was one year younger than those in the high academic aptitude and academic performance groups. Table 12 shows differences in frequency of marijuana use in the past year for low and high academic aptitude and academic performance groups. There were significantly more of the high academic aptitude group in the 'never' category than those in the low academic aptitude group. Conversely, there were significantly more who used more than once a week in the low academic aptitude group compared with the high academic aptitude group. For academic performance groups, there were significantly higher numbers of those in the low academic performance groups in the more frequent use categories (i.e., 'once a week' and 'more than once a week') compared to the high academic performance group. There were significantly higher numbers of those in the high academic performance group in the 'never' and 'a few times per month' categories compared to the low academic

performance group. Tables 13 and 14 show correlations of study variables in these groups.

Table 11

Means (or n) and Standard Deviations (or %) of all Variables by Academic Group

Variables	Mean (SD)		*t*	Range
	Low AA	High AA		
Socioeconomic Status (SES)	2.50 (1.47)	3.30 (1.12)	**-6.98*****	0 – 4
Marijuana Use Frequency	1.46 (1.51)	0.93 (1.22)	**4.42*****	0 – 4
Externalizing Behaviours	4.48 (1.99)	4.14 (2.01)	**3.89*****	0 – 11
Age of First Marijuana Use	15.13 (2.38)	16.15 (2.51)	**-4.20*****	6 – 26
	Low AP	High AP		
Socioeconomic Status (SES)	2.58 (1.45)	3.22 (1.20)	**-5.55*****	0 – 4
Marijuana Use Frequency	1.66 (1.52)	0.72 (1.08)	**8.12*****	0 – 4
Externalizing Behaviours	5.04 (2.02)	3.95 (1.99)	**6.21*****	0 – 11
Age of First Marijuana Use	15.15 (2.28)	16.18 (2.61)	**-4.21*****	6 – 26

Table 12

Frequency of Marijuana Use in the Past Year by Academic Group

Marijuana Use Frequency	Low AA	High AA	Low AP	High AP
Never	101 (38%) [a]	133 (51%) [b]	85 (33%) [a]	149 (57%) [b]
A few times per year	54 (21%)	63 (24%)	50 (19%)	67 (26%)
A few times per month	41 (16%)	35 (14%)	51 (19%) [a]	25 (10%) [b]
Once a week	15 (6%)	8 (3%)	18 (7%) [a]	5 (2%) [b]
More than once a week	50 (19%) [a]	21 (8%) [b]	57 (22%) [a]	14 (5%) [b]
Subtotal 261	260	261	227	
Total	521		521	
χ^2	19.52 (p =.001)		62.26 (p < .001)	

Note. Superscripts with different letters show significant differences in frequency

Table 13

Correlations of Dependent and Independent Variables for Low and High Academic Aptitude

	Low Academic Aptitude (*N* = 262, 54% Male)						High Academic Aptitude (*N* = 261, 43% Male)					
	Sex	SES	AA	AP	MJ	EXT	Sex	SES	AA	AP	MJ	EXT
Sex (Male = 0)	1						1					
Socioeconomic Status (SES)	.02	1					-.04	1				
Academic Aptitude (AA)	.07	**.19****	1				-.06	.12	1			
Academic Performance (AP)	**.28*****	**.13***	**.46*****	1			**.22*****	-.02	**.57*****	1		
Marijuana Use Frequency (MJ)	-.01	.00	**-.18****	**-.39*****	1		-.03	.02	-.12	**-.43*****	1	
Externalizing Behaviours (EXT)	.03	-.01	-.11	**-.18****	**.28*****	1	.01	.02	**-.13***	**-.27*****	**.30*****	1

* p < .05, ** p < .01, *** p < .001

Table 14

Correlations of Dependent and Independent Variables for Low and High Academic Performance

	Low Academic Performance (*N* = 262, 62% Male)						High Academic Performance (*N* = 261, 36% Male)					
	Sex	SES	AA	AP	MJ	EXT	Sex	SES	AA	AP	MJ	EXT
Sex (Male = 0)	1						1					
Socioeconomic Status (SES)	-.02	1					-.07	1				
Academic Aptitude (AA)	-.05	**.29*****	1				**.14***	**.17****	1			
Academic Performance (AP)	.09	.12	**.46*****	1			.07	.03	**.66*****	1		
Marijuana Use Frequency (MJ)	.09	.02	-.07	**-.34*****	1		.01	.08	.00	**-.18****	1	
Externalizing Behaviours (EXT)	**.18****	.02	-.01	-.10	**.19****	1	-.03	.01	-.01	.01	**.32*****	1

* p < .05, ** p < .01, *** p < .001

Chapter 4: Discussion

This study enhances our understanding of how marijuana use in adolescence impacts the association between academic aptitude and academic performance, as well as the role of externalizing behaviours in moderating this association. As hypothesized, marijuana use partially mediated the association between academic aptitude and academic performance. Specifically, lower aptitude in grades seven and/or ten was associated with higher frequency of marijuana use at ages 16 or 17, which, in turn, was associated with lower academic performance in grade 12. While these findings held for those below a clinical threshold for externalizing behaviours, they were not significant for youth with high externalizing behaviours at age 16 or 17. I first discuss frequency of marijuana use and lack of sex differences in marijuana use at ages 16 or 17. Next, I discuss the association between academic aptitude and academic performance and the effect of marijuana on this association. Then, I discuss how externalizing behaviours moderate these pathways, as well as demographic considerations. Finally, I discuss the limitations, future directions, and implications of the research.

Marijuana Use at Age 16 or 17

At age 16 or 17, the majority (55%) of participants had used marijuana at least a few times in the past year. Marijuana use frequency did not differ for males and females, and there were no sex differences for mean levels of marijuana use. Previous literature has found that males use marijuana more frequently than females (Leatherdale & Burkhalter, 2012; Patte, Qian, & Leatherdale, 2017). However, in this sample, overall levels of use and community acceptance is high, possibly influencing use in females.

Age of first marijuana use was examined descriptively in order to understand more about the associations between marijuana use, academic aptitude and performance, and externalizing behaviours. Younger age of first use was associated with lower academic aptitude and academic performance and with higher frequency of marijuana use and externalizing behaviours. The mean age of first use for low academic aptitude or academic performance is one year younger than for those with high aptitude or performance, suggesting that delaying marijuana use even by one year may reduce detrimental effects on academic performance.

The Mediating Effect of Marijuana Use in Academic Pathways

Academic aptitude and academic performance. Participants in the current study performed on par with or slightly better than youth in British Columbia in measures of both academic aptitude and academic performance. A percentile score of 50 for BC FSA tests indicates the provincial median score, and mean percentile scores for participants ranged from 52.54 to 69.16. In measures of academic performance, participants' mean course grades in Math and English, and self-report grades were high (B average), compared to, for example, a C+ average for grade 12 English for British Columbia youth (The Province of British Columbia, 2010). Consistent with the literature (Nicholls, 1978), latent variables for academic aptitude and academic performance had good model fits indicating that standardized test scores are an appropriate measure of academic aptitude and course grades are appropriate measures of academic performance. As hypothesized, and consistent with previous research (Hansen, 2010; Heckman, Stixrud, & Urzua, 2006), academic aptitude and academic performance were moderately correlated ($r = .67$, $p < .001$).

Academic aptitude and marijuana use. Previous literature has examined the link between marijuana use and concurrent or later academic performance (Homel, Thompson, &

Leadbeater, 2014; Meier, Hill, Small, & Luthar, 2015; Patte, Qian, & Leatherdale, 2017; Stiby et al, 2015). The current study adds to the literature by testing the association between academic aptitude and later marijuana use, and shows that lower academic aptitude in grades seven and/or ten is associated with greater marijuana use at ages 16 or 17. One explanation for the association between academic aptitude and marijuana use is that low self-esteem results from school failures, leading youth to use marijuana both to cope with low self-esteem and to fit in with peers who are academically similar. Youth who do poorly on standardized tests may require enriched educational experiences in order for them to perform optimally. While diagnosed learning disorders may be addressed in elementary school, those who do not meet diagnostic criteria for a learning disorder but whom possess lower abilities may require intervention to help improve their engagement in school, which could prevent subsequent engagement marijuana use.

Marijuana use and academic performance. Marijuana use was negatively associated with both academic aptitude and academic performance. Those in low academic aptitude or academic performance groups (i.e., below mean levels) use marijuana at a significantly higher frequency than those in high academic aptitude or academic performance groups. However, 49% of those in the high academic aptitude group and 43% of those in the high academic performance group used marijuana in the past year. Some previous research has found higher frequency of use is associated with poor academic outcomes (e.g., Maggs et al., 2015), but other longitudinal studies have found that any amount of marijuana is associated with poor academic performance (Patte, Qian, & Leatherdale, 2017). Those in the high academic performance group tended to use less frequently than their peers in the low academic performance groups. In contrast, marijuana use among the low academic aptitude and low

academic performance groups was more evenly dispersed, with a large proportion (19-22%) using more than once a week. This suggests that infrequent marijuana use may not be harmful in terms of academics, while frequent use may be associated with higher risk. Marijuana use frequency was also associated with externalizing behaviours ($r = .31$, $p < .001$), reflecting typical findings in the literature (Schulenberg et al., 2005).

Consistent with the literature, marijuana use was associated with lower academic performance (Brook, Stimmel, Zhang, & Brook, 2008). This reflects Weiner's attributional theory of achievement motivation wherein ability and effort facilitate achievement behaviour. Marijuana use likely indicates either impaired cognition or low motivation (or both), thus inhibiting effort. Previous longitudinal studies have interpreted associations between marijuana use preceding academic outcomes as causal (e.g., Lynskey and Hall, 2000), but more recent studies have considered that these associations may be due to overlapping risk factors which both increase marijuana use and decrease educational achievement. For example, in a study using a bivariate twin model, Verweij, Huizink, Agrawal, Martin, and Lynskey (2013) found that shared environmental factors such as familial influences (i.e., parenting style, family dysfunction, and parental substance use) explained the association between marijuana use and early school leaving. The concept of overlapping risk factors is delineated as problem behaviour theory in developmental research; clusters of problem behaviours such as externalizing behaviours and substance use in adolescence and young adulthood may have common determinants and co-vary (Jessor, 2018). More problem behaviours generally result in worse outcomes (Ansary & Luthar, 2009). Literature examining marijuana use and academic outcomes also examines externalizing behaviours, although there are variations in research designs and results are mixed (e.g., Ansary & Luthar, 2009; Bryant et al., 2003; Uemura, &

Rohrman, 2012). The current study found that externalizing behaviours moderate the association between academic aptitude, marijuana use, and academic performance.

Moderating Role of Externalizing Behaviours

Past research shows marijuana use and externalizing behaviours are moderately associated in adolescence (e.g., King, Iacono, & McGue, 2004; Kohornen, 2010) and both are associated with poor academic outcomes (Ansary & Luthar, 2009; Bryant et al., 2003; Uemura, & Rohrman, 2012). In the present study 14% of the participants had levels of externalizing behaviours that were above clinical cut-offs, set at one standard deviation above the mean (i.e., score of seven; Cunningham et al., 2009). Though previous literature has found higher rates of externalizing behaviours in males (Copeland, Shanahan, Costello, & Angold, 2011; Leadbeater, Kuperminc, Blatt, & Hertzog, 1999; Merikangas et al., 2010), externalizing behaviours were not associated with sex in the present study.

Consistent with the literature (Zimmermann, Schütte, Taskinen, & Köller, 2013), externalizing behaviours at ages 16 or 17 were correlated with both academic aptitude (r = -.20, p < .001) and academic performance (r = -.31, p < .001). As expected, externalizing behaviours were moderately correlated with marijuana use (r = .31, p < .001). The present study examined externalizing behaviours as a moderator of the mediation model by dividing participants into low and high externalizing groups using clinical cut-off scores. The mediated pathways between academic aptitude and academic performance were significant for the low externalizing behaviours group but not for the high externalizing behaviours group.

Low externalizing behaviours group. Youth with low levels of externalizing who use marijuana may have cognitive or motivational problems that limit academic performance despite academic aptitude (e.g., Bond et al., 2007; Lisdahl, Wright, Kirchner-Medina, Maple, &

Shollenbarger, 2014). In terms of motivation, marijuana use may be symptomatic of disinterest or disengagement in academic life in high school. For example, Bond et al. (2007) found that low school connectedness in grade eight was associated with later marijuana use and reduced likelihood of completing high school.

Magnetic Resonance Imaging (MRI) studies have found lower brain volumes, different folding patterns and thinning of the cortex, less neural connectivity and lower white matter integrity among youth who regularly use marijuana (Lisdahl, Wright, Kirchner-Medina, Maple, & Shollenbarger, 2014). In addition, adolescent boys who regularly use marijuana show excessive overall neural activity when attempting novel tasks compared to controls, suggesting their brains may be working harder to compensate for structural damage compared to their peers (Jager, Block, Luijten, & Ramsey, 2010). Marijuana use has also been linked to impairment in short-term memory, complex mental tasks, attention, judgement, reaction times, and motor skills (Li et al., 2012) and decreases in IQ (Meier et al., 2012). When using marijuana, working memory is impaired both at the time of use and in the following days (Raganathan & D'Souza, 2006), possibly making it difficult for students to learn and retain information. This can lead to falling behind in school, creating further obstacles for future learning. The present study identified that, for low externalizing youth, lower academic aptitude preceded marijuana use at ages 16 or 17, so lower aptitude may identify youth at risk for early marijuana use. In addition, findings from the present study indicate that interventions should be widespread and not only targeted to youth who might seem more likely to use substances (i.e., those with externalizing behaviour problems).

High externalizing behaviours group. Youth with clinical levels of externalizing behaviours did not show significant differences in most measures of academic aptitude

compared to their low externalizing behaviours peers. However, the high externalizing behaviours group had significantly lower self-reported grades than their peers, suggesting that externalizing behaviours independently impact performance, or youth with high externalizing behaviours have a lower academic self-concept than low externalizing youth.

Marijuana use in the high externalizing behaviours group was significantly higher than in low externalizing behaviours group. Focus for interventions to improve academic performance may need to be directed toward both externalizing and early substance use simultaneously. Youth with high externalizing behaviours require interventions for behaviours that limit academic engagement starting in elementary school. For example, Masten and colleagues (2005) found that externalizing problems in childhood preceded later academic problems. Early externalizing problems may begin a cascading series of problems related to academic performance. Children with problem behaviours may have problems that directly inhibit learning or that exclude them from classroom activities due to their disruptive nature. Intervention should occur at younger ages, with high levels of behavioural support workers in classrooms and efforts to engage lower aptitude youth in learning using alternative methods.

Since learning builds on previous knowledge, high externalizing youth may continue through school with fewer positive experiences, which in turn exacerbates their externalizing behaviours. Zimmerman, Schütte, Taskinen, and Köller (2013) found that self-esteem partially mediated the association between academic performance and later externalizing behaviours. It is likely that poor performance lowers self-esteem and youth may turn to problematic activities and deviant peers in order to feel better about themselves. Involvement with deviant peers who are also excluded from academic life may result in more problematic behaviours (Masten et al.,

2005; Zimmerman & Schmeelk-Cone, 2003). By the time externalizing youth are in high school, comprehensive and specialized interventions are needed to reengage them.

In summary, the present study demonstrated that marijuana use is a risk factor in academic performance. Low externalizing youth with lower academic aptitude may experience school failures that lead to disengagement from school, which leads to marijuana use. Marijuana use may also impact motivation or cognition in low externalizing youth, leading to poorer academic performance. For high externalizing youth, marijuana use may be conceptualized as a co-occurring problem that is not independently associated with academic factors. For these youth, academic disengagement may begin at young ages and requires early intervention to prevent cumulative concerns.

Demographic Considerations

Findings accounted for both sex and SES. Consistent with previous literature (Duckworth & Seligman, 2006; Pomerantz, Altermatt, & Saxon, 2002), females performed better than males in both academic aptitude and academic performance. Although previous literature has found that females typically show lower mean levels of marijuana use and externalizing behaviours (Leadbeater, Kuperminc, Blatt, & Hertzog, 1999; Leatherdale & Burkhalter, 2012), there is limited research showing that associations between academic factors and these risk factors are sex dependent, suggesting that interventions do not need to be targeted to males or females separately. In the current study, females and males use marijuana at equal rates. Youth in BC tend to use marijuana more compared to youth in Canada generally. For example, in 2008/2009, 42% of grade seven to twelve students in BC used marijuana in the past year compared to 27% of grade seven to twelve students using national statistics (Cumming, Bonham, Rynard, & Manske, 2016). Higher community rates of use may explain

why females in the current sample used as frequently as males. For example, rates of binge drinking in Canada tend to be more evenly distributed among males and females; in 2008, 46% of males and 40% of females in grade 11 had more than 5 drinks on one occasion over the previous year (Leatherdale & Burkhalter, 2012). Across Canada, binge drinking is more socially accepted than marijuana use. In areas with higher marijuana use, marijuana use may also be more socially acceptable for both sexes.

In a US study of 1299 adolescents (mean age = 216.1, SD = 1.6), Roditis, Delucchi, Changa, and Halpern-Felsher (2016) found that marijuana use was perceived as less risky and more socially acceptable than tobacco use. Odds of using marijuana were 27% higher for those who reported that their friends used marijuana and were 6% higher for those who saw messages about the benefits of marijuana use. Legalization of marijuana is imminent in Canada, so use is likely to increase, which may lead to greater social acceptability of use and increases in use among adolescents, especially females, across the country.

SES was correlated with academic aptitude and academic performance in the full sample, and in each externalizing behaviours group, suggesting that SES impacts both academic aptitude and academic performance for all youth. Compared to low SES youth, higher SES youth likely have more avenues for support if they are showing academic difficulties.

Limitations and Future Directions

Findings from the present study should be interpreted in the context of limitations. First, the majority of participants in the study were Caucasian and from a medium-sized Canadian city, so findings may not be generalizable to high risk or minority youth. However, the sample was recruited randomly from the community and is representative of socioeconomic diversity

in the population. Generalizability may also be limited due to the high prevalence of marijuana use in the population (Leatherdale & Burkhalter, 2012). On the other hand, the present study adds to our understanding of how marijuana use may impact those in populations where marijuana use is more prevalent and socially acceptable, which is of particular note as legalization of recreational marijuana in Canada is approaching. A second limitation to the present study is that it examines marijuana use and externalizing behaviours at specific ages (i.e., ages 16 or 17) in order to place these factors temporally in the middle of established academic factors. Times of assessment (i.e., grade 10 and age 16) may overlap somewhat. Third, the linked educational data for this study was limited and data was not available for all participants. In addition, standardized measures such as the FSA scores used in the present study may not be considered pure measures of aptitude, as their subject matter has become a part of the curriculum, and so could reflect performance, thus explaining the high correlation between academic aptitude and academic performance. However, the correlations between measures of academic and aptitude and academic performance that were found in the present study were similar to the correlations between measures of academic aptitude and academic performance in the literature (Bowers, 2011; Brennan, Kim, Wenz-Gross, & Siperstein, 2001; Willingham, Pollack, & Lewis, 2002). Fourth, considering the probability that externalizing problems compromise academic progression in childhood, future research should examine these associations at younger ages if possible. Finally, because some participants were 16 in the first wave of data collection, it was not possible to control for previous marijuana use in the model. This limits interpretation of longitudinal effects in the analysis.

Despite these limitations, the current study has several strengths. The sample size was large and representative of the community population from which it was sampled. Low attrition

rates allowed for robust measures of marijuana use and externalizing behaviours at ages 16 or 17. In addition, externalizing behaviours were assessed with a well-validated measure (i.e., BCFPI; Cunningham et al., 1996) allowing for the determination of clinical cut-offs for externalizing behaviours, which contributed to the clinical meaningfulness of the results. The study used administrative data thus reducing self-reporting bias. This study is one of few studies that shows that earlier lower academic aptitude precedes later marijuana use. It is also one of the only studies to examine how externalizing behaviours moderate academic outcomes in the context of marijuana use, showing that low externalizing behaviours youth with low academic aptitude are at increased risk of marijuana use and its further impact on academic performance.

Future research should examine the ways in which marijuana use impacts academic performance for youth with low externalizing behaviours. For example, do low externalizing youth who use marijuana show higher rates of internalizing symptoms, memory problems or lower school engagement? Future research should also examine post-secondary transitions for both low and high externalizing youth in order to better understand how marijuana use in high school might impact young adulthood achievement.

In addition, future qualitative research should examine why low externalizing youth use marijuana in high school. Previous studies have found that Canadian youth perceive marijuana as healthy (McKiernan & Fleming, 2017; Porath-Waller, Brown, Frigon, & Clark, 2013), but there are other possibilities that may influence frequency of use, such as pain relief, boredom, school disengagement, or desire for social belonging. Perhaps ease of obtaining marijuana has an influence; in the sample for the present study, at ages 16 to 22, 93% of participants reported marijuana was either “fairly easy” or “very easy” to obtain. Future research should also

examine strategies that encourage harm reduction or prevention, and how youth perceive these strategies in terms of what might work best.

Implications of the Present Study

The present study has several implications for educators and policy makers. In terms of interventions regarding marijuana use, the present study shows that marijuana use at ages 16 or 17 has implications for academic outcomes in grade 12 for youth who do not show other deviant behaviours and may compound problems for those who do. In other words, youth who do not seem likely to use drugs should be targeted for intervention, both in terms of limiting or reducing marijuana use frequency and in terms of increasing engagement in school. Previous research has shown encouraging results for marijuana prevention in adolescence. For example, a cluster randomized controlled trial of 764 13- to 14-year-old Australian students (60% male) examined an internet-based alcohol and marijuana prevention program (Newton, Andrews, Teesson, & Vogl, 2009). Average weekly alcohol consumption and frequency of marijuana use was reduced for the intervention group at the six-month follow-up. The intervention group also showed significant improvements in alcohol and marijuana knowledge at the end of the course and the six-month follow-up, compared with the control group who received alcohol and drug education as usual.

In a Canadian study of university students, Fischer and colleagues (2013) found evidence for the effectiveness of brief interventions for active marijuana users. These included oral or written information on the risks of marijuana use. Groups who received either oral or written information showed significant reductions in marijuana risk behaviours (i.e., number of days of marijuana use, driving after marijuana use), three months post-intervention; however, there were no differences found for days of marijuana use from baseline.

Education about risks associated with marijuana use is essential for both harm-reduction and prevention efforts for youth (Leatherdale & Ahmed, 2010). While school aged youth are at high risk for marijuana use, they are also accessible for prevention and intervention efforts. Unlike other risk factors that may be more difficult to detect, such as family problems or delinquent peers, low academic aptitude or performance is identifiable by educators, so students at risk may be engaged, not only to promote academic performance but also to reduce psychosocial and behavioural problems. The present study shows that interventions should include information about the educational risks associated with marijuana use, but should also focus on increasing engagement in academic life for students who are not motivated or engaged in traditional academic activities. This is especially important for youth with high externalizing behaviours, who likely need earlier interventions to avoid disengagement in academic life.

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