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Developmental trajectories of marijuana use and psychological distress: Exploring the co-occurrence of these phenomena in early adolescence

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Abstract

Early adolescence is period of rapid changes where psychological distress and marijuana use experimentation are common occurrences. Longitudinal studies examining the association between these two phenomena have provided mixed results and many questions prevail regarding the nature of this association. The purpose of this study is to examine the patterns of co-occurrence between marijuana use and psychological distress in early adolescence. A sample of 448 adolescent boys and girls attending two high schools in Montreal, Canada was followed from Grade 7 to 9. From 1999 to 2001, the participants completed an annual survey which included measures of marijuana use and psychological distress (IDPESQ-14). Using a semi-parametric group based modeling strategy, the study has for objectives to establish the developmental trajectories of marijuana use and psychological distress in early adolescence, to explore how marijuana use or psychological distress measured at baseline is associated with various developmental trajectories and to examine the interrelationship of these two phenomena as they concurrently develop over the span of our study.

Our results provide evidence that marijuana use and psychological distress are phenomena with great heterogeneity as they develop over time. We identified 3 trajectories of marijuana use: *Light Users, Increasers* and *High Chronics* and 3 trajectories of psychological distress: *Low*, *Medium* and *High*. Our findings also demonstrate that adolescents who reported psychological distress at baseline were more likely to follow problematic trajectories of marijuana use when compared to light users and the reverse of the association was also true since adolescent who reported marijuana use at baseline were more likely to follow an elevated trajectory of psychological distress. Our joint trajectory analysis

demonstrated that the developmental patterns of co-occurrence of marijuana use and psychological distress are complex. Our study provides evidence that adolescents following a trajectory of elevated psychological distress are at increased risk of also following a trajectory of elevated marijuana use but adolescents following a problematic trajectory of marijuana use are not necessarily at greater risk of following an elevated trajectory of psychological distress. Our study highlights the presence of an asymmetrical relationship between marijuana use and psychological distress in early adolescence.

Key words: marijuana use, psychological distress, depressive symptomatology, early adolescence, co-occurrence, semi-parametric, developmental trajectories, joint trajectory analysis

Résumé

Le début de l'adolescence est une période de changements rapides où la détresse psychologique et l'expérimentation de la marijuana sont choses fréquentes. Certaines études longitudinales ont démontré que ces deux phénomènes ont tendance à se manifester conjointement tandis que d'autres n'ont pu observer de tel lien. Ces résultats divergents suggèrent que plusieurs questions persistent concernant la nature de cette relation. Cette thèse a pour objectif d'explorer la consommation de marijuana et la détresse psychologique en début d'adolescence afin de mieux saisir les changements à travers le temps, ainsi que d'examiner si ces deux problématiques évoluent conjointement et s'influencent réciproquement. Un échantillon de 448 adolescents garçons et filles fréquentant deux écoles secondaires de Montréal, ont été suivi de secondaire I à secondaire III. De 1999 à 2001, les participants ont complété un questionnaire à chaque année de l'étude incluant des mesures portant sur la consommation de marijuana et la détresse psychologique (IDPESQ-14).

Un modèle de mixture semi-paramétrique (Nagin, 2005) a été utilisé afin d'identifier les trajectoires développementales de la consommation de marijuana et de détresse psychologique. Des analyses ont également été effectuées afin d'établir les liens d'appartenance entre chacune des trajectoires de consommation identifiées et la détresse psychologique lors de la première année de l`étude, ainsi qu'entre chacune des trajectoires de détresse psychologique et la consommation de marijuana en première année du secondaire. Finalement, des analyses de trajectoires jointes ont été effectuées afin de déterminer l'interrelation entre la consommation de marijuana et la détresse psychologique.

Les résultats de notre étude suggèrent qu'il existe une grande hétérogénéité au niveau de la consommation de marijuana et la détresse psychologique. Trois trajectoires développementales ont été identifiées pour la consommation de marijuana: consommation légère, consommation grandissante et consommation élevée et stable. Trois trajectoires ont également été observées pour la détresse psychologique : basse, moyenne et élevée. Nos résultats démontrent la présence d'un lien entre la détresse psychologique rapportée lors de la première année de l'étude et les trajectoires de consommation problématiques. Ce lien a également été observé entre la consommation de marijuana rapportée lors de première année de l'étude et les trajectoires problématiques de détresse psychologique.

Les analyses de trajectoires jointes démontrent la présence d'une concordance entre la consommation de marijuana et la détresse psychologique. Cette interrelation est toutefois complexe puisque les trajectoires de détresse psychologique élevée sont associées à un niveau de consommation de marijuana plus problématique mais l'inverse de cette association est moins probable. Notre étude met en lumière la nature asymétrique de la concordance entre la consommation de marijuana et la détresse psychologique.

Mots clés: marijuana, détresse psychologique, symptomatologie dépressive, adolescence, concordance, semi-paramétrique, trajectoires développementales, trajectoires jointes

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Cet ouvrage est dédié à ma mère…

CHAPTER 1

Introduction

Introduction

Early adolescence is of particular interest for researchers and clinicians since it represents a transitional period of life involving great developmental changes (Griffin, 2010; Cantin & Boivin, 2004; Christie & Viner, 2005; Steinberg & Morris, 2001; Cicchetti & Rogosch, 2002). As individuals enter adolescence, they are confronted with new realities such as puberty, changes in cognitive abilities, greater responsibilities at home and school, shifting peer relationships and the negotiation of romantic relations (Santrock, 2009). As is common in life transitions (Stuart & Robertson, 2003), these new challenges can increase adolescents' risks for a host of emotional and behavioral problems (Mason, Hitch, & Spoth, 2009). These difficulties should not be overlooked since there is evidence that they can impede on the development of social, cognitive, and psychological competencies throughout adolescence and also have implications later on in life (Chen, Haas, Gillmore, & Kopak, 2011).

Research has demonstrated that psychological distress and depressed mood are often experienced by adolescents (Natsuaki, Biehl, & Ge, 2009; Garber, Keily, & Martin, 2002; Larson, Moneta, Richards, & Wilson, 2002) with girls being more at risk than boys (Ayotte, Fournier, & Riberdy 2009). This is a serious concern since the presence of emotional distress in adolescence has been associated with an increased likelihood of severe psychopathology such as major depressive disorder throughout adolescence and adulthood (Dekker, Ferdinand, van Lang, Bongers, van der Ende, & Verhulst, 2007; Keenan-Miller, Hammen, & Brennan, 2007; Zahn-Waxler, Klimes-Dougan, & Slattery, 2000). Other negative outcomes linked to depressed mood, distress and depression in adolescence include lower academic achievement and performance (Jonsson, von Knorring, von Knorring, & Koupil, 2012; Fröjd et al., 2008), poor social functioning (Derdikman-Eiron et al., 2011; Jaycox et al., 2009), suicidal attempts

and hospitalizations (Brent & Birmaher, 2002; Fergusson, Horwood, & Ridder, 2005; Jonsson et al., 2012). There is also evidence that depressed adolescents have poorer general health, higher care utilization and are at greater risk of experiencing work impairment in young adulthood (Keenan-Miller et al., 2007).

Research has also demonstrated that substance use experimentation is a common occurrence in adolescence (Compton, Thomas, Conway, & Colliver, 2005) with marijuana being the most frequently used illicit substance (Johnston, O'Malley, Bachman, & Schulenberg, 2012). A number of negative social, emotional, psychological, educational, health, and legal consequences have been associated with substance use in adolescence (Degenhardt & Hall, 2006; Macleod et al., 2004; Gruber & Pope, 2002; Khalsa, Genser, Francis, & Martin, 2002; McArdle, 2006). More specifically, regular and heavy marijuana use have been linked to low educational achievement (Horwood et al., 2010; Chatterji, 2006), high school dropout (McCaffrey, Pacula, Liccardo, Han, & Ellickson, 2010; Bray, Zarkin, Ringwalt, Qi, 2000; Townsend, Flisher, & King, 2007) and engagement in risky sexual behaviors (Bellis et al., 2008; Grossman, Kaestner, & Markowitz, 2004; Tapert, Aarons, & Sedilar, 2001), delinquency (D'Amico, Edelen, Miles, & Morral, 2008; Mason & Windle, 2002; Fergusson, Lynskey, & Horwood, 1996) and mental health problems (Lynne-Landsman, Bradshaw, & Ialongo, 2010; Fergusson, Poulton, Smith, & Boden, 2006). Other negative outcomes include an increased risk of lower income, unemployment and relationship and life satisfaction in young adulthood (Fergusson & Boden, 2008). There is also evidence of long-term effects of chronic marijuana use such as selective impairment in cognitive functioning and respiratory problems (World Health Organization, 1997). These negative effects

associated with long-term marijuana use are similar to those associated with long-term tobacco use.

The age of onset of marijuana use is also linked to poorer developmental outcomes. Research findings have consistently demonstrated that adolescents who use marijuana before age 15 are at greater risk of more severe mental and physical health outcomes (Tang & Orwin, 2009; Fergusson & Horwood, 1997) and also more likely to develop substance use problems in late adolescence and adulthood (Gruber & Pope, 2002; Kandel, 2003).

In early adolescence, a minority of teens use marijuana regularly or heavily but there is growing evidence that experimentation or occasional substance use is not without consequences (Degenhardt et al., 2010). It has been associated with car crashes, unwanted or unprotected sexual encounters, and violent interpersonal exchanges (Jacobus, Bava, Cohen-Zion, Mahmood, & Tapert, 2009; Asbridge, Poulin, Donato, 2005; Bedard, Dubois, & Weaver, 2007).

There is also strong evidence that substance use and mood problems tend to co-occur during adolescence (Degenhardt, Hall, & Lynskey, 2003; Fergusson, Horwood, & Swain-Campbell, 2002; Hallfors, Waller, Bauer, Ford, & Halpern, 2005; Poulin, Hand, Boudreau, & Santor, 2005; Waller et al., 2006; White, Xie, Thompson, Loeber, & Stouthamer-Loeber, 2001). For example, cross-sectional studies have consistently demonstrated an association between marijuana use and depressive problems (e.g. Dorard, Berthoz, Phan, Corcos, & Bungener, 2008; Rey, Sawyer, Raphael, Patton, & Lynskey, 2002). Longitudinal studies examining the temporal association between these two phenomena have provided mixed results (e.g. Harder, Stuart, & Anthony, 2008; Repetto, Zimmerman, & Caldwell 2008; Needham, 2007; Georgiades & Boyle, 2007). Research also suggests that the co-occurrence

of these problems can have important ramifications in terms of the degree of impairment and their developmental course (Wolff & Hollendick, 2006). There is evidence that concurrent problems interact to influence each other as they develop over time and produce negative outcomes greater than the additive risks of each problem (Jackson, Sher, & Wood, 2000). For example, it has been observed that adolescents with co-occurring problems are typically more severely impaired than adolescents with a single problem (e.g. marijuana use or psychological distress) (Nottelmann & Jensen, 1995). Furthermore, the co-occurrence seems to magnify or exacerbate the negative effects of either problem alone and contribute to high levels of psychosocial impairment in various areas of functioning (e.g. home, school, peers) (Wolff & Hollendick, 2006).

The negative outcomes linked to more severe comorbid disorders (Substance Use Disorders (SUD) and Major Depressive Disorders) have also been examined and the general conclusion is that the deleterious consequences of comorbid of disorders are substantial (Roberts, Roberts, & Xing, 2007). Some studies have found that adolescents with comorbid disorders commonly report impaired role functioning, suicide attempts, and academic problems (Lewinsohn, Rohde, & Seeley, 1995). In a recent study by Roberts et al. (2007), it was observed that both marijuana abuse and dependence combined with depression significantly increased the odds of functional impairment as measured by CGAS scores.

There is also mounting evidence that the burden of problems either alone or co-occurring extend well beyond adolescence and has an impact families and society (Lynch & Clark, 2006). The economic and social burden of substance use and depression in adolescence have not been the object of many studies but it can be expected that these problems in youth increase the use of health care services, school services, and probably other social services

(Lynch & Clark, 2006). In Canadian adult population, it is estimated that the overall social costs of substance abuse in 2002 was $39.8 billion (Rhem et al., 2006). Depression also entails significant social and economic costs to society and was estimated at $83.1 billion in 2000 in the United States (Greenberg et al., 2003). The costs to individuals and society are undeniable and since substance use and depression often emerge in adolescence, a better understanding of how these phenomena develop over time is therefore warranted.

Longitudinal research has provided important insights into the association between marijuana use and psychological distress, but few studies have addressed the questions regarding the developmental progression of these problems over time. A better understanding of the dynamic developmental linkages might help shed some light on how marijuana use and psychological distress relate to each other during early adolescence. This knowledge can help prevent the development of these problems and their associated negative outcomes. Furthermore, elucidating the developmental course of these co-occurring problems may help identify at risk youth and optimal periods for delivery of prevention programs.

Purpose of the study

The purpose of this study is to examine the developmental patterns of marijuana use and psychological distress in a sample of boys and girls in early adolescence, paying close attention to the heterogeneity in the developmental course and interrelation of these problems over time. This will be achieved by identifying various developmental trajectories of marijuana use and psychological distress for adolescents from Grade 7 to Grade 9; by exploring how marijuana use or psychological distress measured at baseline is associated with the developmental course of trajectories and; by examining the interrelationship of these two

phenomena as they concurrently develop over the span of our study. A semi-parametric group based (SPGB) modeling strategy will be utilized to explore these questions (Nagin, 1999; 2005). This analytical approach was selected because it allows to chart the progression of any phenomenon over age or time and provides a way to examine specific developmental patterns over time, their interrelationship and associated predictors (Nagin, 2005).

Aims of the current study

Recent studies have demonstrated that there is a great deal of heterogeneity in the development of depressive symptoms or related problems and marijuana use but there is still a limited number of longitudinal studies examining the developmental course of these problems during adolescence and even fewer studies have focused on early adolescence (e.g. Otten, Barker, Maughan, Arseneault, & Engels, 2010; Martino, Ellickson & McCaffrey, 2008; Tucker, Ellickson, Orlando, Martino, & Klein, 2005; Brendgen, Lamarche, Wanner, & Vitaro, 2010; Brendgen, Wanner, Morin, & Vitaro, 2005). Our study aims at addressing some of the gaps in the literature since the developmental patterns of marijuana use and psychological distress and their co-occurrence in early adolescence are still poorly understood.

A review of the existing literature indicates that studies frequently focus on the more severe forms of depressive and substance use problems in middle to late adolescence (e.g. Wittchen et al., 2007; Libby, Orton, Stover, & Riggs, 2005). Hence, the present study also aims at extending our knowledge regarding the nature of the association between a less severe form of substance use and psychological distress in early adolescence. Additionally, to our knowledge, no other studies have concurrently explored the trajectories of marijuana use and psychological distress in a sample of Quebec adolescents. Our research findings will add to

the body of knowledge on the developmental trajectories of these common problems observed in Western societies.

Finally, our research efforts will contribute to better define the typology of marijuana use in early adolescence which can be helpful in the development of effective prevention policies (Thomas, Flight, Richard, & Racine, 2006). The identification of trajectories within a heterogeneous sample of young adolescents may contribute to the uncovering of specific groups who are particularly at risk of developing marijuana use and psychological distress issues and thus informing us on the profile of teens being the most in need of prevention efforts (Ellickson, Martino, & Collins, 2004; Brook, Lee, Brown, Finch, & Brook, 2011).

Research objectives

The current study is designed to achieve these five overarching objectives:

(1) To establish developmental trajectories of marijuana use in early adolescence

(2) To determine if baseline psychological distress is associated with marijuana use trajectories

(3) To establish separate developmental trajectories of psychological distress in early adolescence

(4) To determine if baseline marijuana use is associated with trajectories of psychological distress

(5) To establish joint developmental trajectories of marijuana use and psychological distress

Definition of constructs

Researchers have pointed to the lack of consensus regarding the terminology used in substance use and mood problems research (Colder, Chassin, Lee, & Villalta, 2010; Scheier, 2010). To ensure clarity, terms and constructs relevant to this study will be defined.

Marijuana use

Marijuana is an illicit psychoactive substance with its main active chemical being delta-9-tetrahydrocannabinol, or THC (Cooper & Haney, 2009). It is considered a psychoactive drug because of its effect on brain functioning, behavior, mood and consciousness (Vaccarino, 2007). In the literature, marijuana and cannabis are often used interchangeably. In general, marijuana "use" refers to the usage of this substance without giving rise to health or behavioral problems that might harm users or anyone else (Addiction Prevention Center, 2012). This type of use also refers to adolescents who are experimenting with marijuana or are occasional marijuana users. Marijuana use in this context is often influenced by peers or curiosity and is usually limited to recreational settings (Steinberg, 2009; McMahan, 2009).

Marijuana misuse

This type of use is more severe and often refers to regular use, daily use or chronic marijuana use (Steinberg, 2009). Misuse involves a type of substance use behavior causing physical, psychological, economic, legal, or social harm to users or to people directly or indirectly associated with them (Addiction Prevention Center, 2012). Marijuana abuse and dependence fall under the umbrella of marijuana misuse.

Abuse and dependence

Abuse and dependence refer to the more problematic patterns of substance use and have been defined by formal diagnostic criteria found in nomenclature of psychiatric disorders such as the *Diagnostic and Statistical Manual of Mental Disorders*, (4th ed., text revised or *DSM-IV-TR*). The DSM-IV-TR is commonly used in North America and includes substance abuse and dependence under the broad category of Substance Use Disorders (SUD). Substance abuse and dependence can develop by using different types of psychoactive substances (e.g. alcohol, marijuana, opioid, sedatives, cocaine amphetamines, hallucinogens, inhalants). Abuse is broadly described as a maladaptive pattern of use while dependence is characterized by the continued use of a substance even after experiencing serious substance-related problems. The presence of tolerance and withdrawal symptoms (e.g. anxiety, insomnia, nausea, perspiration, body aches or tremors when substance use is stopped or reduced) are also key components of the substance dependence diagnosis (American Psychiatric Association, 2000).

Negative mood state

Negative mood state refers to the experience of an aversive emotional state (e.g. depression, anxiety, anger) that is momentary and may fluctuate as a result of daily events, situational characteristics, and other factors (Graber, 2004; Kassel, 2010).

Psychological distress

Psychological distress is defined as a nonspecific syndrome that includes dimensions such as depression, anxiety, cognitive problems, irritability (Ilfeld, 1976; Préville, Potvin, &

Boyer, 1995). It is usually conceptualized as a continuous measure fluctuating from the absence of symptoms to high level of distress involving suicidal ideation and high level of impairment (Gold, 1990). Furthermore, psychological and behavioral symptoms associated with psychological distress are not specific to any particular psychiatric disorder as defined by the DSM-IV-TR (Marchand, Demers, Durand, & Simard, 2003; Dohrenwend, Shrout, Egri, & Mendelsohn, 1980). Some authors define the construct of psychological distress even more broadly by describing it as any type of emotional suffering or negative emotional state resulting in an unpleasant feeling (Henry & Crawford, 2005).

Depressive symptomatology

This construct refers to the experience of a constellation of depressive symptoms below the subclinical threshold established by the DSM-IV-TR (Graber, 2004). Some of these symptoms include experiencing feelings of sadness, loss of interest in activities or hobbies once pleasurable, fatigue and decreased energy, feelings of guilt, worthlessness, and/or helplessness, feelings of hopelessness and/or pessimism, difficulty concentrating, remembering details, and making decisions, insomnia or excessive sleeping, irritability, restlessness, overeating or appetite loss, persistent aches or pains, persistent sad, anxious, or "empty" feelings (Steinberg 2009). These symptoms often tend to co-occur (Graber, 2004).

Major Depressive Disorder

This construct as defined by the DSM-IV-TR represents a more severe form of pathology. Major Depressive Disorders (MDD) is characterized by a combination of symptoms that interferes with a person's ability to work, sleep, study, eat, and enjoy once-

pleasurable activities (American Psychiatric Association, 2000). Some people may experience only a single episode of major depression which is characterized by feelings of depression, sadness, or loss of pleasure for a period of 2 weeks or more, but more often a person will experience multiple episodes (National Institute of Mental Health, 2011).

Internalizing problems

The conceptualization of internalizing problems is broadly defined as a combination of symptoms directed inward, involving an internal state of distress or disturbance in emotion or mood (Small et al., 2008; Kreuger & Markon, 2006; Graber, 2004; Kendler, Prescott, Meyers, & Neale, 2003). Internalizing problems often include shyness, withdrawal, anxiety, depression, fear, self-consciousness, self-defeating thoughts and behaviors, and inattention (Graber, 2004). In the literature, depression and anxiety disorders and their subclinical manifestations are considered internalizing problems.

Delimitations of the study

This study focuses exclusively on marijuana use even if alcohol and tobacco are other substances commonly used by teens (Johnston et al., 2012). While there is evidence that the use of these substances are often correlated in adolescence (Adlaf & Paglia-Boak, 2005), there is also evidence that the physiological effects of each substance and the social context in which they are used may differ (American Psychiatric Association, 2000). This means that there are benefits to studying substances separately since the relationship between psychological distress and marijuana use may have unique particularities that would be lost if studied in combination with other substances (Fleming, Mason, Mazza, Abbott, & Catalano,

2008; White et al., 2001; Flory, Lynam, Milich, Leukefeld, & Clayton, 2004). Furthermore, the recent work by Marmorstein, White, Chung, Hipwell, Stouthamer-Loeber, & Loeber (2010a) confirmed that the association between internalizing symptoms is highly influenced by the type of substance used (e.g. marijuana, alcohol or cigarettes) and the type of internalizing symptoms (depressive, generalized anxiety, and social anxiety symptoms and disorders). Considering this evidence, it was decided to only consider marijuana use in our study in order to further explore the validity of the developmental course of this substance as well as the substance-specific association with psychological distress.

Focusing exclusively on marijuana is also needed since few studies have examined the interrelationship with psychological distress as it develops over time. Our study uses the construct of psychological distress which consists of a constellation of symptoms. Unfortunately, the number of studies using psychological distress as conceptualized in the current study is limited. Most research efforts have focused on depression and depressive symptomatology (Otten et al., 2010; Lynne-Landsman et al., 2010) and few studies have concentrated on anxiety problems (Van Oort, Greaves-Lord, Verhulst, Ormel, & Huizink, 2009, Graber, 2004). A factor-analytic study conducted by Lahey et al. (2008) showed that internalizing problems such as depression and anxiety represent separate constructs with unique patterns of comorbidity. Similar conclusion have been reached by Kaplow, Curran, Angold, & Costello, 2001; Marmorstein, White, Loeber, & Stouthamer-Lober, 2010b). Since the experience of depressive feelings is an important component of psychological distress as defined in our study, it was therefore decided to only review studies examining depressive symptomatology and depression to complement our understanding of the co-occurrence between our variables of interest.

Summary

Psychological distress and marijuana use are problems affecting many adolescents and there is some evidence that these difficulties often co-occur. However, the nature of the longitudinal association remains unclear and more efforts need to be dedicated to detangle how these problems develop over time and their interrelationship. A better understanding of these issues is necessary if we are to effectively prevent the development of these problems and create tools and strategies to better equip teens to cope with some of the common challenges of adolescence.

CHAPTER 2

A Review the Literature

Chapter overview

The first section of this chapter will provide an overview of the epidemiology of marijuana use and psychological distress, depressive symptomatology and depression in adolescence. Next, theoretical models of experimental substance use and the hypotheses pertaining to the co-occurrence of marijuana use and psychological distress will be presented followed by a presentation of empirical evidence. This will be followed by a discussion about the use of a developmental framework and a review of studies using trajectory modeling to explore the developmental course of marijuana use and psychological distress. Finally, this chapter will conclude by presenting our research hypotheses.

Epidemiology

Large scale studies and surveys have helped uncover important trends regarding marijuana use and psychological distress during adolescence. Some of these important trends will be presented.

Marijuana use in adolescence

Marijuana is a prominent substance of choice among adolescents and young adults (Johnston et al., 2012). Epidemiological studies conducted in Quebec, Canada and the United States have shown that prevalence rate of marijuana use have fluctuated in the past decades. For example, in Quebec, after reaching a plateau from 2000-2004, adolescents' marijuana use has decreased from 36% in 2004 to reach 27% in 2008 (Cazale, Fournier, & Dubé, 2009). In the United States, SAMHSA's Annual National Surveys on Drug Use and Health (2011) found that past month marijuana use among adolescents (ages 12 to 17) generally decreased from

2002 (8.2%) to 2005 (6.8%), and then remained constant between 2005 and 2007 before increasing to 7.3% in 2009 and 7.4% in 2010. The prevalence rate of marijuana use in early adolescence tends to be lower when compared to middle to late adolescence. The national American survey Monitoring the Future (2012) shows that among eighth graders (approximately age 13–14), 12.5% of teens have used marijuana in the past year (Johnston et al., 2012).

In comparison to other countries, marijuana use among Canadian youth is relatively high (Vega et al., 2002). Prevalence rates for Canadian youth have stabilized in recent years with 17% of students in Grades 7 to 9 reporting marijuana use at some point in their lives (Health Canada, 2006). In Quebec, youth report higher level of marijuana use in the past year compared to the national average with prevalence rate ranging from 7.6% in Grade 7, 18.5% in Grade 8 and 28.9% in Grade 9 (Cazale et al., 2009).

Data on early adolescence show that the average age of first use of marijuana usually occurs at around age 14 (Adlaf & Paglia-Boak, 2005; Boyce, 2004; Hotton & Hence, 2002). Results from a nationally representative sample of Canadian adolescents from grades 7 to 9 demonstrated that the mean age for the first use of marijuana was 12.6 (±1.3) years in 2002 and 12.7 (±1.5) years in 2004 (Leatherdale, Hammond, & Ahmed, 2008).

Research has shown that the gender gap in marijuana use has narrowed considerably over the years but modest differences prevail between boys and girls in their patterns of marijuana use (Johnston et al., 2012). For example, surveys indicate that girls are as likely as boys to drink alcohol, binge drink, get drunk, smoke, and use an illicit drug (Cazale et al., 2009; Boyce, 2004; Adlaf & Paglia-Boak, 2005; Tjepkema, 2004) but adolescent males are

still more likely to use most illicit drugs at a higher frequency than girls (Cazale et al., 2009; Canadian Center for Substance Abuse, 2007).

Another important trend emerging from adolescent substance use data is that marijuana and other licit substances (e.g. alcohol, tobacco) are often used and abused concurrently (Derringer, Krueger, Iacono, & McGue, 2010; Agrawal, Neale, Prescott, & Kendler, 2004; Adlaf & Paglia-Boak, 2005; Leatherdale & Ahmed, 2010, Leatherdale et al., 2008; Choquet, Morin, & Hassler, 2004). The phenomenon of simultaneous polysubstance use is also common in adolescence (Brière, Fallu, Deschenaux, & Janosz, 2011). Overall, survey and study results demonstrate that over the course of adolescence, it is fairly rare among adolescent users to find anyone who uses only one substance exclusively (Canadian Center on Substance Abuse, 2007).

General patterns of marijuana use have been observed during adolescence with most teens initiating with substance use in middle to late adolescence (Gfroerer, Wu, & Penne, 2002) followed by a peak in late adolescence and young adulthood (Schulenberg et al., 2005). However, recent studies also demonstrated that there is considerable heterogeneity in the developmental pathways of marijuana use, with trajectories differentiating themselves from each other based on the age of initiation of use, the highest frequency of use, and the duration of use (Ellickson et al., 2004).

Psychological distress, depressive symptomatology and depression in adolescence

Epidemiological studies have demonstrated that approximately 30% of teens report moderate to severe emotional distress (Rushton, Forcier, & Schectman, 2002) and between 30%-50% of adolescents experience depressed mood (Kessler, Avenevoli, & Merikangas,

2001; Compas, Hinden, & Gerhardt, 1995; Compas, Ey, & Grant, 1993; Petersen et al., 1993). When looking at psychological distress, a large survey conducted in Quebec demonstrated that a substantial proportion of teens in early to middle adolescence experience psychological distress (Breton, Légaré, Goulet, Laverdure, & D'Amours, 2002). Results showed that 22% of adolescents at age 13 and 19% of teens at age 16 reported elevated level of psychological distress.

Studies have shown that the experience of more severe depressive symptoms and depression as defined by the DSM-IV-TR is also observed in adolescence (Sihvola et al., 2007; Steinhausen, Winkler, & Metzke, 2003; Jacobs, Reinecke, Gollana, & Kane, 2008). The 12 months prevalence is estimated at 12.4% for major depression, 7.1% for minor depression (Kessler & Walters, 1998) and between 0.4% to 8.3% for Major Depressive Disorders (MDD) (Birmaher, Ryan, Williamson, Brent, & Kaufman, 1996). The estimates of lifetime prevalence for MDD among adolescents range from 7% to 20% (Kessler, Berglund, Demler, Jin, & Walters, 2005; Birmaher et al., 1996; Lewinsohn & Essau, 2002). Determining the prevalence of depressive problems in adolescence has been challenging since studies often vary in their measure of depressive symptoms (DSM criteria versus continuous measures of depression), age of initial assessment, length of follow-up, analytic techniques and sample characteristics.

Gender differences in the experience of negative mood have been consistently observed in adolescence (Botticello, 2009). It is well established that adolescent girls tend to experience more depressive symptoms and psychological distress than boys (Chen et al., 2011; Angold, Erkanli, Silberg, Eaves & Costello, 2002; Garber et al., 2002; Cyranowski, Frank, Young, & Shear, 2000; Wade, Cairney, & Pevalin, 2002). In a survey conducted in Montreal by Ayotte et al. (2009), it was observed that 23% of adolescent girls in Grade 7 reported high

level of psychological distress compared to 18% of adolescent boys. In Grade 9, the prevalence increased to 30% for girls and decreased to 12% for boys.

There is strong evidence that gender differences in the prevalence of depressive symptoms and depression are in part due to a combination of biological, cognitive and social factors (Natsuaki et al., 2009; Hyde, Mezulis, & Abramson, 2008; Cyranowski et al., 2000). For example, it is well documented that puberty presents social, psychological, and biological challenges to early adolescents which can amplify girls' proneness to depression (Ge, Conger, & Elder, 1996; Mendle, Harden, Brooks-Gunn, & Graber, 2010; Meadows, Brown, & Elder, 2006; Benoit, Lacourse, & Claes, in press). There is also some evidence that adolescent girls experience more psychological distress due to the increased likelihood to engage in rumination (Nolen-Hoeksema, 2000). A ruminative style involves thinking repetitively and passively about the negative emotions elicited by negative events (Hyde et al., 2008). Research has shown that when a rumination style is used to attempt at emotional regulation and coping, it may contribute to developing and maintaining depressed mood (Abela & Sarin, 2002; Nolen-Hoeksema, 2000).

Despite gender differences, the general pattern for adolescents has been described as an increase of depressive symptoms in early and mid-adolescence followed by a decline in late adolescence and early adulthood (Ge, Natsuaki, & Conger, 2006; Nolen-Hoeksema, 2001). Many studies have observed an inverse U-shaped trajectory usually involving an increase in depressive symptoms from ages 12 to 14, reaching its peak between 15 and 16, and then gradually declining thereafter (Adkins, Wang, Dupre, van den Oord, & Elder, 2009; Hankin, 2009; Natsuaki et al., 2009; Ge et al., 2006). Recent studies have confirmed that many adolescents deviate from following this average trajectory identified and suggesting that there

is great deal of heterogeneity in development of depressive symptoms in adolescence (Brendgen et al., 2010; 2005; Dekker et al., 2007; Stoolmiller, Kim, & Capaldi, 2005; Repetto, Caldwell, & Zimmerman, 2004).

Theoretical perspectives on adolescent substance use

Theoretical models have played a crucial role in the development of hypotheses regarding adolescent substance use. Despite prolific research on the topic, there is still the absence of a unified theory or a framework presenting an integrated conceptual model (Scheier, 2010). Ideally, an integrative model of substance use would consider biological, psychological and social factors from different domains (individual, family, school, peers, community) (Scheier, 2010, Petraitis, Flay, & Miller, 1995). An important challenge with the elaboration and testing of such model is that it requires the integration of a multitude of variables and the use of large representative samples of participants followed longitudinally (Glantz, 2010). Considering these significant hurdles, numerous theories have been developed, each emphasizing important influences and factors in the development of experimentation, continued use, escalation and cessation of adolescent substance use. Some theoretical models have also focused their efforts on developing theoretical models to explain why some adolescents do or do not experiment with substances. This is particularly relevant for the current study since substance use is usually initiated in early adolescence. The work of Petraitis et al., (1995) has been instrumental in organizing and synthesising the major theoretical approaches linked to substance use behavior.

Some theories focus on the cognitive and affective processes to explain substance use behavior by exploring the role of adolescents' beliefs about a substance. An important

assumption of this theoretical framework is that the beliefs held by adolescent are contributing to the adolescent's decision to use the substance or not (Ajzen, 1985; Petraitis et al., 1995). More precisely, substance use is explained by the adolescent's perceptions about the costs and benefits of using the substance (Botvin, 2000). For example, if an adolescents has a positive attitude toward substances and expect some benefits (e.g. feeling relaxed, happy), he or she is more likely to use because the perceived benefits outweigh the expected costs (e.g. punishment, legal problems). An adolescent's social normative beliefs (what he or she believes is expected of her regarding substance use behavior), will also influence the decision to use a substance. If the adolescent perceives that others (e.g. friends, family members) want him or her to use a substance, there will be a greater motivation to comply to the perceived expectations of others (Jackson, 1997). In addition to positive attitude and social normative beliefs, an adolescent's beliefs in his or her abilities to obtain and successfully use a substance and in his or her abilities to resist social pressure to begin using substances can be of significant importance leading to the decision to experiment with a substance (Ajzen, 1985; Petraitis et al., 1995).

Social learning processes oriented theories not only consider the beliefs associated with a specific substance but also consider the root causes of those beliefs. Inspired by the work of Bandura's (1986) on social cognitive / learning theory, it examines the role of models like peers and parents who use substances as an important factor in the acquisition of beliefs about substance use and other delinquent behaviors (Bandura, 1986; Petraitis et al., 1995). By observing various models, adolescents will develop outcome expectations linked to using the substance (e.g. social, personal, physiological benefits and consequences). Hearing favorable statements or attitudes regarding substance use by a role model, such as a close friend, can

also contribute to substance use behaviors by shaping adolescents beliefs about the costs and benefits of using the substance (Pandina, Johnson, & White, 2010). Self-efficacy is another component linked to this theoretical framework and is a major determining factor explaining why some teens will use a substance (Scheir, 2010). For example, a teenager who does not believe that he or she can refuse marijuana offers will be more likely to use than a teen with high self-efficacy. This theoretical approach highlights the influence of peers and role models in the development of substance use and the implications of the involvement with substance using peers. However, it does not address why some teens are initially inclined to associate with substance using peers (Petraitis et al., 1995).

Conventional commitment and attachment theories provide some explanations as to why some teens are more prone to associate with deviant peers. This approach explains substance use behavior by considering the emotional attachment to peers who use substance and also consider the lack of conventional bonds to society and institutions as a cause of substance use. The key component of these models is that adolescents who feel uninvolved with, uncommitted to, or alienated from conventional society, school, and religion will not internalize conventional values or standards for conventional behavior (Akers & Lee, 1999). Consequently, these adolescents are more prone to become attached to substance-using peers and also more likely to engage in substance use behaviors. In this model, it is hypothesized that adolescents who are alienated, or rebellious, who feel detached from their families and/or their school are more likely to attach to deviant peers. In the presence of deviant peers, these teens are more likely to observe, imitate, and be socially rewarded and reinforced for engaging in behaviors such as substance use (Andrews & Hops, 2010; Hawkins & Weis, 1985; Petraitis et al., 1995).

The cognitive and affective, social learning processes, conventional commitment and attachment theories highlight the importance of beliefs and attitudes toward substances, and social setting (influence of peers, families and community) in the development of substance use and suggest that adolescents are more at risk of substance use if they have little incentives to commit to conventional values or bond to parents. Even if beliefs and social setting are crucial elements leading to substance use in early adolescence, it does not fully explain substance use behavior since not all adolescents in social setting conducive to substance use will engage in that behavior. Some of these differences have been linked to the personal characteristics of the individual.

Interpersonal characteristics and personality traits theories put emphasis on examining the adolescents' personality characteristics, emotions, and behavioral skills as a cause to substance use. These theories take a closer look at how stress, negative mood, self-esteem, rebelliousness, sensation seeking, social and coping skills, emotional distress and family dynamics are contributing to substance use (Wills & Ainette, 2010; Brook, Brook, Gordon, Whiteman, & Cohen, 1990; Petraitis et al., 1995).

Considering the variables of interest in this study, a theoretical approach focusing on interpersonal characteristics was deemed best suited to adopt in order to explore the co-occurrence of marijuana use and psychological distress. Under this theoretical framework, different hypotheses have emerged to explain the association of these phenomena. The first hypothesis suggests that marijuana often co-occurs with psychological distress because the substance is used to cope with the experience of psychological distress (self-medication hypothesis). The second hypothesis suggests that marijuana use often co-occurs with psychological distress because marijuana use increases the vulnerability to develop

psychological distress through various physiological mechanisms or through the detrimental effects resulting on interpersonal dysfunction leading to emotional distress.

The following section will discuss these hypotheses and review the empirical evidence associated with each model.

The self-medication hypothesis

Research has demonstrated that emotional instability and psychological distress rise with entry into adolescence (Garber et al., 2002; Larson et al., 2002). Some theorists have suggested that the experience of psychological distress is so uncomfortable that individuals are compelled to find ways to cope with these negative feelings (Measelle, Stice, & Springer, 2006). Exploring how individuals deal with the emotional pain associated with psychological distress has been a central component of the self-medication hypothesis (Khantzian, 1985; Kassel, 2010).

Today's understanding of the self-medication hypothesis is that individuals who experience negative emotional states use a substance to alleviate or cope with specific symptoms (Hall & Queener, 2007; Lagoni, Crawford, & Huss, 2011). The self-medication is deeply rooted in the psychoanalytic tradition and initially paid particular attention to the role of pleasure in the development of drug use (Yorke, 1970). Psychodynamic approach to substance abuse has moved beyond the pleasure principle to increasingly focus on drug use as an adaptation to problems and coping difficulties. The emphasis on adaptation has been a key component of the self-medication hypothesis developed by Khantzian (Bell & Khantzian, 1991). According to Khantzian, substance users experience intense emotional distress as intolerable and overwhelming and cannot manage these emotional states on their own.

Substance users need the drug actions (both physiological and psychological effects) to regulate distressful emotions and achieve an emotional stability (Khantzian, 1997). Another important point of the self-medication hypothesis is that people do not randomly use drugs as a result of psychological distress. The drug selected is based upon its ability to alleviate certain psychological states of being, resulting in the individual relying on a "drug of choice". For example, stimulants such as cocaine and amphetamines are used to relieve the pain associated with helplessness and depression. Sedatives, such as alcohol are use to allow for cohesion and connectedness with other people. Depressants, such as marijuana and opiates are use to buffer feelings or rage and aggression (Khantzian, 1999). In sum, the self-medication hypothesis stipulate that substance use is linked to a person's inability to tolerate strong negative affect, which then acts as a primary motivator for using a substance as it helps to modify the negative emotions (Suh, Ruffins, Robins, Albanese, & Khantzian, 2008).

Initially, the self-medication hypothesis was mostly investigated in adult populations with severe psychiatric and substance use disorders. However, Khantzian's later writing advocated against the use of diagnostic categories as measures of affective problems but instead encouraged the use of a wide range of subjective symptoms and states of distress (Khantzian, 2003). This assertion helped to broaden the applicability of the self-medication hypothesis to non-clinical adult populations (Arendt et al., 2007). The self-medication hypothesis has been applied to explain adolescence substance use with most research efforts focusing on alcohol and cigarette use (Tomlisson & Brown, 2012; Audrain-McGovern, Rodriguez, & Kassel, 2009). Self-medication highlights that emotional distress during adolescence is due to transitional changes and maturation and in order to cope, adolescents

may turn to using psychoactive substances to escape or cope with internalizing symptoms such as anxiety and depression (Damphousse & Kaplan, 1998, Johnson & Kaplan, 1990).

A great deal of research has been conducted to explore the validity of the hypothesis to explain the co-occurrence of mental distress and substance use behaviors. Decades of scientific work has provided some evidence that the conceptualization of the self-medication hypothesis often vary from study to study, which often makes it challenging to determine whether the hypothesis is empirically supported or not (Arendt et al., 2007; Henwood & Padgett, 2007). One common way to test the hypothesis is to longitudinally explore the temporal ordering of events and examine whether emotionally distressed or depressed individuals are more at risk of later substance use. The following section will review empirical studies examining the longitudinal association between psychological distress and subsequent marijuana use in adolescence.

Empirical evidence

Several longitudinal studies involving cohorts of children and adolescents have failed to find an association between depression in early to mid-adolescence and later marijuana use. For example, in a large study of African American participants, Miller-Johnson, Lochman, Coie, Terry, and Hyman (1998) found no link between depression in late childhood (Grade 6) and marijuana use in middle adolescence (Grade 10). Similar results were observed in the Ontario Child Health Study, which evaluated the relationship between substance use (tobacco, alcohol, marijuana, hard drugs) and psychiatric disorders in early adolescence and substance use in late adolescence (Boyle et al., 1992). Evidence showed that only conduct disorder in

early adolescence made an independent contribution in predicting the use of marijuana and other hard drugs in late adolescence.

The study conducted by King, Iacono, and McGue (2004) examined the relationships between childhood externalizing and internalizing disorders and substance use in early adolescence. A total of 699 twin females and 665 twin males participated in the study. Externalizing and internalizing disorders were assessed with the DSM III-R at age 11 and substance use at age 14. It was observed that internalizing disorders were not significantly associated with elevated odds of substance use with the exception of major depression, which showed a significant relationship with cigarette and alcohol use at age 14.

Similar results were observed in a large sample of older adolescents who were followed into young adulthood. In a study involving students enrolled in public high school in New York State, Kandel and Davies (1986) failed to find an association between depressive problems in middle adolescence (15 and 16 years old) and marijuana use for both male and female participants at ages 24 and 25. The study conducted by Bardone et al., (1998) involving a sample of 459 female adolescents also showed that adolescents with depression at age 15 were not more likely to experience drug abuse or dependence in young adulthood. Adolescent depression predicted only adult tobacco dependence and more medical problems. Similar findings were observed in the study conducted by Brook, Cohen, and Brook (1998). In this study, logistic regressions were used to determine if there was a longitudinal association between adolescence psychiatric disorders in adolescence and young adult substance use. The authors found no evidence that psychopathology in adolescence was associated with young adult substance use, even when controlling for adolescent substance use.

A longitudinal association between negative affect disorders and substance use has also been difficult to observe in at risk samples of children. For example, Clark, Parker, and Lynch (1999) observed that the children and adolescents of parents with Substance Use Disorders (SUD) were more likely to develop negative affect and antisocial disorders. However, they failed to find that negative affect disorders predicted substance use (alcohol and marijuana) involvement in early adolescence.

Some studies focusing on middle and late adolescence have been able to find some evidence of an association between internalizing problems and substance use. A large representative sample of 1420 children followed from late childhood to late adolescence showed that most psychiatric disorders showed their first symptoms before the onset of substance use (Costello, Erklanli, Ferderman, & Angold, 1999). This observation was confirmed with older adolescents in a study of a birth cohort from Dunedin, New Zealand. The authors, McGee, Williams, Poulton, and Moffitt (2000) found that mental disorders assessed with the Diagnostic Interview Schedule for Children (DISC) at age 15 led to a small but significantly elevated risk of marijuana use at age 18. The recent work by (Hooshmand, Willoughby, & Good, 2012) provides additional evidence in support for the self-medication hypothesis in older adolescents. They observed that higher levels of depressive symptoms in grade 9 resulted in a greater increase in cigarette smoking, marijuana use, and hard drug use across the high school years when compared to adolescents who reported less depressive symptoms.

The recent study conducted by Wittchen et al., (2007), used a representative population sample of German adolescents and young adults to examine the association between cannabis use (CU) / cannabis use disorder (CUD) as defined in the DSM-IV and mental disorders

assessed in participants ages 14-17 over a 10 year period. One of the conclusions of the study was that depressive disorders independently predicted an association with CU/CUD even after controlling for externalizing disorders (e.g. Attention Deficit Hyperactivity Disorder (ADHD), Oppositional Defiant Disorder (ODD), Conduct Disorder (CD)).

When looking at the association between depression and later marijuana use, some differences between depressed boys and non-depressed boys have been observed. For example, in a recent study involving a sample of African American adolescents (ages 15-19), Repetto et al. (2008) observed that depressive symptoms predicted marijuana use only in adolescent males, but marijuana use did not predict depressive symptoms. The association remained even after controlling for previous marijuana use, use of other substances, sex, GPA, and SES.

Lewinsohn, Solomon, Seeley, and Zeiss (2000) examined less severe form of depressive problems as it relates to later problematic substance use. More precisely, the authors examined the relationship between self-reported symptoms of depression in adolescence (mean age of 16.6 years old at baseline) and the development of substance use disorder over a 5-year follow-up period. The data demonstrated that greater level of depressive symptoms were associated with greater risks of developing problematic patterns of substance use.

The earlier work of Hansell & White (1991) is one of the few studies that focused of psychological distress and substance use. In a community sample of adolescents followed at 12, 15 and 18 years old, the authors failed to find that adolescents used drugs (alcohol use, marijuana use, and other drug use) to cope with pre-existing psychological distress and physical problems. However, they found evidence that drug use was associated with

psychological distress and physical symptoms and later adolescence (from ages 15 to 18). The authors concluded that in their sample, there was no evidence of impairment related to drug use or alcohol use in early adolescence (from ages 12 to15).

In sum, there is a lack of consensus regarding self-medication hypothesis as an explanation for the co-occurrence between depressive problems and subsequent marijuana use. The difficulties to reach a strong conclusion regarding the nature of the association are due in part to factors such as differences in sample characteristics (clinical sample versus community sample), the gender and age of participants, the sample size, the number of assessment points, length of follow-up and the instruments used to measure substance use, marijuana use and emotional distress. These differences most likely contribute to the contrasting research findings in the literature ranging from the no, to mild and strong association between depressed mood or psychological distress with marijuana use.

Another important issue to consider in the interpretation of these results is that most studies do not consider a variety of factors such as social disadvantage, family dysfunction and peer groups that may antedate psychological distress in adolescence and also appear to be associated with drug use (McArdle & Macleod, 2004; Maughan & McCarthy, 1997; McGee et al., 2000). Despite various strategies to minimize the influence of confounding variables, there are no completely reliable means to identify confounded associations within observational data and this can often lead to misleading conclusions and contradictory findings observed in studies (Smith & Ebrahim, 2002).

Nevertheless, some conclusions can be reached when grouping studies based on the time period covered in adolescence, namely early/middle adolescence versus late adolescence. Most studies focusing on early to middle adolescence have failed to found an association

between depressed mood and marijuana use therefore providing little support for the self-medication hypothesis. The difficulty to find an association during this period of life could be caused in part by the small percentage of teens using marijuana or experiencing severe depressive problems. It also suggests that the use of a substance in response to distress is less likely involved in the initiation process but could be a factor once the experimentation has occurred. Through a reinforcement process, a teen who has experienced a reduction of depressive symptoms following the use of marijuana might be more inclined to use again as a way to self-medicate. Studies focusing on later adolescence / young adulthood have provided more support for the self-medication hypothesis.

Marijuana use as a predictor of psychological distress

The co-occurrence of marijuana and psychological distress has also been explained by the role played by marijuana use on the development of later psychological distress. Before proceeding with a discussion about the negative consequences of marijuana use, it is important to point out that the use of this substance may in fact momentarily decrease psychological distress via the psychopharmacological effect on the users, resulting in a change of mood or affect in the short-term (Cooper & Haney, 2009). Commonly reported positive short-term effects or marijuana use include euphoria, feelings of relaxation, increased social confidence and self-esteem (Damphousse & Kaplan, 1998). Since marijuana experimentation and use often occurs with peers, other positive consequences may involve a feeling of being part of the "in crowds" which in turn can contribute to higher level of self-esteem (McMahan, 2009). Marijuana use may also calm or settle people who are typically uncomfortable in social situations or public settings (Marmorstein et al., 2010b).

Despite some of these positive short-term effects of marijuana use, there is some evidence that marijuana use over time can lead to an increase in psychological distress through neurobiological mechanisms or through the indirect consequences on interpersonal functioning (Bovasso, 2001; Holden & Pakula, 2001; Degenhardt et al., 2003).

Several neurobiological processes are involved in depression and substance (Rao, 2006; 2012). Teenagers may be at greater risk of negative impact of marijuana use due to the rapid changes in their neurobiological systems during this life period. Adolescence is characterized by a developmental shift from producing a large number of neurons to creating efficient neuronal pathways (Luna, 2009). Through the process of synaptic pruning, synapses relevant for survival and optimal functioning flourish while changes in white and grey matter allow for brain refinement (Whitford et al., 2007). There is evidence that the use of marijuana, has the potential to disturb the fine neural refinement that takes place during this time period of development, making adolescence a particularly vulnerable period for the impact of marijuana use (Rubino, Zamberletti, & Pardero, 2012; Rubino et al., 2008).

There is also the possibility that marijuana use is indirectly related to emotional distress through the consequences of psychological adjustment. Some authors have argued that drug use during adolescence significantly interfered with the ability to successfully deal with the demands and responsibilities of their interpersonal relationships, particularly in the domains of romantic, peer, and family relations (Bentler & Newcomb, 1988).A consequence of these difficulties has been the experience of internal distress (LaGreca & Harrison, 2005; Rudolph, 2002; Sheeber, Hops, Alpert, Davis, & Andrews, 1997). To further support this hypothesis, many studies have examined the implications of impaired social functioning as adolescent transition into adulthood. There is evidence that the early marijuana use is related

to several aspects of later impaired functioning such as lowered educational and occupational expectations, workforce failure (occupational termination and collecting welfare), and lowered conformity to societal rules and norms (Brook, Adams, Balka, & Johnson, 2002). Despite evidence of such association, these results might be also the result of different background characteristics (observed or non-observed) associated with substance use and poor interpersonal functioning. Nevertheless, a recent study conducted by Stuart & Green (2009) used using propensity score matching, a statistical approach which allows to control for a wide range of background characteristics linked to adolescent drug use (e.g. aggression, history of family substance use), found that heavy marijuana users in adolescence had lower educational attainment when compared to participants who were light users or who did not use marijuana when they were adolescents. Females who were heavy users were also at greater risk of experiencing poverty and unemployment. The experience of difficulties and negative outcomes could predispose some individuals to experience internal distress.

The next section will provide a review of empirical evidence examining these hypotheses suggested to explain the association between these phenomena.

Empirical evidence

Many studies examining the longitudinal association between marijuana use and later psychological distress have provided mixed results. For example, the earliest work by Kandel, Davies, Karus, and Yamaguchi (1986) failed to found that marijuana use at ages 15–16 years was associated with depressive symptoms at ages 24–25 years. Arseneault et al., (2002) reached similar conclusions in their study by showing that marijuana use at age 15 was not associated with depressive symptoms at age 26. A large cohort study conducted by Harder et

al., (2008) used propensity score matching and failed to find evidence of causality between adolescent marijuana problems and young adult depression even when using a combined or a separate sample for males and females. Finally, the recent work of Pederson (2008) involving a large population-based sample of Norwegians adolescents (*N*=2033) followed from early adolescence to their late twenties also failed to observe any negative emotional consequences related to marijuana use in adolescence. The author points out that the inability to find an association might due to low statistical power caused by the low prevalence rate of marijuana use in the sample.

The pioneer work conducted by Fergusson and Horwood (1997) explored the association between marijuana use and psychological distress while considering common factors that could potentially explain the association between the two phenomenon. Common factors included were low socio-economic status, other drug use, personality and involvement with drug-using peers. The authors found that adjusting for antecedents linked to early marijuana use reduced to non significance the effects of marijuana use on later psychosocial adjustment, suggesting that the effects of adolescent marijuana use on adolescent psychosocial adjustment are simply a reflection of a combination of common risk factors for both marijuana use and psychosocial adjustment.

Nevertheless, a number of studies have provided some support for the association between marijuana use and later depressive problems. For example, Brook, Brook, Zhang, Cohen, and Whiteman (2002) used a community based sample to investigate the association between early drug use in childhood, adolescence and early 20s and the development of psychiatric disorder in the late 20s. They observed that early alcohol use, marijuana use and other illicit drug use significantly predicted later major depressive disorder, alcohol

dependence, and substance use disorders in the late 20s, even after controlling for age, sex, parental education level, family income, and prior episodes of major depressive disorder and substance use disorders.

In the longitudinal study conducted in New Zealand involving 1265 children, Fergusson et al. (2002) assessed participants annually from ages 14 to 21 regarding substance use behavior and related health outcomes. The authors found that regular use of marijuana was associated with the increased risk of problems such as depression. The risk of developing depressive problems was more pronounced for younger users (ages 14-15). The strength of the association was significantly reduced but remained significant after controlling for confounding variables such as adverse life events, deviant peer affiliation, alcohol abuse or dependence.

Similarly, in a study using a seven wave cohort study over six year period, Patton et al. (2002) used logistic regressions to examine if depression and anxiety in young adults could be predicted by marijuana use in adolescence. Study results showed that females who reported daily usage in adolescence had over four fold higher odds of later depression in young adulthood compared to non-users even after adjusting for potential confounding variables such as concurrent use of alcohol, tobacco, and other illicit substances and family disadvantage. The association linking depression and anxiety and later marijuana use was also explored and results showed that depression and anxiety in adolescence did not predict later weekly nor daily cannabis use in young adulthood.

The recent research findings from a large Australian population-based cohort study conducted by Hayatbakhsh et al. (2007) confirmed previous results showing that adolescents who used marijuana use before age 15 and continued to use the substance frequently at age 21,

were more likely to report symptoms of anxiety and depression at the age of 21. Similarly, in their study using the data from the from the Ontario Child Health Study (OCHS), Georgiades and Boyle (2007) also observed some association between marijuana use during adolescence, continued use in adulthood, lower levels of life satisfaction and an increased risk for major depressive disorders in adulthood.

Consistent with previous research findings, the study conducted by Trim, Meehan, King, and Chassin (2006) with a high risk sample (children of alcoholic parents) found that substance use at age 13 combined with an increase in use throughout adolescence predicted higher levels of internalizing symptoms in early adulthood (ages 18 to 22), even after considering concurrent substance use and developmental risk factors for both internalizing symptoms and adolescent substance use (parental depression, adolescent externalizing and externalizing symptoms).

Despite some difficulties to compare studies to each other due similar issues mentioned previously, the evidence reviewed suggests that there is some association between marijuana use and later psychological distress, especially among early onset users, regular and heavy users. Adolescents who continue to use throughout adolescence and into adulthood also appear at greater risk of experiencing depressive problems. Several mechanisms have been suggested to explain why heavier marijuana users are at greater risk of experience psychological distress. First, frequent marijuana users represent a subgroup of individuals who are socially marginalized and the isolation could result in greater risk for depressive problems (Pederson, 2009). Secondly, heavy marijuana users are more at risk of experiencing negative outcome such as academic difficulties and education failure, dropping out of school, unemployment (Lynskey, Coffey, Degenhardt, Carlin, & Patton, 2003; Fergusson, Horwood, & Beautrais,

2003), which in turns increases the risk of experiencing emotional distress. Finally, the direct and indirect pharmacological of marijuana use on the brain and on a range of brain functions may also lead to depressive problems (Squeglia, Jacobus, & Taoert, 2009).

Finally, few longitudinal studies have simultaneously examined whether patterns of marijuana use predicted depressive problems or vice versa. Using multivariate logistic regression analyses, Hallfors et al. (2005) have found that substance use predicted an increase in depression, but depression did not predict an increase substance use. These results provide evidence that substance use contributes to depression but provide little support for substance use behaviors due to self-medication motivation. Similar results were observed in the study conducted by Patton et al. (2002), where it was found that marijuana use was associated with later depression and anxiety but the reveres association was not observed. Finally, in a large school based study, Needham (2007) observed that adolescents who reported higher initial level of depressive problems also had substantially higher levels of substance use (smoking, heavy drinking and illicit drug use) than their better-adjusted peers, but they were less vulnerable to increases in smoking (girls only), binge drinking (girls and boys), and illicit drug use (girls only) across the transition to young adulthood. Also, it was observed that adolescents who initially had higher than average cigarette, alcohol, and illicit drug use, experienced a faster rate of decline in symptoms of depression over time compared to those who initially reported lower levels of substance use.

Given the often contradictory evidence presented in studies previously reviewed, continued efforts to further explore the nature of the co-occurrence between marijuana use and depressive problems are warranted. Since the emergence of the self-medication hypothesis, the idea that people use and abuse drugs in order to self-medicate their distress has become

commonplace and has been an intuitively appealing explanation for the association between marijuana and psychological distress (Kassel et al., 2010; Hendwood & Padgett, 2007). However, the overall findings regarding the association between depressed mood and subsequent marijuana use in early adolescence is weak and is inconsistent at best in middle adolescence and young adulthood. This suggests that the association may well depend upon the stage of the individuals' development at which use occurs and the severity of the problems with more severe forms of depressive problems increasing the risk for later marijuana use in adolescence or young adulthood.

Studies focusing on marijuana use and later psychological distress have also shown some inconsistencies but overall, there is more robust evidence that frequent and heavy marijuana use in adolescence may not be without risk of later mental health problems, such as depression. However, the association is less clear for less severe forms of depressive problems and for psychological distress. It is notable that the association between marijuana use and depression are still present, albeit substantially weaker, even after controlling for potential confounding factors such as externalizing problems (Colder et al., 2010).

The evidence presented so far does not fully explain the association observed between marijuana use and psychological distress. Another possible explanation for this association is that factors that may increase the risk of developing depression may also increase the risk of developing a substance use. Hence, the presence of these factors could explain the co-occurrence of these problems in adolescence. The “common factor model” or “common liability model” attempts to explain this association by suggesting that co-occurring problems may be different expressions of an underlying risk factor (e.g., difficulty with emotion regulation) and shared comorbid condition (e.g., conduct disorder, delinquency) (Marmorstein,

Iacono, & Malone, 2010). There are different candidates for a common factor including aggression, conduct problems, delinquent behavior, poor familial relations, family conflict, and parental history of substance use and mental health problems. For example, studies have observed an interrelationship between depression, substance use, and delinquency (Vaske & Gehring, 2010; Wiesner & Kim, 2006). It has been well established that the co-occurrence of delinquent behavior (or conduct problems) and depressive symptoms is a common phenomenon in adolescence (Wiesner & Kim, 2006; Angold, Costello, & Erkanli, 1999; Capaldi, 1992; Capaldi & Stoolmiller, 1999). More precisely, some studies have demonstrated that changes in depressive symptoms were linked to changes in conduct problems over time (Ge, Best, Conger, & Simons, 1996; Lahey, Loeber, Burke, Rathouz, & McBurnett, 2002) while other studies have found that conduct disorder predicted increases in depressive symptoms among adolescent boys and girls (Hops, Lewinsohn, Andrews, & Roberts, 1990). Conversely, numerous studies have provided evidence for the strong link between substance use and delinquency among adolescents (Barnes, Welte, & Hoffman, 2002; Bui, Ellickson, & Bell, 2000; Helstrom, Bryan, Hutchison, Riggs, & Blechman, 2004; Lipsey & Derzon, 1998; Loeber, Stouthamer-Loeber, & White, 1999; Mason, Hitchings, McMahon, & Spoth, 2007). Some authors have observed that marijuana use predicted delinquency, but delinquency did not predict marijuana use (Ford, 2005). Others have observed delinquency in middle and high school students predicted the initiation of marijuana use and the progression to regular use (van den Bree & Pickworth, 2005). In older adolescents, more frequent delinquent behaviors in the grade 10 were associated with greater problem drug use at grade 12, but drug use problems in the grade 10 was not associated with delinquent behavior in the grade 12 (Bui et al., 2000). The strong correlation between marijuana use and delinquency has been explained

by some as the natural tendency for risk behaviors, such as drug use and delinquency to cluster together (Jessor, 1991; van den Bree & Pickworth, 2005; White, 1990). Furthermore, delinquency provides both a context and peer group which are conducive to involvement with substance use (van den Bree & Pickworth, 2005; White & Gorman, 2000; Patterson, 1996). The strong correlation between these behaviors makes it challenging to evaluate the unique contribution of delinquency and marijuana use and its association with psychological distress. Although research supports links between delinquency and substance use among teens, questions remain about whether and to what extent broader psychosocial functioning (e.g depression) mediates these associations.

Recent studies suggest that self-control is potentially important factor that may also explain co-occurrence observed between marijuana use and depressive symptoms (Otten et al., 2010). The lack of self-regulatory control has been found to increase engagement in risk-taking (Magar, Phillips, & Hosie, 2008). In particular, individuals who show lower levels of self-control have been found to be more delinquent (De Kemp et al., 2009) and to be more at-risk to use alcohol, tobacco, and cannabis (Wills, Ainette, Stoolmiller, Gibbons & Shinar, 2008; Wills & Stoolmiller, 2002) as well as emotional problems including low self-esteem (Finkenauer et al., 2005) and depression (Kaslow, Rehm, Pollack, & Siegel, 1988).

In sum, it is very likely that marijuana use and psychological distress may share common etiological factors. This would explain the co-occurrence of these problems in adolescence but even the consideration of common factors seems to provide only part of the explanation (Rao, 2006). Common factors models are often presented as an alternative to the self-medication hypothesis and hypotheses of marijuana leading to internal distress. However,

since each of these frameworks has some received empirical support, and it is likely that all may be operating to some extent.

Longitudinal co-occurrence of marijuana use and psychological distress

Recent speculation has gone beyond the traditional hypotheses to include the possibility of a changing relationship between marijuana use and psychological distress over time (McLeod et al., 2004). Although the line of research reviewed previously has provided important insights into the patterns of temporal association between the two problems, most studies have not addressed the questions about the linkage in developmental progression or courses of co-occurring problems over time (Wiesner & Kim, 2006). To our knowledge, only a few studies have sought to map out the developmental course of co-occurring depressive symptoms and substance use over time. The study conducted by Otten et al., (2010) examined the concurrent development of marijuana use and depressive symptoms from early to middle adolescence using a semi-parametric group model. In a sample of 428 Dutch teens ages 12-16, the authors established two trajectories of marijuana use with a majority of adolescents following a trajectory of no or minimal level of use and a smaller group of adolescents following a trajectory of high / increasing levels of marijuana use. When looking at depressive symptoms, most teens followed a trajectory of medium level of depressive symptoms, approximately 25% of participants followed a trajectory of high level of depressive symptoms and another 25% followed a trajectory of low level of depressive symptoms. The authors then established joint development trajectories of marijuana use and depressive symptoms. The joint trajectories analysis allowed to examine the likelihood of following a specific trajectory of depressive symptoms conditional on following a marijuana use trajectory and vice-versa.

The authors concluded that there was significant overlap between marijuana use and depressive symptoms as these phenomena evolve over time in early to middle adolescence. This study provides further evidence that marijuana use and depressive symptoms are developmentally intertwined in early adolescence but more studies are needed to replicate and confirm these research findings.

It is possible that the mixed results often observed regarding the association between marijuana use and psychological distress is attributable, in part, to the presence of subgroup of adolescents with different developmental trajectories of marijuana use and depressive symptoms. The use of more sophisticated statistical modeling techniques has helped to reshape data analysis and improve our ability to appreciate the role of developmental change and heterogeneity (Scheier, 2010). The application of group modeling analysis in recent years has also helped further our understanding of the complexity of drug use and emotional distress.

Developmental framework to study change during adolescence

Using a developmental framework to study marijuana use and psychological distress can be useful to explore the processes linked to the co-occurrence of these problems and examine why some adolescents are more at risk than others to develop substance use and mental health problems (Cicchetti & Luthar, 1999). Recent research has helped confirm that the average development trajectories are of limited usefulness to explain the developmental changes of all adolescents since not all adolescents follow the same pathways (Adkins et al., 2009; Ellickson et al., 2004). The use of a person-centered approach in research has been useful and allowed to classify individuals according to their specific profile of multiple behaviors/characteristics (Laursen & Hoff, 2006; Bergman & Magnusson, 1997). The focus of

a person-centered approach is to identify pathways of relatively homogeneous subgroups who share particular attributes or relations among attributes (Magnusson & Stattin, 1998). Consequently, a person-centered approach is best suited to address questions that concern group differences in patterns of development and to identify vulnerable typologies associated with marijuana use, psychological distress and the co-occurrence of these problems. Person-centered analyses take several forms, although all have in common (1) a rejection of the assumption that the entire population is homogeneous with respect to how variables influence each other and (2) a search for categories of individuals characterized by patterns of association among variables that are similar within groups and different between groups (Parra, DuBois, & Sher, 2006). By using such approach, it is possible to examine which individuals are most likely to change over time, identify factors that differentiate the subgroups of individuals (Juon, Fothergil, Green, Doherty, & Ensminger, 2011) and to better understand the common and uncommon pathways associated with a variety of behaviors in adolescence, such as marijuana use and psychological distress (Cicchetti & Rogosch, 1996).

In the literature, variable-centered approaches have been contrasted with person-centered approaches (Schulenberg, Wadsworth, O'Malley, Bachman, & Johnston, 1996). Variable-centered approaches focus on average patterns of inter-individual change rather than more person-specific patterns of intra-individual change (Schulenberg et al., 1996). This approach is well suited for addressing questions that concern the relative contributions of predictor variables to a particular outcome. It is also an appropriate approach for the study of normative developmental change in homogeneous populations insofar as trajectories of growth are similarly experienced by all (Bates, 2006). Considering the heterogeneity observed in

adolescent substance use and emotional distress, a person-centered approach was deemed more appropriate to answer the research questions presented in this study.

A number of studies have examined the developmental nature of marijuana use and depressive problems by using such person-centered approach. A semi-parametric group-based mixture modeling approach (SPGM) or latent growth mixture modeling approach (LGMM) both enable mixture modeling of unobserved heterogeneity in a sample where subjects are numbers of different subpopulations, or trajectory groups, that are inferred from the observed data (Nagin, 1999; 2005). The advantages associated with using this approach include the ability to uncover time periods during which specific groups are particularly vulnerable to onset and escalation of use and pinpoint subgroups in need of more intense intervention programs because they are at especially high risk for experiencing adverse consequences or exhibiting related problem behaviors (Rapkin & Dumont, 2000). Furthermore, identifying trajectory groups enhances our ability to predict subgroup behavior.

The following section will describe empirical findings regarding the developmental trajectories of marijuana use and psychological distress.

Developmental trajectories of marijuana use

Studies examining substance use from early adolescence to early adulthood have demonstrated that there is considerable heterogeneity in the developmental trajectories of marijuana use. Early work conducted by Guo, et al. (2002), identified four distinct trajectories of marijuana use in a sample of adolescents ages 13 to 18: *early highs, escalators, late on-setters, and nonusers*. Similar trajectories have been observed in the work of Flory et al. (2004) in a sample of 481 adolescents ages 11 to 22. The authors identified a group of

adolescents who initiated with marijuana before ages 11–12 (early onset), a second group who initiated with marijuana by ages 14–15 (late onset) and a third group who never used marijuana (nonusers). Trajectories identified for males and females had similar shapes but the levels of both alcohol and marijuana use were higher for adolescent males. The results showed that the nonusers trajectory reported less occurrence of internalizing problems, antisocial personality disorders, substance use and dependence symptoms in young adulthood (ages 20-22) when compared to the other two trajectories. The authors concluded that non-users were better adjusted and less dysfunctional than other trajectory groups identified in the study.

Some studies have observed 3 to 4 trajectories depending on the ethnicity of the participants. Brown, Flory, Lynam, Leukefeld, and Clayton (2004) examined differences in the developmental trajectories of marijuana use between Caucasian and African American adolescents. For Caucasian teens, groups of *nonuser*, *early onset*, and *late onset* were identified. For African Americans teens, groups of *early onset*, *mid onset*, and *late onset* group were also identified but a group of nonuser group was not observed. They found that adolescents who began using marijuana around Grade 8 had significantly higher incidence of past year marijuana use and more arrests at age 20 than either the adolescents in the early onset (Grade 6) or the late onset groups.

A greater number of trajectory groups have been identified in the study conducted by Ellickson et al. (2004). In their large sample (*N*=5,833) of adolescents ages 13 to 23, five trajectories were identified: *early high users*, who decreased from a relatively high level of use at age 13 to a more moderate level, *stable light users*, who maintained a low level of use, *steady increasers*, who consistently increased their use, *occasional light users*, who began using at age 14 and used at a low level thereafter and *abstainers,* who never used marijuana.

Similar to the conclusions of previous studies, the authors observed that non-problematic marijuana use trajectories were associated with better life outcome at age 23.

Windle and Wiesner (2004) also identified 5 trajectories in a sample of older teens from Grade 10 to Grade 12. The trajectory groups identified were labelled *abstainers, experimental users, decreasers, increasers,* and *high chronics*. Results showed that the more problematic trajectories were associated with behavioral and psychological issues. For example, the *high chronics* had the highest levels of delinquency, the most stressful life events, the lowest GPA, and more drug using friends while *increasers* had highest levels of depressive symptoms at base line.

When looking at multiple substance use such as smoking, binge drinking and marijuana use from early adolescence (age 13) to emerging adulthood (age 23), Tucker et al. (2005) found 5 trajectories of marijuana use including: *abstainers, early high users, steady increasers, stable light users* and *occasional light users*. Similar to other studies, the authors found that abstainers tended to have the best outcomes at age 23 in terms of drug selling, predatory violence, physical health, and substance use problems when compared to other groups.

Recent research has focused on extending the follow-up period of studies in order to cover adolescence and adulthood. For example, in a sample of African-American and Puerto Rican participants followed from ages 14 to 29, Brook et al. (2011) identified four trajectories including *Non-low-users, Late-onset users, Maturing-out users*, and *Chronic users*. Results showed that the maturing-out, late-onset, and chronic marijuana-users had greater adverse life-course outcomes (externalizing and internalizing behaviors) than nonusers and low-users trajectory groups. Subsequent work by Brook, Zhang, and Brook

(2011), studied the association between developmental trajectories of marijuana use extending from adolescence to age 32 and later antisocial behavior at age 37. Five distinct trajectories of marijuana use were identified: *never-users, quitters/decreasers, occasional users, chronic users*, and *increasing users*. Being either a chronic user or an increasing marijuana user was associated with an increase in the risk of exhibiting antisocial behavior in adulthood even after controlling for earlier delinquency.

Finally, Juon, et al. (2011) examined the developmental trajectories of marijuana use among a cohort of urban African-Americans followed from the 1st grade to mid-adulthood (age 32). They identified four trajectory groups that were similar for men and women: *abstainers, adolescent only users, early adulthood decliners,* and *persistent users*. They identified a fifth trajectory group (*late starters*), involving male users who initiated with marijuana after age 20. Problematic marijuana use was associated with being more likely to have a substance use disorder, being incarcerated, never been marry, and have high levels of depression.

Despite some difficulties to integrate research findings due to differences in sample characteristics, age ranges, length of follow-up and measures, common marijuana use trajectories have been identified across studies (Tucker et al., 2005). These groups include the nonuser or stable low-user, early onset persistent or chronic high-user, decreasers or maturing-out user, and increasing user (Jackson, Sher, & Schulenberg, 2008). Most studies have concluded that problematic trajectories (chronic users, increasers) of marijuana use are associated with poorer life outcome, life satisfaction, mental health problems in young adulthood and adulthood when compared nonuser/occasional users trajectories. For example, chronic marijuana use have been associated with increased likelihood of lowered life

satisfaction (Ellickson et al., 2004), antisocial personality disorders, arrests (Flory et al., 2004), and aggression (Tucker et al., 2005). Trajectories involving late-onset marijuana use are also associated with poorer outcomes (Brook et al., 2011; Juon et al., 2011).

Developmental trajectories of depressive problems

Less research has been conducted on the developmental trajectories of internalizing problems in adolescence but the result to date show that there is also a great deal of heterogeneity in the developmental course of depression and depressive symptoms. Some studies have identified trajectories of internalizing symptoms (e.g. Toumbourou, Williams, Letcher, Sanson, & Smart, 2011), others have looked at depressive symptoms (e.g. Brendgen et al., 2010; 2005; Dekker et al., 2007), and to our knowledge no studies have specifically looked at the developmental trajectories of psychological distress in early adolescence.

Empirical evidence

Three studies have focused on developmental trajectories of depressive symptoms in early adolescence. In a study using a small sample (*N*=201) of Quebec adolescent boys and girls ages 11 to 13, Brendgen et al. (2010) identified three distinct profiles of depressed mood trajectories. The first trajectory demonstrated a consistently low level of depressed mood over time and consisted of almost 75% of the sample. The second trajectory showed a stable high depressed mood almost reaching clinical levels and included 10% of the sample. The last trajectory showed a low depressed mood group in Grade 5 followed by an increase in subsequent years of the study and represented 15% of the sample. Gender differences emerged between trajectories with girls being more likely than boys to follow a consistently

high depressed mood trajectory. They also observed that adolescents in the high trajectory group were more likely to be characterized by low self-esteem and high levels of family adversity.

In a former study also focusing on depressive symptoms, Brendgen et al. (2005) identified four subgroups in a sample of adolescent boys and girls ages 11 to 14. The four trajectory groups included *Stable Low, Stable Moderate, Increasing* with level of depressed mood at age 11 resembling that of the stable low group but sharply increasing until it approached the clinical range in subsequent years of the study, and *Stable High* with an elevated level of depression already experienced in late childhood.

Using a community sample of girls, Marmorstein et al. (2010a), explored adolescent girls' initial use of alcohol, cigarettes, and marijuana and its associated changes in depressive, generalized anxiety, and social anxiety symptoms. The girls were assessed at ages 5 to 8 and followed for 6 years. The authors identified a four-trajectory group model for depressive symptoms including a *stable low, stable high, increasing* and *decreasing* depressive symptoms trajectories. They observed that initial use of marijuana was related to increases in depressive symptoms among girls already experiencing high levels of depressive symptoms at baseline.

A few studies have focused on the developmental trajectories in late adolescence. In their study, Rodriguez, Moss, and Audrain-McGovern (2005) explored the association between depressive symptoms and smoking behavior in a sample of 925 of high school students (Grade 9 to 12). Three developmental trajectories of depressive symptoms were identified: *high, medium, and low*. They found that being female was a risk factor for higher depressive symptoms when considering smoking behavior (cigarettes). The study conducted by Repetto et al. (2004) is one of the few study exploring race and ethnicity specific

trajectories of depression in a sample of at-risk African-American youth. In a sample of 579 teens followed for three years from Grade 9 to 12, the authors found a total of four trajectories of depressive symptoms. Similar to the study conducted by Rodriguez et al. (2005), the authors found a trajectory of *consistently high* (15.9%) and *consistently low* (21.1%) depressive symptoms but failed to find a trajectory of medium depressive symptoms. Instead, they found a trajectory of *decreasing* symptoms (41.8%) and a trajectory of *increasing* symptoms (21.2%). When comparing trajectories to each other, it was observed that adolescents who presented consistently high levels of depressive symptoms were more likely to be female, reported more anxiety symptoms, had lower self-esteem, experienced higher level of stress, and had lower grade point average (GPA) compared with adolescent members of the other trajectories.

Some studies have followed adolescents from early adolescence to young adulthood. Stoolmiller et al. (2005) examined the course of depressive symptoms in a small sample of adolescent males from high crime areas (N=206) for a 10-year period, from ages 14–15 years to ages 23–24 years. Four trajectories were identified: *very-low*, *moderate-decreasing*, *high-decreasing* and *high-persistent* groups. The authors also found that the high-persistent group were different from the other three groups when considering parental transitions, childhood academic achievement problems, parents' depressive symptoms, and negative life events.

Similar results were reported in the study conducted by Costello, Swendsen, Rose, and Dierker (2008) where participants were followed from ages 12 to 25. Four distinct trajectory groups were identified: *no depressed mood, stable low depressed mood* trajectory, *early high declining depressed* and *late escalating depressed mood.* This study has a longer follow up than the studies mentioned previously which allowed to observe a small group of teens

showing high levels of depressed mood in late childhood (10%) and another smaller group characterized by a sharp increase from early to mid-adolescence (3%).

Gender differences associated with the developmental trajectories of depressive symptoms were explicitly explored in the study conducted by Dekker et al. (2007). In a large Dutch community-based sample, six trajectories of depressive symptoms were identified from ages 4 to 18 including: *low decreasing, very low increasing, low stable, moderate stable, adolescent onset increasing high,* and *high increasing*. It is important to note that for adolescent girls, the trajectories of *increasing high* and *high increasing* comprised only 10 and 14 participants, respectively out of 1,060 participants. The study results showed that gender differences emerged not only in the level and the shape of trajectories but also in the timing of onset of deviant levels of depressive problems. The authors explain these differences by the particular challenges and stressors faced by adolescent girls and suggest that changes in hormonal balances, relationship with parents and peers, school might make vulnerable adolescent girls (e.g. genetic make-up, comorbid disorders, family history of depression, negative family environment, reactive temperament, negative attributional style) more likely to develop depressive problems when compared to adolescent boys.

A recent study by Toumbourou et al. (2011) established the longitudinal trajectories of internalizing behaviour from early childhood to mid-adolescence (ages 3 to 25) for Australian boys and girls through parent ratings. They found that the number and shape of trajectory groups were broadly similar for males and females, but differed in the proportion of males and females classified within each group. For males, two groups showed stable, low levels of symptoms, one group showed moderate and stable symptoms, and another group showed moderate decreasing symptoms. The remaining two groups were very small, with one showing

increasing symptoms and the other fluctuating high symptoms. For females, there were three trajectory groups with low levels of symptoms, two groups with decreasing symptoms over time and a final group with increasing moderate to moderately high symptoms. They observed some gender differences with more females (16%) found in the increasing internalizing trajectory when compared to males (4%). Furthermore, they observed that a higher proportion of males than females showed relatively stable low levels of internalizing behaviors.

Finally, the study conducted by Picard (2007) using the data from the present study in addition to two cohorts of participants ranging from Grade 7 to Grade 12, examined the association between psychological distress and parental bond in adolescence. For adolescent boys, 5 trajectories were identified: *Low and stable, Medium Stable, Temporarily Decreasing* characterized by an initial high level of distress followed by a decrease from Grade 7 to 9 and an increase to match initial level from Grade 9 to 11, *Temporarily Increasing* characterized by an initial low level of distress followed by an increase from Grade 7 to 10 followed by a slight decrease in Grade 11 and *High Chronic* trajectories. For adolescent girls, 4 trajectories were identified including *Low and Stable, Rapid Increasing, Medium Decreasing* and *High Chronic* trajectories.

Overall, the review of the studies examining depressive symptomatology throughout adolescence has allowed to identify common trajectories such consistently low, medium and high depressive symptoms. Other trajectory groups showed consistently moderate, increasing, (Brendgen et al., 2005; Repetto et al., 2004) and decreasing (Repetto et al., 2004; Stoolmiller et al., 2005) depressive symptoms. When looking at psychological distress, consistently low, medium and high, increasing and decreasing trajectories have been observed as well as curvelinear patterns only for adolescent boys (Picard, 2007). Some studies have observed

gender differences with females being more at risk of following a more problematic depressive symptoms trajectories then males (Dekker et al., 2007) while other failed to observed such differences (Tombourou et al., 2011).

Summary

Our literature review clearly indicates that understanding the developing patterns of marijuana use in early adolescence is important even if the experimentation with this substance tends to peak around middle to late adolescence. There is a need for more research exploring substance use behavior during this critical period of life evolves over time.

Our review also provides some evidence that psychological distress is a common experience throughout adolescence but little is known about the developmental course of this problem. Most studies have used some measures of depressive symptoms or symptomatology to chart the development course of distress and few studies have used the construct of psychological distress as defined in the present study. The use of a broader construct which includes symptoms of depressive problems, anxiety, irritability and cognitive problems might results in different number and shapes of trajectories when compared to studies focusing exclusively on different measure of depression, depressive symptoms or negative affect. It might also provide new insight on the development of emotional distress during adolescence.

Finally, few studies have simultaneously examined marijuana use and psychological distress using a group based approach. Hence, many questions remain regarding the developmental course and longitudinal co-occurrence of marijuana use and psychological distress. This provides an incentive to continue to explore these phenomena through a longitudinal study.

Research hypotheses

Our review of the literature helped identified some gaps regarding the developmental course of marijuana use and psychological distress in early adolescence and their co-occurrence as they develop over time. The current study will address some of these issues by achieving the following research objective:

Objective 1. To establish developmental trajectories of marijuana use

Empirical research has demonstrated that there is a heterogeneity in the development of substance use in adolescence (e.g. Brook et al., 2011; Otten et al., 2010; Lansford et al., Bates, 2008; Wanner, Vitaro, Ladouceur, Brendgen, & Tremblay, 2006; Tucker et al., 2005; Brown et al., 2004; Flory et al., 2004; Ellickson et al., 2004; Windle & Wiesner, 2004). Studies covering different developmental time period ranging from early adolescence to adulthood have identified 2 to 6 trajectories of marijuana use depending on the sample characteristics and the number of follow up years.

Developmental trajectories of marijuana use identified in previous studies include Non-Users, Experimenters, Increasers, Rapid Increasers, Decreasers, High Chronics. Since the longitudinal sample used in the current study consists of participant in early through middle adolescence, we expect the majority of our participants to be abstaining from marijuana use or be occasional experimenters with use limited to a few times a year.

We also expect a small number of adolescents to report high frequency of marijuana use. We anticipate that a significant portion of the sample will follow an increasing trajectory group since adolescence is a period of life where experimentation and substance tend to augment with age. Finally, considering the grade level of our participants, we do not expect to

find a trajectory group with relatively high initial level of marijuana use followed by a decline since decrease in use occurs in middle to late adolescence.

Hypothesis 1.1 There will be four trajectories of marijuana use corresponding to the distinctive patterns identified in prior studies

1.1.1 Non-Users – trajectory characterized by a flat slope indicating no use of marijuana over time

1.1.2 Experimenters – trajectory characterized by a flat slope above the non-users, representing stable occasional use of marijuana over time

1.1.3 Increasers – trajectory characterized by a low starting point of marijuana use followed by a steady increase over time

1.1.4 High Chronics – trajectory characterized by stable and high level of marijuana use across the three waves of measure

1.1.5 The majority of our participants will follow a Non-Users or Experimenters developmental trajectories while a small percentage of our participants will report stable and elevated level of marijuana use in early adolescence.

Objective 2. To determine if baseline psychological distress is associated with marijuana use trajectories

Studies focusing on early adolescence have failed to consistently find evidence that depressive problems are associated with marijuana use (King et al., 2004; Miller-Johnson et al., 1998; Hansell & White, 1991). Nevertheless, there is some evidence that psychological distress or depressive symptoms are associated with heavier marijuana use especially in older

adolescents (Wittchen et al., 2007; Degendhardt et al., 2003; Clark et al., 1999). This association between elevated distress and marijuana use have been explained by the self-medication hypothesis. Based on the premises of this hypothesis, we expected that there will be an association between elevated level of distress at baseline and marijuana use trajectories.

Hypothesis 2.1 There will be an association between baseline psychological distress and marijuana use trajectories

2.1.1 Adolescents who report more psychological distress at baseline will be more likely to follow the High Chronics and Increasers marijuana use trajectories

2.1.2 Adolescents who report less psychological distress at baseline will be more likely to follow the Non-Users and Experimenters marijuana use trajectories

Objective 3. To establish separate developmental trajectories of psychological distress in early adolescence

To our knowledge, no other studies have examined the developmental trajectories of psychological distress in early adolescence. Consequently, the current hypotheses are based on studies focusing on depressive symptoms, which represent an important component of the psychological distress as defined in the present study. There is empirical evidence demonstrating the heterogeneity in developmental trajectories of depressive symptoms during adolescence. Overall, 3-4 trajectories of depressive symptoms have been identified depending on the sample characteristics and number of follow-up years (Brendgen et al., 2005, 2010; Costello et al., 2008; Dekker et al., 2007; Stoolmiller et al., 2005 ; Repetto et al., 2004). Some studies have observed trajectories characterized by consistently low, consistently moderate,

consistently high, increasing and decreasing depressive symptoms. We expect to find similar trajectories with the majority of adolescents in our sample following a low psychological distress trajectory.

Hypothesis 3.1 There will be at least four trajectories of psychological distress corresponding to the distinctive patterns identified in prior studies

3.1.1 Stable low level of psychological distress trajectory - characterized by a flat slope below the levels of other trajectories identified in our sample

3.1.2 Stable moderate level of psychological distress trajectory - characterized by a flat slope above the low level of psychological distress identified in our sample

3.1.3 Stable high level of psychological distress trajectory - characterized by a flat slope above the low and medium level of psychological distress identified in our sample

3.1.4 Rapid increasers trajectory - characterized by a sharp increase in psychological distress over time

3.1.5 The majority of adolescents in our sample will follow a low trajectory of psychological distress while a small percentage of teens will follow a high trajectory of psychological distress

Objective 4. To determine if baseline marijuana use is associated with trajectories of psychological distress

Marijuana users have been identified as an at-risk group for impaired emotional functioning (Dorard et al., 2008) and psychosocial and mental health difficulties (Moore et al., 2007; Arseneault et al., 2002; Fergusson et al., 2002). Some studies have found evidence that

marijuana use may increase the risk of depressive symptoms (Bovasso, 2001; Holden & Pakula, 1998; Degenhardt et al., 2003) while others have not found a link between these two phenomena (Harder et al., 2008; Pederson, 2008). Based on the evidence reviewed, we expect to find an association between marijuana use and trajectories of psychological distress.

Hypothesis 4.1 There will be an association between baseline marijuana use and psychological distress trajectories

4.1.1 Adolescents who report marijuana use at baseline will be more likelihood to follow the High and Rapid Increasers psychological distress trajectories

4.1.2 Adolescents who do not report marijuana use at baseline will be associated with lower level of psychological distress

Objective 5. To establish joint developmental trajectories of marijuana use and psychological distress

To our knowledge, no other studies have examined the developmental co-occurrence of marijuana use and psychological distress in early adolescence by conducted a joint trajectory analysis. The study conducted by Otten et al. (2010), used this methodology to explore the interrelation between marijuana and depressive symptomatology. Their results showed that adolescents who follow a low cannabis use are more likely to also follow a medium trajectory of depressive symptoms. They also observed that the likelihood of following the high depressive symptoms trajectory was higher for those following the high cannabis use trajectory. Overall, these findings point to the evidence of co-occurrence and an interrelationship between marijuana use and depressive symptoms. Based on these findings, it

is hypothesized that similar patterns of longitudinal co-occurrence will be observed in our study sample.

Hypothesis 5.1 There will be a longitudinal co-occurrence between marijuana use and psychological distress.

5.1.1 Following a problematic trajectory of marijuana use will increase the likelihood of also following a problematic trajectory of psychological distress

5.1.2 Following a less problematic trajectory of marijuana use will increase the likelihood of also following a less problematic trajectory of psychological distress

5.1.3 Following a more problematic trajectory of psychological distress, will increase the likelihood of also following a problematic trajectory of marijuana use

5.1.4 Following a less problematic trajectory of marijuana use will increase the likelihood of also following a less problematic trajectory of psychological distress

CHAPTER 3

Methodology

Chapter overview

This chapter will begin by providing a description of the study design, the sample, the instruments used to measure the variables of interest and the strategies adopted to handle missing data. This will be followed by a description of the analytical plan to test our study hypotheses.

Study design

This study is part of a larger project called *Parental and Peer Relations and Psychosocial Adjustment during Adolescence: A longitudinal Study*, which investigated various aspects of social and emotional development in adolescence. The data was collected from 1999 to 2001 by the Laboratory for Research on the Psychosocial Development of Adolescents at the University of Montreal under the supervision of Michel Claes, Ph.D. This large scale project was the recipient of a 5 year grant (1999-2003) by the Social Sciences and Humanities Research Council (SSHRC). A total of 1955 participants (male=50.00%) were surveyed over three consecutive years. The age for the entire sample ranged from 11.3 to 20.3 years old. This study used a multi-cohort sequential design, which combines longitudinal and cross-sectional strategies by using adjacent segments of longitudinal data from different age cohorts over an extended period of time (Moerbeek, 2011; Miyazaki & Raudenbush, 2000). At each year of the study (1999, 2000 and 2001), three different cohorts of participants based on their school grade completed the survey concurrently. The first cohort (Grade 7, 8 and 9) included adolescents who were in Grade 7 in 1999 (M= 13.44 years old; SD 0.69). The second cohort (Grade 8, 9 and 10) included adolescents who were in Grade 8 in 1999 (M= 14.5 years old; SD 0.74). The third cohort (Grade 9, 10 and 11) included adolescents who were

in the Grade 9 grade in 1999 (*M*=15.6 years old; *SD* 0.77). Since the focus of this study is on the co-occurrence of marijuana use and psychological distress in early adolescence, only the first cohort was selected to conduct our analyses. Using a single cohort offered many advantages including the ability to study change within individuals and to observe the variations between individuals during a crucial developmental period (Moerbeek, 2011).

Sample description

Our study sample consists of 448 participants (51.4% female) who were in Grade 7 at Wave 1 (*M* = 13.44 years, *SD* = 0.69), in Grade 8 at Wave 2 (*M* = 14.42 years, *SD* = 0.63), and in Grade 9 at Wave 3 (*M* = 15.41 years, *SD* = 0.61). The age of our participants ranged from 11.25 to 18.75 years old. Participants were recruited from two French speaking public high schools located in the Montreal area, Canada. The first high school was located in Lasalle (*n*= 203) and represented 45.3% of the sample. In 2001, this high school enrolled 1538 students from Grade 7 to Grade 11. The student population served by this school is considered low to middle socioeconomic status (SES) with parents' annual mean income estimated at $33, 000. This school is characterized by ethnic diversity with 36% of its students born outside Canada. The Lasalle high school estimates that 30% to 40% of its new students every year have parents born outside Quebec. The second high school included in the study was located in St-Hubert (*n*=245), a suburb near Montreal and represented 54.7% of the sample. In 2001, 2284 students from Grade 7 to Grade 11 were enrolled in the school. In addition to its regular academic stream, this school offers an international curriculum. Parents' annual mean income in 2001 was estimated at $50,500 and the majority of students and their parents were born in Quebec, Canada (Benoit, 2004).

Socioeconomic status

The socioeconomic status of the participants' parents (mother and father) was established by using the Canadian socio-professional scale created by Blishen, Carrol and Moore (1987). This index was developed from a list of 480 occupations in Canada and considers the parents' educational level, their income, and the prestige associated to their occupation. The scale permits a classification in 3 distinct categories: (1) unspecialized workers, blue-collar workers, or occupations requiring few qualifications; (2) intermediate occupations, such as merchants, technicians, white-collar workers; and (3) executives, managers, and professionals. For families with two working parents, the highest category obtained for a parent was used to determine the socioeconomic status of the family. Using this classification, 36.0% of our sample was characterized as low SES, 26.4% as medium SES and 37.6% high SES.

Family structure

In the first year of the study, 60.9% of participants reported that their parents were married or lived together and 39.1% reported that their parents were divorced or separated. Data suggest that for the majority of our study participants, parental divorce or separation occurred in early to middle childhood. On average, the divorce or separation occurred 7.23 years ago (*SD*= 4.04).

The majority of participants reported maintaining contact with both parents despite a divorce or separation. Data indicated that 22.3% of participants did not have contact with one of the divorced parent. When examining the family composition of our participants, 17.4% of

adolescents reported being an only child, 73.4% reported having 1 to 2 siblings and 9.2% reported having 3 or more siblings. Among participants with siblings, 49.9% reported having brother (s) and 50.1% having sister (s).

Ethnicity

The ethnicity of participants was determined by using the parents' country of origin. The majority of participants reported having a parent born in Quebec/Canada (father, 78.7%; mother, 80.3%). The parents of the rest of the sample were born in continents such as Latin America, Europe, North Africa and Asia (father, 21.3%; mother, 19.7%).

Procedures

Participants completed a paper-and-pencil survey in school at each wave of the study from 1999-2001 (Claes, 1996). Each year of the study, participants in every classroom who attended school on that day were met by a team of research assistants. The purpose of the study was explained to participants and they were asked to complete all self-report measures included in the survey. Participants were also informed that the study was voluntary and that their answers were confidential. Interviewers followed clear and strict guidelines regarding the administration of the questionnaire to ensure the consistency among groups of students participating in the study. This research project has also been evaluated and approved by the ethic committee of the University of Montreal. Written consent was also obtained for each student, their parents or legal guardian and respective schools.

Measures

The self-administered questionnaire consisted of questions regarding several aspects of social and emotional development during adolescence. For the purpose of this study, sociodemographic variables for each participant and their families, measures of psychological distress and marijuana use were selected. The questionnaire was administered in French.

Psychological distress

Psychological distress was measured by the Psychological Distress Index of Health Quebec (IDPESQ-14) (Préville, Boyer, Potvin, Perrault, & Légaré, 1992). The IDPESQ-14 is a self-administered questionnaire made up of 14 items examining four distinct factors including depression, anxiety, irritability and cognitive difficulties, without giving a specific psychiatric diagnosis. The French version of the index is based on the *Psychiatric Symptoms Index* developed by Ilfeld (1976). Using a Likert-type scale, the participants were asked if in the past week, they experienced a variety of symptoms such as feeling blue, irritable, restless, discouraged or if they experienced difficulties concentrating or remembering (1 = never, 2 = sometimes, 3 = frequently, 4 = often). Examples of items included ‘‘I was bothered by things that usually don’t bother me…’’, ‘‘I felt tense or under pressure…’’ ‘‘I felt alone… ’’ ‘‘I had lapses of memory…’’. Participants obtained a global score ranging from 14 to 56 on this scale and a higher score indicated higher level of psychological distress. It has been established, that a score above the 80th percentile indicates a high level of psychological distress (Boyer, Préville, Légaré, & Valois, 1993; Ayotte et al., 2009; Breton et al., 2002).

The IDPSQ-14 is a widely used scale with adult populations and has shown solid construct validity for men and women of different age groups and considerable internal

consistency (Cronbach's α = .92) (Préville et al., 1992). The reliability and validity of the instrument were also assessed in an adolescent population in the study conducted by Deschesnes (1998). Study results demonstrated a good internal consistency (α = .83) which remained constant for all participants of both sexes ages 12-18. These results confirmed the index's psychometric attributes previously reported for adult populations. Deschesnes' study also provided evidence that this scale is less discriminant for younger adolescents ages 12-13. Consequently it has been recommended to use a global score of this scale when dealing with younger teens.

Previous analyses conducted by Picard (2007) using the current sample showed strong internal consistency for the psychological distress scale. The Cronbach's alpha coefficient ranged from 0.88 and 0.90 for each year of the study. Results are presented in Table 1.

Table 1. *Cronbach alpha (α) for psychological distress (IDPESQ-14)*

	n	α
Grade 7		
Boys	191	0.88
Girls	199	0.89
Total	390	
Grade 8		
Boys	210	0.90
Girls	237	0.89
Total	447	
Grade 9		
Boys	207	0.89
Girls	228	0.88
Total	435	

Finally, our measure of psychological distress resulted in a variable that was positively skewed at each wave of the study. It was log-transformed in order to meet the assumption of multivariate normality.

Marijuana use

Marijuana use was assessed with a single self-reported item included in the survey section on the use of various licit and illicit substances in the past year. Self-reports are generally accepted as reliable and valid indicators of delinquent behavior and drug use (Winters, Stinchfield, Henly, & Schwartz, 1991; Farrington, Loeber, Stouthamer-Loeber, Van Kammen, & Schmidt, 1996). The question pertinent to marijuana use in the questionnaire asked if "In the last 12 month, did you use marijuana, pot, joints, hashish or cannabis?". Five categories were identified in order to measure the frequency of marijuana use: 1= Never, 2= A few times / year, 3= At least once or twice /month, 4= At least once or twice / week, 5= Everyday. The categorization of frequency of marijuana use in this study is consistent with what has been reported in other studies (Beato-Fernandez, Rodrıguez-Cano, Pelayo-Delgado, & Calaf, 2007; Fergusson & Horwood, 1997).

Missing data

Missing data and attrition are a common challenge in longitudinal research (Merkle, 2011; Jelicic, Phelps, & Lerner, 2010; Baraldi & Enders, 2010) and the problem is often pronounced in studies using self-report instruments (Shrive, Stuart, Quan, & Ghali, 2006).

The data collected did not provide details regarding the rate of initial attrition. Our final sample consisted on 448 participants but the number of students who refused to participate in the study or were absents on the day of the data collection remains unknown. It is possible that students who were absent represent a group of teens who are more likely to experience higher level of psychological distress, use psychoactive substances or engage in deviant behavior.

Of the 448 youth participants, 245 subjects participated at all waves of the survey, 105 participated in any two waves, 89 participated in only one wave and 9 participants did not provide any answers regarding their marijuana use (but provided answers for psychological distress and other measures). Details are provided in Table 2. In total, 78.12% of participants completed the questionnaire in at least two years of the study.

Table 2. *Patterns of missing data (N=448)*

1999		2000		2001	Frequency
X	→	X	→	X	245
X	→	X			68
X		→		X	22
		X	→	X	15
X					85
		X			4
				X	-
-		-		-	9
Total					448

There can be many reasons for missing data in any given longitudinal study. Hence, defining the missing data mechanism within our data set was an important step before proceeding with our various analyses (Jelicic, Phelps, & Lerner, 2010; 2009). A Missing Value Analysis (MVA) using SPSS software was initially conducted to examine the patterns of missing data. A review of the descriptive statistics helped conclude that data are not missing completely at random (MCAR) since missing values were not randomly distributed across all observations. This conclusion was also confirmed by the Little's MCAR test, which is a chi-square test for missing completely at random ($\chi^2 = 102.14$, $df = 60$, $p < 0.001$). The null hypothesis for the

Little's MCAR test is that data are missing completely at random and since the significance value is less than 0.05, it was concluded that the data are not missing completely at random.

Previous work conducted by Picard, Benoit, and Claes (2005) examined the patterns of missing data for the entire study sample (including cohort 1, cohort 2 and cohort 3). It was observed that participants who did not complete the three years of the study were more likely to be older boys, with parents that were separated or divorced with a lower SES. It was also observed that participants with missing data were less likely to have higher level of psychological distress, academic difficulties, engagement in problem behaviors, association with deviant peers and greater use of drugs and alcohol. These findings suggest that the pattern of missingness is related to other measured variables in the analysis model and is therefore predictable. Since the propensity for missing data is correlated with other study-related variables in an analysis, the mechanism of missingness is described as *missing at random* (MAR).

In the present study, trajectory modeling analyses were conducted by using PROC TRAJ which accommodates missing at random data (MAR) and uses maximum likelihood estimation to deal with missing data in forming the trajectories (Haviland, Jone, & Nagin, 2011; Nagin & Odgers, 2010b). Therefore, all participants who contributed at least one data point in the entire sample were used in forming the trajectories.

Analytic Plan

Descriptive analyses were first conducted to examine the prevalence of marijuana use and mean level of psychological distress for the entire sample and separately by gender over

time. This was followed by correlation analyses in order to assess the association among the measured variables of interests. T-tests and chi square analyses were also conducted to examine within and between group similarities and differences for the variables considered in present investigation over three time of measure.

Semi-parametric group based modeling

In order to identify the distinct developmental trajectories of marijuana use and psychological distress, the present study employed a semi-parametric group-based trajectory modeling approach (Nagin, 1999). Developmental trajectories can be determined by using different strategies such as hierarchical modeling (Bryk & Raudenbush, 1992; Goldstein, 1995) and latent growth curve analysis (Willett & Sayer, 1994). Like group-based trajectory modeling these methodological approaches can specify the shape of developmental trajectories as a function of age (Nagin, 1999; Nagin & Tremblay, 1999). However, an important limitation of these methods is that they assume that individuals within the population follow the same general pattern of development. By assuming a continuous distribution of trajectories within the population, these approaches are not well suited for identifying groups that have unique developmental patterns (Nagin, 2005).

In contrast, the group-based approach assumes that a given population is composed of a mixture of distinct subgroups, each defined by a prototypical growth curve (Jones & Nagin, 2007). Because this method allows for cross-group differences in the shape of trajectories, it is especially appropriate for identifying and modeling heterogeneity within a given sample (Nagin, 1999). The literature reviewed in Chapter 2 strongly suggests that marijuana use and psychological distress do not follow a general developmental pattern and therefore, a semi-

parametric group based approach was deemed best suited for examining these phenomena as they change over time. Another significant advantage of group-based trajectory modeling is that it allows for the identification of groups with distinct developmental trajectories without preconceived notions about what constitutes a group (Jones & Nagin, 2007). Unlike other methods requiring that the groups be identified prior to trajectory identification based solely on subjective classification schemes, the group-based modeling uses *posteriori* indices to determine the identification of groups and the precision of group membership (Nagin, 2005).

In the current study, our research questions revolve around the longitudinal co-occurrence of marijuana use and psychological distress. Dual trajectory modeling or joint trajectory modeling is useful to increase our understanding of the developmental interrelationship of two distinct but related outcomes (Nagin & Tremblay, 2001; Jones & Nagin, 2007). The interrelations between the variable of interests are explored through the probability of membership in each identified trajectory group, and conditional probabilities linking membership across the trajectory groups of the two respective behaviors (Jones & Nagin, 2007).

There has been a rapid rise in the application of trajectory based models to better understand the developmental course of a number of different types of behavioral and psychological phenomenon (Nagin & Odgers, 2010a; Nagin & Tremblay, 2005b). With its increased use also emerged some debate regarding the application and interpretation of group-based trajectory modeling. Some articles have centered on this debate (Nagin & Tremblay, 2005a; Sampson & Laub, 2003) and they caution readers when applying these complex methodologies so as not to misinterpret the results obtained. For example, it is important to emphasize that individuals do not actually belong to trajectory groups, the number of groups is

not immutable, and even individuals with a high probability of belonging to a particular group do not necessarily follow that group trajectory exactly (Nagin & Tremblay, 2005a; Nagin & Odgers, 2010b).

Given these features of group-based trajectory modeling, it has been argued that results provided by this type of technique are potentially flawed due to ambiguity in groups and group membership, an inability to accurately predict individual outcomes based on group membership, and a tendency to rely on results of statistical analyses to draw conclusions and inform future analyses as opposed to relying strictly on theory (Sampson & Laub, 2003). Despite these criticisms, utilizing this statistical approach can provide important new information that can then be useful in the revision and refinement of existing theories, provided the analyses are applied and interpreted appropriately (Nagin & Odgers, 2010a). After thoughtful consideration of the advantages and disadvantages of various statistical methods available to explore the developmental course of marijuana use and psychological distress and its co-occurrence, it was concluded that group-based trajectory modeling was a suitable and appropriate method for answering our research questions.

Overview of the statistical model

Group-based trajectory models allow the identification of homogenous clusters of individuals with similar developmental patterns (Nagin, 2005). The group-based trajectory model assumes the population is composed of a mixture of J underlying trajectory groups such that

$$P(Y_i) = \sum_j \pi_j P^j(Y_i),$$

where $P^j(Y_i)$ is the probability of *Yi* given membership in group *j*, and πj is the probability of group *j*. Two key components of the semi-parametric mixture model are the probability of group membership and the posterior group-membership probabilities. The probability of group membership, denoted by $\pi_{j,}$, quantifies the proportion of the population following each trajectory group (Nagin, 2005). π_j is estimate as followed :

$$\pi_j = \frac{e^{\theta_j}}{\sum_{j=1}^{J} e^{\theta_j}}.$$

The posterior group-membership probabilities estimate for every individual represent the probability of belonging to each trajectory groups in the model (Nagin, 2005). The posterior probability that individuals belong to a certain group can be calculated by using the following equation:

$$\grave{P}(j|Y_i) = \frac{P(Y_i|j)\grave{\pi}_j}{\sum_j^i P(Y_i|j)\grave{\pi}_j}$$

Where *Yi* is a vector of individual *i*'s measured behavior at each time period, *t*, and $\grave{P}(j|Y_i)$ is the estimated probability that individual *i* belongs in group *j*, given *Yi*. Because it is impossible to calculate $\grave{P}(j|Y_i)$ from parameter estimate, its value is estimated from $P(Y_i|j)$, which represents the probability that individual's *i* behavior would have been observed given membership in group *j*. Also, $\grave{\pi}_j$ is the estimated proportion of the population in group *j*. Because $P(Y_i|j)$ will inherently be inflated for larger sized groups, these values are weighted by $\grave{\pi}_j$. The mean of $\grave{P}(j|Y_i)$ can provide a useful tool for identifying the optimal model (i.e., >.70) (Nagin, 2005).

Our data was modeled as a censored normal distribution to accommodate the possibility of clustering at the scale. The censored normal model allows the linkage between age and behavior and is established via a latent variable y_{it}^{*j}, that can be thought of as a measure of the potential for engaging in the behavior of interest, such as marijuana use or experiencing psychological distress. Up to a fourth-order polynomial relationship is assumed between y_{it}^{*j} and age:

$$y_{it}^{*j} = \beta_0^j + \beta_1^j Age_{it} + \beta_2^j Age_{it}^2 + \beta_3^j Age_{it}^3 + \beta_4^j Age_{it}^4 + \varepsilon_{it},$$

where ε_{it} is a disturbance assumed to be normally distributed with a zero mean and a constant standard deviation σ (Andruff, Carraro, Thompson, Gaudreau, & Louvet, 2009).

The SAS Trajectory Procedure

The present study utilizes the TRAJ procedure (PROC TRAJ) in SAS which is designed to estimate developmental trajectories using data collected at multiple waves (Jones, Nagin, & Roeder, 2001). The PROC TRAJ software is a model add-on that is designed to run on the SAS platform and was downloaded from the Bobby Jones' PROC TRAJ homepage (http://www.andrew.cmu.edu/user/bjones/).

Model estimation

Overall, the PROC TRAJ procedure empirically tests whether different groups with distinct trajectories exist in the population and provides an empirical basis for determining the number of groups as well as the shapes of the trajectories in the different groups that best fit the analyzed data (Jones & Nagin, 2007). The first step for estimating models in PROC TRAJ

is to determine which distribution (count, binary or psychometric data) is best suited to model trajectories for the measured outcomes. The censored normal distribution is ideal for modeling outcomes based on psychometric scales that have finite ranges of possible scores with clustering occurring at the scale minimum and maximum. The Poisson distribution is ideal for count data in which values are censored at zero, while the binary logit is specified for data with a binary outcome (Jones et al., 2001; Nagin, 1999; Nagin & Tremblay, 1999). The current analysis specified a model based on a censored normal distribution for developmental trajectories of marijuana use and psychological distress.

The next step in the analysis is to identify the best-fitting model by specifying separate models, each with a different number of groups. Within each of these different models (i.e., number of groups specified) the shape of each group's trajectory is identified. This is an iterative process in which the user specifies an order (polynomial) for each group and observes the parameter estimates to identify the best-fitting trajectory shape for each group. The PROC TRAJ procedure allows the user to specify up to third order polynomials for time (Jones et al., 2001). Each group's trajectory can take on a constant or flat shape specified by a zero-order polynomial, a linear trajectory specified as a first degree polynomial, a curvilinear shape specified by an second order polynomial, or a cubic shape specified by a third degree polynomial. To select the optimal number of groups, a set of possible multiple group models were tested. For our marijuana and psychological distress models, we tested whether a two group, three-group, four-group, or five-group model best fit the data. In order to determine the best shape of the trajectories for each group, several models were created allowing each trajectory to vary between zero order polynomial (i.e. intercept) and first degree polynomial

(i.e. linear) models. Given that the outcome variables comprised only three data points, curvilinear and cubic trajectory shapes were not considered.

Once the best-fitting model for each different number of groups specified was identified, the Bayesian Information Criterion (BIC) was used as a basis for selecting the optimal number of trajectory groups. The BIC is a common measure for model selection (Kass & Raftery, 1995) and the equation is presented below.

The equation for calculating the BIC is:

$$\text{BIC} = \log(L) - 0.5*\log(n)*(k)$$

where L is the maximized likelihood for the model, n is the sample size, and k is the number of parameters in the equation. Thus, multiplying by k penalizes models with more parameters (Nagin, 2005). The model with the maximum BIC (i.e., closest to zero) was selected (Nagin, 2005). Although the BIC provides an objective statistical approach to model selection, it is not always useful for selecting the best model and more subjective means of model selection are necessary. It has been pointed out by Nagin (2005) that in the model selection process, a balance is needed between objective approaches that favor parsimony and subjective interpretation that weigh the substantive meaning of the groups identified. Finally, BIC scores can also be converted into a probability that model j is the best model, as indicated by the following equation:

$$p_j = e^{BIC_j - BIC_{max}} / \sum_j e^{BIC_j - BIC_{max}}$$

In this equation, pj = the probability that model j is the best model, $BICj$ = the BIC of model j, and $BICmax$ = the BIC of the model with the maximum BIC score. The best fitting model

should show stronger odds of being the ideal model when compared to competing models, as indicated by its BIC (Nagin, 2005; Andruff et al., 2009).

Diagnostic of assignment accuracy

The PROC TRAJ procedure also provides a metric for evaluating the precision of group membership called the posterior probabilities. These measures can be used to determine the probability that an individual belongs to each group. Hence, the posterior probabilities provide an index of the probability that each individual belongs to each group (Nagin, 1999; 2005). The higher the probability the more confident one can be that an individual's trajectory has been correctly identified. These probabilities are then used to classify individuals into a certain group. A high mean posterior probability for each group is a good indicator that the model specified best fits the data. It has been recommended that the mean of these probabilities fall above .70 (Nagin, 2005).

The odds of correct classification (OCC) is also a diagnostic tool used to assess the model adequacy.

OCC are calculated as follows:

$$OCC_j = \frac{AvePP_j / 1\text{-}AvePP_j}{\pi_j / 1 - \pi_j}$$

According to Nagin (2005), OCC should be > 5:1 for each group for model adequacy.

Predictors of group membership

Multinomial logistic regression analyses were conducted for marijuana use trajectories in order to explore whether psychological distress at baseline predicted membership to

marijuana use trajectories. All trajectories identified were compared to each other while accounting for socio-demographic variables including gender, family structure and ethnicity. Similar analyses were completed to examine differences among psychological distress trajectories based on the level of marijuana use at baseline. Finally, additional analyses were conducted to test for any interactive effect between sociodemographic variables and the independent variables.

Joint trajectory analyses

Following the identification of marijuana use and psychological distress trajectories, a joint trajectory model was estimated. Joint trajectory analyses provide an analytic tool to examine the developmental overlap between two types of distinct but related phenomena (Jones & Nagin, 2007; Barker et al., 2007). Probabilities are used to describe the interrelation between trajectories of marijuana use (j) and psychological distress (k). Therefore, $P(j \mid k)$, $P(k \mid j)$ and $P(j\&k)$ will allow to describe the overlap in developmental course (Nagin, 2005). Key outputs from a joint trajectory analyses include joint probabilities of belonging to trajectories of marijuana use and psychological distress (e.g., the probability of following high chronic marijuana use trajectory and high psychological distress trajectory) and conditional probabilities (e.g., the probability of following a high chronic marijuana use trajectory conditional on following a high psychological distress trajectory and the reverse probability of following a high psychological distress trajectory conditional on following a high chronic marijuana use trajectory) (Nagin, 2005; Nagin & Odgers, 2010b).

CHAPTER 4

Results

Chapter overview

The first section of this chapter will provide a summary of the descriptive analysis conducted in our study. This will be followed by the results of the semi-parametric group modeling analysis for marijuana use and psychological distress. The last section of this chapter will show the results for the joint trajectory analysis.

Descriptive analysis

Descriptive analyses were first conducted to examine the sample characteristic (See Table 3). T-tests and chi square analyses were completed to compare gender based on socio-demographic variables. Significant gender differences emerged in the mean age for adolescents in Grade 7, Grade 8 and Grade 9 ($p<.05$). No significant differences were observed based on family structure ($\chi^2 = 2.15$, $df = 2$, $p > .05$). Finally, significant differences emerged when considering the socioeconomic status ($\chi^2 = 10.91$, $df = 4$, $p < .05$) and ethnicity ($\chi^2 = 8.11$, $df = 2$, $p < .05$) of our study participants.

Table 3. *Sample characteristics for adolescent girls and boys*

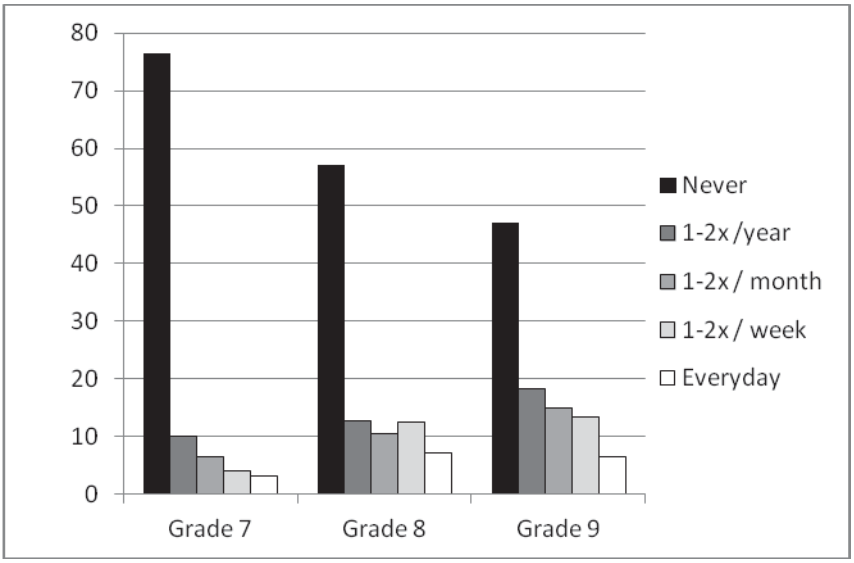
	Girls (n =225)	Boys (n =213)
Age (SD)		
Grade 7	13.4 (0.6)	13.5 (0.7)
Grade 8	14.4 (0.6)	14.5 (0.7)
Grade 9	15.3 (0.6)	15.5 (0.6)
Ethnicity (%)		
Canada/Quebec*	79.8	75.0
Other**	20.2	25.0
Family structure (%)		
Intact family	68.9	63.9
Divorced/separated	31.1	36.1
Socioeconomic status (%)		
Low SES	34.6	37.1
Medium SES	32.7	19.6
High SES	32.7	43.3

* Adolescents with a parent born in Quebec/Canada

**Adolescents with parents born outside Quebec/Canada

In order to determine if the frequency of marijuana use changed over time, the prevalence at each year of the study was examined. Results are presented in Figure 1.

Figure 1. *Prevalence of marijuana use of over time for the entire sample*



Our results show changes in the prevalence of marijuana use over time. Seventy-six percent (76.4%) of adolescents reported no marijuana use at T1. The percentage of abstainers steadily decreased to reach 58.7% at T2 and 47.5% at T3. Adolescents reporting occasional marijuana use (1-2x/year) increased their use over time with a prevalence rate of 10.0% at T1, 13.3% at T2 and 17.7% at T3. A similar pattern of increased use was observed for adolescents reporting usage once a twice a month with 6.4% at T1, 9.6% at T2 and 17.0% at T3. A small percentage of teenagers reported frequent use in Grade 7. At T1, 4.0% of adolescents reported using marijuana at least once or twice a day and this percentage steadily increased to 13.6% at T2 and 12.4% at T3. Heavy users (daily marijuana use) represented 3.1% of teens at T1. At T2, the percentage increased to 4.8% and followed by a small decline to 5.3% at T3. Paired t-tests were also conducted to determine if differences emerged in mean levels of marijuana use

over the three years of the study. Significant differences were observed between T1 and T2, T1 and T3, and T2 and T3 for each year of the study ($p<.001$).

To determine if similar differences emerged in our sample, the prevalence by gender was calculated. Results are presented in Table 4.

Table 4. *Prevalence of marijuana use of over time by gender*

	Time 1		Time 2		Time 3	
	%		%		%	
Marijuana use	Girls	Boys	Girls	Boys	Girls	Boys
Never	80.4	72.6	57.7	59.9	44.7	50.3
A few times a year	7.9	11.7	15.5	10.8	17.3	18.3
At least once or twice	5.6	7.6	9.5	10.2	20.7	13.0
At least once or twice	4.7	3.6	15.5	10.8	14.0	10.8
Everyday	1.4	4.5	1.8	8.3	3.3	7.6

No significant difference were found between gender for non-users, occasional yearly users, monthly users or weekly users ($p >.05$) over the three years of the study. Significant differences emerged with daily marijuana users at T1 ($\chi^2 = 17.85$, $df = 2$, $p <.001$), at T2 ($\chi^2 = 7.31$, $df = 2$, $p <.05$) and at T3 ($\chi^2 = 3.92$, $df = 2$, $p <.05$).

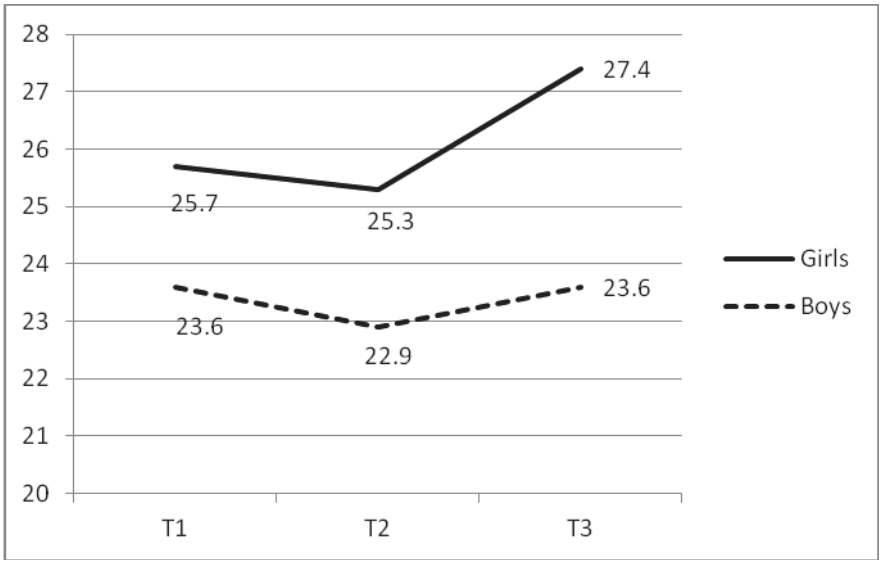
To determine if psychological distress changed over time, mean level of psychological distress for each wave of the study was calculated. Results are presented in Table 5.

Table 5. *Mean level of psychological distress for entire sample*

	Time 1	Time 2	Time 3
Psychological distress	(n =420)	(n = 328)	(n = 283)
Mean	24.8	24.2	25.7
SD	8.3	8.0	8.4

Paired t-tests were conducted to determine if differences emerged between the mean level of psychological distress. Significant differences were observed between T1 and T3, and T2 and T3 ($p<.05$). No significant differences were observed between T1 and T2 ($p>.05$). Since gender differences in level of psychological distress are frequently reported in the literature, mean level of psychological distress was calculated for boys and girls. Results are depicted in Figure 2.

Figure 2. *Mean level of psychological distress for adolescent boys and girls*



Results show that overall, adolescent girls report a greater mean level of psychological distress when compared to boys. Significant difference between gender were found in Grade 7 and Grade 8 ($p<.05$) and Grade 9 ($p<.001$). Results also show that for adolescent girls, mean levels of psychological distress decreased between Grade 7 (M = 25.7, SD=8.1) and Grade 8 (M = 25.3, SD=7.9) and then increased in Grade 9 (M = 27.4, SD=8.7). Paired t-tests were conducted to determine if the differences in the level of psychological distress were statistically significant. There was no significant difference for girls between T1 and T3, and

T2 and T3 ($p<.05$). No significant differences were found between T1 and T2 ($p>.05$). Our results also show that the mean level of psychological distress for adolescent boys is more stable over time but similar pattern involving a slight decrease between Grade 7 (M = 23.6, SD=7.9) and Grade 8 (M = 22.9, SD=7.7) followed by a slight increase in Grade 9 (M = 23.6, SD=7.7) was observed. Paired t-tests demonstrated no significant differences between T1 and T2, T1 and T3, and T2 and T3 ($p>.05$).

Before proceeding with our trajectory analyses, it had to be determined if an association existed between marijuana and psychological distress. T-tests analyses were conducted to determine if differences emerged between marijuana user (occasional to regular users) and non-users based on their level of psychological distress. Results are presented in Table 6. Significant differences emerged between user and non-users regarding their mean level of psychological distress at each year of our study. These results confirmed that marijuana users report more psychological distress than Non-Users.

Table 6. *Mean level of psychological distress based on use or no marijuana use*

	Psychological Distress		
	%	Means	t-tests
Marijuan use T1			
No	76.4	24.0 (7.8)	***$p<.001$
Yes	23.6	27.4 (8.8)	
Marijuan use T2			
No	58.7	23.2 (7.1)	**$p<.01$
Yes	41.3	26.9 (9.7)	
Marijuan use T3			
No	47.5	25.1 (8.2)	*$p<.05$
Yes	52.8	28.6 (8.8)	

Correlation analyses

To further test if there is an association between marijuana and psychological distress, correlation analyses were conducted at each time of measurement. Results are presented in Table 7 and demonstrate that there are significant correlations between marijuana use and psychological distress.

Table 7. *Bivariate correlations between marijuana use and psychological distress*

	1. MUT1	2. MUT2	3. MUT3	1. PDT1	2. PDT2	3. PDT3
1. Marijuana use T1 (MUT1)	-	-	-	-	-	-
2. Marijuana use T2 (MUT2)	0.50**	-	-	-	-	-
3. Marijuana use T3 (MUT3)	0.35**	0.66**	-	-	-	-
4. Psychological distres T1 (PDT1)	0.18**	0.21**	0.15*	-	-	-
5. Psychological distres T2 (PDT2)	0.16**	0.24**	0.15*	0.49**	-	-
6. Psychological distress T3 (PDT3)	0.18**	0.22**	0.26**	0.39**	.55**	-

** Correlation is significant at the 0.01 level

* Correlation is significant at the 0.05 level

Correlations analyses were also conducted to examine the association among sociodemographic variables and the independent variables at each time of measurement. Results are presented in Table 8 and demonstrate that there are significant correlations between sociodemographic variables (gender, family structure and ethnicity) and marijuana use and/or psychological distress. No association was observed between socioeconomic status (SES) and the independent variables.

Table 8. *Bivariate correlations between marijuana use, psychological distress and sociodemographic variables*

	Marijuana T1	Marijuana T2	Marijuana T3	Distress T1	Distress T2	Distress T3
Gender	0.10*	0.01	-0.05	-0.12*	-0.17**	-0.24**
Family structure	0.22**	0.19**	0.25**	0.08	0.05	0.08
Ethnicity	-0.07	-0.12	0.28**	0.03	0.01	-0.40
SES	-0.06	0.01	0.11	0.03	0.00	-0.12

** Correlation is significant at the 0.01 level
* Correlation is significant at the 0.05 level

Semi-parametric group modeling for marijuana use

Model Selection

For marijuana use, a three group model was chosen as the best fitting model. The Bayesian Information Criterion (BIC) was used to select the best model. A better model fit was indicated by BIC values closer to zero. Based on the BIC reported in Table 9, a three group solution appeared the most appropriate number of trajectories.

Table 9. *Marijuana use: Bayesian Information Criterion (BIC) for selection of number of trajectory groups*

			Trajectory Group Prevalence				
Model	BIC	Probability correct model	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)
1	-1682.46	0.00	100.00				
2	-1547.77	0.00	72.07	27.93			
3	**-1459.60**	**1.00**	**64.12**	**24.65**	**11.23**		
4	-1470.70	0.00	63.36	24.68	11.23	0.77	
5	-1480.45	0.00	48.12	24.65	11.78	11.23	4.22

The BIC was also used to specify the optimal shape of the trajectories in our model. Given that the outcome variable comprised of three data points, only zero-order polynomial (0) defined by an intercept and first-order polynomial (1) defined by an intercept and a linear growth term were considered. Table 10 shows the different parameters tested for our three trajectory group models in order to determine the optimal shapes for each trajectory group. Since a three trajectory group model was selected, the first column labeled "Model" included the number "3" followed by a letter (a to d) to clearly indicated the different model tested (3a, 3b, 3c, 3d).

Table 10. *BIC model fit for 3 trajectory group model of marijuana use*

Model	Order [1]			BIC	Probability fit model
3a	**1**	**1**	**1**	**-1459.60**	**0.94**
3b	0	1	1	-1462.37	0.06
3c	0	0	1	-1563.01	0.00
3d	0	0	0	-1607.67	0.00

[1]A zero-order model (0) is defined by intercept only and a first-order model (1) is defined as intercept.

Data presented in Table 10 show that model 3a is the most appropriate since it has the combination with the largest BIC score. In the selected model (3a), all groups followed linear trajectories. As discussed previously in the analytic plan section, the BIC scores can be used to determine the posterior odds of a model being the correct model given the data (Nagin, 2005). The probabilities of being the correct model are also presented in Table 10. The probability of model (3a) being correct is 0.94.

Finally, adequacy of the selected model was judged according to two additional key diagnostics of assignment accuracy: 1) average posterior probability of assignment and 2) odds of correct classification. Results are presented in Table 11.

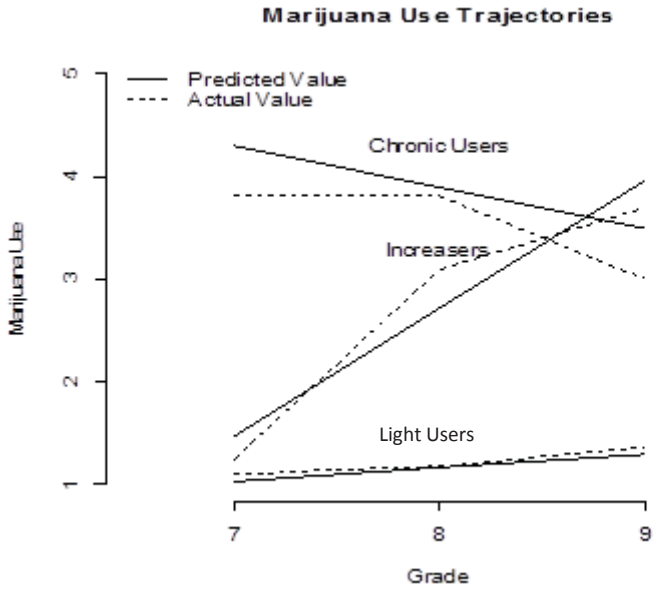
Table 11. *Average posterior probability of assignment and odds of correct classification for marijuana use trajectories*

Groups	Pj (proportion classified in group *j*)	Average posterior probabilities	Odds correct classification
Light Users	64.12	0.91	15.66
Increasers	24.65	0.91	30.91
High Users	11.23	0.85	44.79

Table 11 indicates that overall, the model's estimation of the group membership is very good. For instance, the average posterior probabilities are .91 for the Light Users, .91 for the Increasers group and .85 for the High Users. Odds of correct classification greater than 5 for all groups are indicative that the model has high assignment accuracy (Nagin, 2005). The odds of correct classification are well above 5 for all three trajectories.

The final step involved plotting the 3 trajectory group model. The graph is presented in Figure 3.

Figure 3. Developmental trajectories of marijuana use



Our trajectory analysis shows that most adolescents (*n*=288, 64.4% of sample) followed a trajectory of no use or occasional use (few times a year at T3). This trajectory remained relatively flat and stable over time and was labelled "Light Users". The second trajectory group was labelled "Increasers" (*n*=110, 24.6% of sample) and is characterized by a low level of marijuana use followed by an increase of marijuana use over time. The level of use in the last year of the study for the Increasers trajectory reached the highest level of all the trajectory groups identified. The last group was labelled "High Users" (*n*=50, 11.2% of sample) and is characterized by a high and fairly stable level of use followed by a small decline in the last year of the study. Despite the small decrease in use, the overall level of marijuana use remained elevated overtime.

After the final model has been selected, the posterior probabilities were calculated using the model's estimated coefficients to check the model fit. The posterior probabilities measure the probability that an individual with a specific profile belongs to a specific trajectory group *j* in the selected final model. The posterior probabilities provide an objective basis for assigning individuals to the trajectory group and can be used to assess the quality of the model's fit to the data (Nagin, 2005). Table 12 provides the average assignment posterior probabilities for the final three trajectory model.

Table 12. *Average assignment posterior probabilities for model fit for marijuana use trajectories*

	Assigned Group Membership		
	Light Users	Increasers	High Users
Light Users	0.91	0.07	0.05
Increasers	0.08	0.91	0.10
High Users	0.01	0.02	0.85
Total	1.00	1.00	1.00

The average posterior probabilities for the assigned groups are .91. 0.91 and 0.85 for the Light Users, Increasers, and High Users groups respectively. These coefficients indicate the probability of subjects being assigned in the correct group. For example, adolescents assigned to the Light Users trajectory have a probability of being assigned correctly to this group with a probability of 0.91 and to the Increasers trajectory with a probability of 0.08. This suggests that most adolescents in the Light Users trajectory are assigned correctly to the Light Users group, but there is a small chance (0.08) that they could be in the Increasers group. The average posterior probability of assignment for each group should equal to 1. The average posterior probabilities for the three identified trajectories are well above the minimum threshold recommended (0.7) (Nagin, 2005).

Psychological distress at baseline and its association with marijuana use trajectories

Preliminary analyses involved examining the association between marijuana use trajectories and sociodemographic variables (gender, family structure, ethnicity and SES). Our results showed no differences between marijuana use trajectories when considering gender and SES ($p > .05$). Significant differences emerged based on family structure and ethnicity for some trajectory groups. When comparing Increasers and Light Users, it was observed that Increasers were more likely to be from divorced families (OR: 0.38, $p < 0.01$) and have parents of Canadian/Quebec origin (OR: 4.06, $p < 0.01$). When comparing Increasers to High Users, Increasers were more likely to have parents of Canadian/Quebec origin (OR: 3.60, $p < 0.05$). Finally, when comparing Light Users to High Users, family structure differentiated the two trajectories with Light Users being more likely to be from an intact family than High Users (OR: 4.18, $p < 0.01$). No significant differences emerged based on gender and SES.

Our analyses then involved examining the association between psychological distress at T1 and marijuana use trajectories while considering sociodemographic variables including gender, family structure and ethnicity. The SES variable was left out the analyses since initial analyses demonstrated no correlation with marijuana use and the inability to differentiate between our trajectories of marijuana use.

Gender differences have consistently been observed in the literature so it was therefore decided to include this variable in our analysis even if we failed to observe differences between the identified trajectories in our sample. Results are presented in Table 13. It was observed that adolescents following an Increasers trajectory were more likely to experience psychological distress when compared to Light Users (OR: 2.97, $p<.05$). Differences also emerged between Light Users and High Users with psychological distress at baseline increasing the likelihood of following the High Users trajectory group when compared to Light Users (OR: 7.77, $p<.001$). No significant differences emerged between Increasers and High Users when considering psychological distress at baseline ($p> .05$).

The final step in our analysis involved testing for interactive effects between our control and independent variables by adding interaction terms to our final model. No significant interactions were observed ($p >.05$).

Table 13. *Multinomial logistic regression models for marijuana use trajectories*

	Model 1		Model 2	
Variables	β (SE)	OR	β (SE)	OR
Gender				
Light Users vs Increasers	0.28(0.32)	1.32	0.04(.87)	1.04
Light Users vs High Users	0.51(0.40)	1.66	0.66(.31)	1.33*
Increasers vs High Users	0.79(0.46)	2.20	0.62(.33)	1.86
Family Structure				
Light Users vs Increasers	-0.98(0.34)	0.38**	0.72(0.32)	0.46*
Light Users vs High Users	1.43(0.41)	4.18**	1.49(0.40)	4.43***
Increasers vs High Users	0.46(0.46)	1.59	0.72(0.43)	2.06
Ethnicity				
Light Users vs Increasers	1.40(0.49)	4.06**	1.12(0.42)	3.06**
Light Users vs High Users	-0.12(0.47)	0.89	-0.48(0.49)	0.62
Increasers vs High Users	1.28(0.63)	3.60*	0.65(0.58)	1.92
Psychological Distress				
Light Users vs Increasers	-	-	1.09(.35)	2.97*
Light Users vs High Users	-	-	2.05(.44)	7.77**
Increasers vs High Users	-	-	0.85(.64)	2.33

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

Semi-parametric group modeling for psychological distress

Model Selection

For psychological distress, a three-group model was chosen as the best fitting model. The Bayesian Information Criterion (BIC) was used to select the final model. Results are presented in Table 14.

Table 14. *Psychological distress: Bayesian Information Criterion (BIC) for selection of number of trajectory groups*

			Trajectory Group Prevalence				
Model	BIC	Probability correct model	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)
1	-272.21	0	100.00				
2	-209.10	0	51.86	48.14			
3	**-204.08**	**1**	**53.29**	**35.12**	**11.59**		
4	-204.77	0	42.74	35.83	11.10	10.33	
5	-212.65	0	34.95	23.25	22.71	11.53	7.55

The analytical steps described for our analysis of marijuana use trajectories were replicated to establish the psychological distress trajectories. Table 15 shows the different parameters tested for the three trajectory group models in order to determine the optimal shapes for each trajectory group. Since a three trajectory group model was selected, the first column labeled "Model" included the number "3" followed by a letter (a to d) to clearly indicated the different model tested (3a, 3b, 3c, 3d).

Table 15. *BIC model fit for 3 trajectory group model of psychological distress*

Model	Order [1]			BIC	Probability fit model
3a	1	1	1	-204.08	0.00
3b	0	1	1	-200.71	0.01
3c	0	0	1	-199.03	0.05
3d	**0**	**0**	**0**	**-195.99**	**0.95**

[1]A zero-order model (0) is defined by intercept only and a first-order model (1) is defined as intercept

The BIC score with the lowest value indicated the best fit for the model. In model (3d), the best shape for the three groups identified was obtained when trajectories were constrained to be constant. The probabilities of being the correct model are also presented in Table 15. The probability of model 3d being correct is 0.95.

The final step involved determining the adequacy of the selected model using average posterior probability of assignment and odds of correct classification. Results are presented in Table 16.

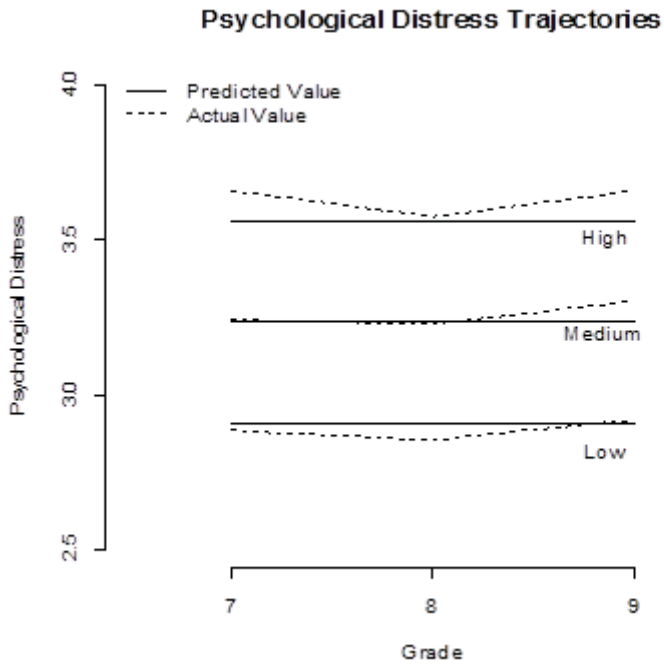
Table 16. *Average posterior probability of assignment and odds of correct classification for psychological distress trajectories*

Groups	Pj (proportion classified in group *j*)	Average posterior probabilities	Odds correct classification
Low	35.84	0.84	15.47
Medium	53.05	0.79	2.12
High	11.10	0.76	24.49

Table 16 indicates that overall, the model's estimation of group membership is very good. The average posterior probabilities are .84 for the Low psychological distress trajectory, .79 for the Medium psychological distress trajectory and .76 for the High psychological distress trajectory. The odds of correct classification are above 5 for two of the three trajectory groups and the Medium trajectory's OCC is close to the suggested the cut off point.

The final step involved plotting the 3 trajectory model. The graph is presented in Figure 4. Three distinct trajectory groups of psychological distress were identified and were labelled Low, Medium and High. The graph shows that a majority of adolescents (*n*=238, 53.05% of sample) followed a slightly elevated but stable level of psychological distress over time and was labelled "Medium" trajectory. The second trajectory was labelled "Low" (*n*=160, 35.84% of sample) also remained flat and stable over time and was characterized by low level of psychological distress over time. The third group was labelled "High" (*n*=50, 11.10%) and was characterized by elevated and stable level of psychological distress use throughout the three years of the study.

Figure 4. *Developmental trajectories of psychological distress*



Following the selection of the final model, the posterior probabilities were calculated using the model's estimated coefficients to check the model fit. Table 17 provides the average assignment posterior probabilities for the final four trajectory model.

Table 17. *Average assignment posterior probabilities for model fit*

	Low	Medium	High
Low	0.81	0.15	0.22
Medium	0.12	0.85	0.00
High	0.07	0.00	0.78
Total	1.00	1.00	1.00

The average posterior probabilities for the assigned groups are .81, 0.85 and 0.78 for the Low, Medium and High trajectory groups respectively. The average posterior probabilities for the three identified trajectories are above the minimum threshold recommended of 0.7 (Nagin, 2005).

Marijuana use at baseline and its association with psychological distress

Our preliminary analyses examined the association between sociodemographic demographic variables (gender, family structure, ethnicity and SES) and psychological distress trajectories. No differences between marijuana use trajectories were observed when considering family structure, ethnicity and SES ($p > .05$). Gender was the only significant sociodemogaphic variable able to differentiate among the psychological distress trajectories. When comparing Low and Medium psychological distress trajectories, males were more likely to follow a Low trajectory when compared to females (OR:1.63, $p<.05$). Similar differences were observed between Low and High psychological trajectory where males were more likely to follow the Low trajectory (OR:1.89, $p<.05$). No differences emerged between Medium and High psychological distress when considering gender.

Analysis then involved examining marijuana use at T1 and its association with the three identified trajectories of psychological distress while accounting for sociodemograhic variables. To ensure consistency, our trajectory analyses for psychological distress included the sociodemographic variables retained for the marijuana use trajectory analyses (gender, family structure and ethnicity). Results are presented in Table 18. Our results showed that marijuana use at baseline increased likelihood of membership in the High psychological distress when compared to the Low psychological distress trajectory (OR:2.63, $p<.001$). Marijuana use also increased the likelihood of membership in High psychological distress trajectory when compared to Medium psychological distress (OR:2.08, $p<.01$). No significant differences emerged between Low and Medium psychological distress trajectories when considering marijuana use at baseline ($p > .05$).

The final step in our analysis involved testing for interactive effects between all control and independent outcome variables by adding two-way interaction terms to our final model. No significant interactions were observed (p >.05).

Table 18. Multinomial logistic regression models for psychological distress trajectories

	Model 1		Model 2	
Variable	β (SE)	OR	β (SE)	OR
Gender				
Low vs High	0.64(0.31)	1.89*	1.00(0.34)	2.72**
Medium vs High	0.17(0.23)	1.19	0.47(0.25)	1.60
Low vs Medium	0.49(0.23)	1.63*	0.66(0.24)	1.93**
Family Structure				
Low vs High	-0.76(0.30)	0.47	-0.49(0.33)	0.61
Medium vs High	-0.14(0.22)	0.87	0.03(0.24)	1.03
Low vs Medium	-0.55(0.26)	0.58	-0.53(0.26)	0.59
Ethnicity				
Low vs High	0.43(0.31)	1.54	0.60(0.35)	1.83
Medium vs High	0.04(0.25)	1.04	0.05(0.26)	1.06
Low vs Medium	0.41(0.24)	1.50	0.41(0.25)	1.59
Marijuana use				
Low vs High	-	-	0.97(0.18)	2.63***
Medium vs High	-	-	0.73(0.11)	2.08**
Low vs Medium	-	-	0.23(0.16)	1.25

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

Joint trajectories analyses

Building on the trajectory group models for marijuana use and psychological distress previously presented, a joint trajectory analysis was conducted to further increase our understanding of the co-occurrence of these phenomenon. Joint trajectory analysis allows to capture the dynamic dimension of the overlap between behaviors of interest by summarizing the interrelationship across these trajectory groups and providing the probability of

membership in each trajectory group and the probabilities linking membership in trajectory group across behaviors (Nagin, 2005; Nagin & Odgers, 2010b).

The first part of our joint trajectory analysis examined the probability of psychological distress based on the membership of marijuana use trajectories. Results are presented in Table 19.

Table 19. *Probability of psychological distress conditioned on marijuana use*

	Marijuna Use		
Psychological Distress	Light Users	Increasers	High Users
Low	0.441	0.162	0.165
Medium	0.516	0.693	0.453
High	0.042	0.143	0.382

Our findings demonstrate that adolescents who are Light Users are more likely to follow a Low or Medium trajectory of psychological distress, with probalities of 0.44 and 0.52 respectively. Conversely, Light Users are also less likely to follow a High trajectory of psychologcal distress (0.04 probability). Furthermore, adolescents in the Increasers trajectory group are more likely to follow a Medium psychological distress trajectory with a probability of 0.69. When looking at the High marijuana users, results show that this group is less likely to follow a Low level of psychological distress, with a probability of 0.17. Small differences emerged in the probability of membership between a Medium and High psychological distress trajectories (0.45 and 0.38 respectively).

The next part of our analysis examined the reverse set of conditional probabilities, the probability of membership of the marijuana use upon membership in the psychological distress trajectories. Results are presented in Table 20.

Table 20. *Probability of marijuana use conditioned on psychological distress*

	Psychological distress		
Marijuana use	Low	Medium	High
Light Users	0.830	0.601	0.263
Increasers	0.117	0.309	0.337
High Users	0.053	0.090	0.400

Results demonstrate that adolescents following the Low psychological distress trajectory were more likely to follow a Light Users trajectory and least likely to follow a High Users trajectory with a probability of .83 and 0.05 respectively. Similar patterns were observed with adolescents following the Medium psychological distress trajectory with this subgroup of teens being more likely to follow a Light Users marijuana trajectory and less follow the High Users marijuana trajectory with probabilities of 0.60 and 0.09 respectively. Finally, following the High psychological distress increased the likelihood of also following the Increasers and High Users trajectories (0.34 and 0.40 respectively).

The final component of our analysis involved the calculation of joint probability of membership in a specific marijuana use trajectory and psychological distress trajectory. Results are presented in Table 21 and show all the possible combinations of marijuana use and psychological distress in early adolescence. The total of probabilities equal to 1.

Table 21. *Joint probability of psychological distress and marijuana use*

	Marijuana use		
Psychological Distress	Light Users	Increasers	High Users
Low	0.284	0.040	0.018
Medium	0.333	0.171	0.050
High	0.028	0.035	0.042

Results demonstrate that most individuals had low or medium level of psychological distress and were non marijuana users, with 61% of the sample. Finally, 17.9% of our sample experienced medium level of psychological distress trajectory group and increased their marijuana use over time. It is important to note that the overlap between the most at-risk trajectories (high marijuana use and high psychological distress) represented a small percentage of individuals totalling 4.2% of the sample.

Taken together, the three components of our joint trajectory analyses show that there is longitudinal co-occurrence between the developmental trajectories of marijuana use and psychological distress.

CHAPTER 5

Discussion

The first part of our study focused on establishing the developmental trajectories of marijuana use and psychological distress in early adolescence. Once the trajectories were identified, we proceeded to examine if adolescents reporting psychological distress in Grade 7 were more likely to follow different patterns of marijuana use and conversely if adolescents reporting marijuana use in Grade 7 were also more likely to follow different trajectories psychological distress. The first part of the study confirmed that there is heterogeneity in the development of both marijuana use and psychological distress in early adolescence and that these phenomena tend to co-occur with high level of either marijuana use and psychological distress at baseline increasing the likelihood of following problematic trajectories.

The evidence stemming from these results provided the building blocks for the analyses in our second part of our study, which focused on investigating the longitudinal interrelationship between marijuana use and psychological distress as they concurrently evolve during early adolescence. It is important to emphasize that our research design did not allow to determine the presence of a causal association between marijuana use and psychological distress. However, establishing the developmental trajectories of each phenomenon separately, their respective association with each other at baseline and their co-occurring patterns across early adolescence provided valuable information regarding the intricacy of the relationship.

Research findings

Longitudinal patterns of marijuana use in early adolescence

The marijuana use trajectories observed in the present study replicated key features of the developmental patterns reported in previous work (Otten et al., 2010; Brook et al., 2011,

2010; Lansford et al., 2008; Tucker et al., 2005; Brown et al., 2004; Flory et al., 2004; Ellickson et al., 2004; Windle & Wiesner, 2004). Based on our review of the literature, it was hypothesized that 4 trajectories of marijuana use would be observed (Hypothesis 1.1). We found partial support for this hypothesis since our analyses resulted in the identification of only 3 distinct trajectories of marijuana use in early adolescence. Contrary to our expectations, we observed one trajectory composed of abstainers and experimenters (use limited to a few times per year), which was labeled Light Users. This conclusion was reached by examining the slope of this trajectory. In our first year of the study, the initial starting point of our Light Users trajectory indicated that this subgroup was abstaining from marijuana use (Never = 1) but over the three times of measure, the trajectory slightly increased to reach an end point between "Never=1" and "Few times per year=2". This pattern suggests that marijuana use in the Light Users trajectory slightly increased over time but the frequency remained limited to a few times a year. The fact that we could not identify two separate trajectories for Non-Users and Experimenters is not alarming but simply indicates that the most parsimonious model in our sample did not meaningfully distinguish between these two groups (e.g. Windle & Wiesner, 2004; Tucker et al., 2005). Experimentation is considered a normative behavior in adolescence (Griffin & Botvin, 2010) and a majority of teens will have experimented with drug use by the time they finish high school (Johnston et al., 2012; Cazale et al., 2009; Adlaf, Begin, & Sawka, 2005). Hence the slight increase over time in our Light Users trajectory seems to reflect this tendency for teens to be more susceptible to experiment with marijuana use as they age.

Considering the focus of our study on younger adolescents, it was hypothesized that the majority of our participants would report no or occasional marijuana use (Hypothesis

1.1.5). As expected, the trajectory labeled Light Users (including abstainers and experimenters) represented the largest group of our sample (64.4%). Our findings confirm that the majority of adolescents do not use marijuana in early adolescence and also suggest that among experimenters, a portion of these occasional users remain at a low level of use in early adolescence.

The second trajectory identified in our sample displayed a significant change in the frequency of marijuana use over time and confirmed our hypothesis that a subgroup of teens (24.6% of our sample) would increase its marijuana use in early adolescence (Hypothesis 1.1.3). As mentioned previously, marijuana use tends to increase during adolescence and it was therefore expected to observe such pattern of increasing use in our sample. Our results confirm previous research findings suggesting that for some teenagers, their marijuana use will go beyond experimentation (Brook et al., 2011; Ellickson et al., 2004; Flory et al., 2004). Our findings are also in line with the estimation that more than 50% of adolescents who experiment with marijuana and, of those who try the drug more than once, a third eventually escalate to regular use (Gruber & Pope, 2002).

The Light Users and Increasers trajectories reported similar level of marijuana use in Grade 7 but differed over time with one group maintaining no or occasional use while the other group showed an increase in use. This finding highlights the importance of studying developmental patterns using a group based approach since it captures the different patterns of use emerging over time and demonstrates that teens will not necessarily follow the average trajectory of marijuana observed in some studies (e.g. Kosterman, Hawkins, Guo, Catalano, & Abbott, 2000; Kandel & Logan, 1984). Some authors have suggested a variety of factors that could explain why some adolescents escalate to greater substance use while others maintain

their level of use to experimentation (Behrendt, Wittchen, Höfler, Lieb, & Beesdo, 2009; Kandel & Chen, 2000). Common factors cited in the literature to explain the escalation of marijuana use include depressive symptoms, low self-esteem and anger/hostility (Pahl, Brook, & Koppel, 2011; Veselska, et al., 2009). Examining the association of psychological distress in the development of an increasing marijuana use trajectory will be addressed shortly.

The last trajectory identified in our sample consisted of teens showing a relatively high and stable level of marijuana use (11.2% of our sample) across the three waves of the study when compared to Light Users and Increasers trajectories (Hypothesis 1.1.4). High chronic users trajectories have been consistently observed in previous studies (e.g., Brook et al., 2011; Tucker et al., 2005; Ellickson et al., 2004; Flory et al., 2004), and we expected to observe a similar pattern of use in our sample. Interestingly, this subgroup of High Users reported high level of use in Grade 7, followed by a steady and slow decline over the last two years of the study. The decrease is important to point out because by the end of the study, High Users showed a lower level of marijuana use than the Increasers group. Based on the literature reviewed, we would expect to find such pattern of decreased use among older teens. A possible explanation for the slight decrease in marijuana use in our sample is that our High Users trajectory group includes adolescents who remain consistently high in their level of use over time (high chronics) and adolescents who have a high initial level of use and reduce their use over time (decreasers). Many studies with a longer follow-up time frame have observed a sub-group of teens with relatively high level of marijuana use at age 13 who steadily reduce their level of use over time to eventually reach a moderate level of use around 18 years old and older (Brook et al., 2011; Ellickson et al., 2004; Tucker et al., 2005). Our inability to identify two distinct trajectories for High Users and Decreasers indicates that the most parsimonious

model in our sample did not meaningfully distinguish between these two groups. Such pattern of decreased use might have been easier to observe with a follow up period including late adolescence and young adulthood.

Understanding the reasons behind this decreasing pattern of marijuana use has been the focus of many studies. Some authors have argued that the decrease in substance use is linked to the inherent changes involved with the transition into adulthood. Adopting adult roles such as ending formal education and beginning employment, becoming financially independent of parents, establishing new living arrangements, and getting married and starting a family have been linked to a decline in substance use behavior (Staff et al., 2010; O'Malley, 2004; Brook et al., 2011; Brook et al., 2002). However, it is important to note there is also evidence that for some teens, the transition into adulthood involving leaving the parental home, whether to attend college or not, actually coincide with an increase in substance use behavior (Arnett, 2005; White, et al., 2006; O'Malley & Johnston 2002).

Psychological distress and its association with marijuana use trajectories

Our first hypothesis was inspired by the self-medication hypothesis and we expected to observe that a higher level of psychological distress would be associated with greater marijuana use in early adolescence. The self-medication hypothesis involves many components including the temporal sequence of events (e.g. internal distress preceding marijuana use) and the motivation leading to marijuana use (e.g. I use marijuana because I am depressed). Our study design did not allow to test these components of the self-medication hypothesis but we were able to examine whether the experience of psychological distress at baseline would be associated with a higher level of marijuana use over time (High Chronics

and Increasers trajectories) when compared to non-marijuana users or experimenters (Hypothesis 2.1.1).

Our results confirm that there were some differences between trajectories of marijuana use based on the level of psychological distress measured in the first year of our study. In our sample, adolescents who reported higher level of psychological distress in Grade 7 were more likely to follow a trajectory of chronic marijuana use when compared to Light Users (Hypothesis 2.1.1). Hence, our results provide some evidence for a pattern of co-occurrence between high level of psychological distress reported in the first year of our study and problematic marijuana use trajectories. Our findings also provide preliminary evidence that the difference between developmental patterns of marijuana use between problematic and non-problematic trajectories may be linked to the level of psychological distress experienced by teens as they transition from elementary school to high school.

The question remains as to why adolescents who follow a High Users marijuana trajectory are more likely to also experience more psychological distress than Light Users in their first year of secondary school. This pattern may be linked to the level of emotional or behavioral functioning (e.g. poor affect regulation, acting out, inattention) prior to entering Grade 7. A number of developmental studies have observed that early emotional and behavioral problems are predictive of later experience of depressive symptoms and delinquency and/or drug use (Storr, Wagner, Chen, & Anthony, 2011; Diamantopoulou, Verhulst, & van der Ende, 2011; Kofler et al., 2011; McCord, Widom, & Crowell, 2001; Stouthamer-Loeber & Loeber, 2002; Wasserman et al., 2003; Hall, Degenhardt, & Teeson, 2009). Hence, it is possible that adolescents following the High Users trajectory represent a

group of teens with elevated psychological distress and marijuana use due to some difficulties experienced in childhood.

Research has demonstrated that childhood difficulties (e.g emotional and behavioral problems) tend to co-occur (Ingoldsby, Kohl, McMahon, & Lengua, 2006). The implications of co-occurring difficulties in childhood on psychosocial development and functioning can be staggering. The work of Capaldi and Stoolmiller (1999) explored the implications of co-occurring problems in childhood. Their research findings suggest that children with behavioral and conduct problems are more likely to experience conflict with parents and peers and greater peer rejection (failure in social domain) and interference with academic skills (failure in academic domain), which in turn may lead to depressed mood when the child repeatedly "fails" in his or her environment.

This dual failure pathway has been supported in longitudinal analyses and have provided evidence that children who experience emotional or behavioural difficulties are less likely to succeed in various domains of life (poor relationships with peers, conflict with family, academic problems) and can experience a lower sense of competence, poor self-esteem and distress due to the repeated experience of failure (Griffin, Scheier, Botvin, & Diaz, 2001; Eccles, Lord, Roeser, Barber, & Jozefowicz, 1997; Witkowski & Stienshasmeier-Pelster, 1998; Capaldi, 1992; Capaldi & Stoolmiller,1999).

As children transition into adolescence, issues of self-esteem, low sense of competence can further exacerbate feelings of distress (Fergusson et al., 2005; Schaeffer et al., 2006; Mason et al., 2009; Glantz & Leshner, 2000). Hence, adolescents with a history of behavioral and emotional problems may be more prone to experience elevated emotional distress upon entry in Grade 7 as they are forced to deal with new challenges associated with the transition

to elementary to high school. With more autonomy and interaction with peers, these adolescents may be more susceptible to seek new maladaptive methods of coping, including the use of marijuana to deal with the distress or engage in other delinquent behaviors.

Our results also indicate that adolescents in the Increasers trajectory group are more likely to experience higher levels of psychological distress when compared to adolescents in the Light Users trajectory (Hypothesis 2.1.1). Our Increasers group is a source of concern since their experimentation evolved to a steadily increase of use over time to the point where they caught up to and exceeded the frequency of use reported by High Users trajectory. The difference between these two trajectories suggests that psychological distress could play a role in the escalation of marijuana use since Increasers and Light Users show similar level of marijuana use in Grade 7 but differ in their level of psychological distress reported at baseline. These results are in line with the self-medication hypothesis since for a subgroup of teens, psychological distress at baseline appears to be associated with an increase of marijuana use over time. However, it is important to note that the escalation of marijuana use could also be related to other factors not considered in this study. Nevertheless, our findings tend to suggest that the experience of psychological distress appears to be related to the development of marijuana use in early adolescence.

In addition to the self-medication hypothesis, other mechanisms have been proposed to explain why distressed adolescents represent a subgroup of individuals who are more at risk of increasing their marijuana use over time. First, there is a possibility that distressed teens may have greater positive expectations regarding the effect of using marijuana, which could provide them with a strong incentive to experiment and use marijuana. As discussed previously, outcome expectancies regarding marijuana or other drugs and alcohol play a

crucial role in a teen's decision to use a substance (Clark, Ringwalt, & Shamblen, 2011). Common expectations associated with substance use include the reduction of negative affect, enhancement of positive affect, creativity and social cohesion (Skenderian, Siegel, Crano, Alvaro, & Lac, 2008; Jones, Corbin, & Fromme, 2001). In their recent study, Hooshmand, Willoughby, and Good (2012) found that adolescents with higher levels of depressive symptoms in Grade 9 had a faster increase in cigarette smoking, marijuana use, and hard drug use across their high school years when compared to adolescents with lower levels of depressive symptoms in Grade 9, when the substance was perceived as providing mood-enhancing functions. Even if the study was conducted with older teens, it provides some evidence that adolescent who believe that their negative internal state will be relieved by using a substance, are more at risk of using this substance. Studies such as Clark, Ringwalt, and Shamblen, (2011) and Friedman-Wheeler, Ahrens, Haaga, McIntosh, and Thorndike (2007) also confirmed that there is strong association between positive expectations regarding a substance and subsequent decision to use the substance. Most studies on outcome expectancies have focused on alcohol use and older teens. Therefore, there is a pressing need for more research efforts focusing on early adolescence and examining the specific link between outcome expectancies marijuana as they might differ from other substances (e.g. alcohol or cigarette use) (Connor, Gullo, Feeney, & Young, 2011; Musher-Eizenman, Holub, & Arnett, 2003).

Secondly, as observed in some recent studies (e.g. Alfonso & Dunn, 2007; Skenderian et al., 2008), the effect of marijuana on depressed adolescents can also encourage an increase in use over time through a process of positive reinforcement. If a teen feels less distress after using marijuana, she/he will be more likely to continue or increase his/her use of the substance

in order to experience relief from negative feelings. For some emotionally distressed teens, marijuana use can become a way of coping with their negative internal feelings creating a vicious circle where marijuana is used to cope with distress and the increase in marijuana use leads to greater distress. This pattern is often involved in the processes leading to dependence where substance use is viewed as a coping response to life stress and negative affect by inducing a sense of relaxation, calmness and lesser anxiety and leading to increased use over time (Kassle, 2010). Studies conducted by Wills, Sandy, Yeager and Shinar (1999) and Wagner, Myers and McIninch (1999) have provided evidence for such process involved in the developmental of substance use problems and depressive problems. Hence, the adolescents who are abstainers or occasional marijuana in Grade 7 but experience psychological distress may represent a group of teens who are more at risk to increase their frequency of marijuana use when faced with life stressors and negative feelings because of their expectations and the reinforcement effect of the substance. Our findings suggest that the increase in marijuana use in a subgroup of teens may be associated with the experience of elevated psychological distress in Grade 7 which provides some support for the self-medication hypothesis.

Finally, emotionally distress and depressed teenagers are associated with loneliness and social isolation (Witvliet, Brendgen, van Lier, Koot, & Vitaro, 2010). The role of peers is particularly important in early adolescence and having difficulties to establish relationship with others can be significant challenge for teenagers. These relational difficulties contribute to the shaping of affective experiences throughout adolescence (Demuth, 2004). The strong need to belong and to associate with peers may lead some teens to get involved with deviant peer groups as a way to alleviate their sense of social isolation in the short term but in the long term, the engagement with deviant peers may result in more depression and delinquent

behavior including substance use (Connell, Dishion, & Deater-Deckard, 2006). The association with deviant friends may foster delinquent behavior through peer pressure, positive reinforcement and through modeling of various types of rule breaking behavior including substance use (Brendgen, Vitaro, & Bukowski, 2000). This association with deviant peers is a well-established predictor of substance use behavior in adolescence (Ryzin, Fosco, & Dishion, 2012). It is important to note that some studies have failed to observe such association and conclude that isolated teens tend to engage in less delinquent behaviors than more socially connected peers mainly because they have less opportunity to interact with others in social settings (Demuth, 2004).

Our study results also provide evidence that Light Users might be better adjusted than marijuana users since they report lower levels of distress at baseline when compared to Increasers and High Users (Hypothesis 2.1.2). Adjustment has been defined in broad term in the literature and often consist of several social and psychological dimensions, including overall well-being, satisfaction with different domains of life (e.g. family, friends, school), self-esteem, sense of self-worth, pro-social behaviour (Gutman, Brown, Akerman, & Obolenskaya, 2010). Our results replicate study findings suggesting that abstainers are better functioning and experience less psychological distress than teens who use substances (Degenhardt et al., 2010; Tucker, Ellickson, Collins, & Klein, 2006; Rey et al., 2002). Even if our study focuses exclusively on early adolescence, our research findings are in direct contradiction with the conclusions reached by Shelder and Block (1990), who observed that adolescents who abstain from marijuana until age 18 were less psychologically healthy (e.g. more tensed, over-controlled, emotionally constricted, socially isolated and lacking in interpersonal skills) than adolescents who use drugs. These conclusions have remained

questionable and other authors such as Tucker et al. (2006) and Degendhart et al. (2010) have also challenged the validity of these results. In the present study, a longer follow up period would have allowed to determine if this co-occurring pattern of light use and lesser psychological distress prevails throughout adolescence.

Longitudinal patterns of psychological distress in early adolescence

It was hypothesized that four distinct trajectories of psychological distress would be identified in the present sample (Hypothesis 3.1). As expected, we observed a stable low level of psychological distress, a stable moderate level of psychological distress and a stable high level of psychological distress (Hypotheses 3.1.1, 3.1.2, 3.13). A general conclusion regarding our trajectories is that psychological distress is rather stable over time in early adolescence. These stable patterns have also been observed in a similar study conducted by Otten et al. (2010) where 3 stable trajectories of High, Medium and Low depressive symptoms were identified in early adolescence. Contrary to our expectations, we failed to find a "Rapid Increasers" group characterized by a sharp increase in psychological distress over time (Hypothesis 3.1.4), a trajectory observed in studies involving participants in early adolescence (Brendgen et al., 2005; 2010). Other longitudinal studies have observed a general trend where depressive symptoms tend to increase from late childhood to early adolescence (Angold et al., 2002; Ge, Conger, & Elder, 2001a; Twenge & Nolen-Hoeksema 2002) but we were unable to observe such pattern in our sample.

The inability to identify a trajectory of increasing psychological distress may be in part due to some differences in the operationalization of our variable of interest, psychological distress. Studies using various measures of depressive symptoms were considered when

developing our hypotheses regarding the developmental trajectories of psychological distress. This construct includes measures of depressive symptomatology, anxiety, irritability and cognitive difficulties. The use of a different but related construct may have influenced the shape and group composition of our developmental trajectories of psychological distress.

Our inability to observe a sharp increase may also be linked to the time frame of our study. There is consensus that early maturation increases the risk of experiencing psychosocial adjustments, especially in girls (Ge et al., 2006; Ge et al., 1996; Natsuaki et al., 2009; Weichold, Silbereisen, & Schmitt-Rodermund, 2003). Some studies have also found evidence that early pubertal timing is associated with distress in adolescent boys (Ge, Conger, & Elder, 2001b; Nadeem & Graham, 2005). There is a great deal of variability regarding the onset of puberty and the transition into adolescence. Hence, pubertal timing involving rapid physical, emotional, and behavioral changes which are associated with an increased interpersonal and internal stress, and the emergence of mood problems might have occurred before the transition to Grade 7, the first year of our study. Since the average age of participants in our first year of study is 13.44 years old, it might have limited our ability to capture the critical time period of increased distress linked to the pubertal onset. Some studies who observed an increasing trajectory of depressive symptoms followed their participants from late childhood (e.g Grade 5 or 6) (Brengden et al., 2010; Marmorstein et al., 2010a). A follow up from early childhood through adolescence would have ensured that emotional changes linked to pubertal timing were captured.

Some differences emerged between our results and previous research findings regarding the proportion of adolescents allocated to each trajectory groups. Contrary to some studies looking at depressive symptoms (Brendgen et al., 2010; Costello et al., 2008) we found

that our largest trajectory group was the Medium psychological distress with 53.1% of our sample. This finding does not support our Hypothesis 3.1.5., which stated that the low psychological distress trajectory would represent the largest group in our sample. However, our results are similar to findings presented by Otten et al. 2010, where the largest trajectory group was the medium depressive symptoms trajectories. The second largest group was the Low psychological distress trajectory with 35.8% and the High psychological distress trajectory with 11.4%. These findings suggest that prevalence of psychological distress follows a relatively normal distribution, with most adolescents reporting moderate level of psychological distress and smaller percentage of adolescents reporting high or low levels of distress (Otten et al., 2010).

In sum, although adolescence is no longer characterized as a period of inevitable and universal storm and stress (Hall, 1908), our results suggest that the experience of mood disruptions such as psychological distress is commonly experience but follows different developmental patterns that are fairly stable over time.

Marijuana use and its association with psychological distress trajectories

Our results show that marijuana use at baseline was able to differentiate between the High and Low trajectories of psychological distress. This confirms our hypothesis (4.1.1) that a higher level of marijuana use in Grade 7 would be associated with a more problematic trajectory of psychological distress. A similar pattern of co-occurrence was observed when High psychological distress trajectory group was compared to Medium psychological distress trajectory group. We found that marijuana use at baseline increased the likelihood of following the more elevated trajectory of psychological distress. From these results, it can be concluded

that for some adolescents, marijuana use in Grade 7 is associated with a greater risk of experiencing elevated psychological distress across early adolescence. This is consistent with previous research findings that demonstrate that initial levels of adolescent substance use is linked to higher levels of internalizing symptoms (Brook et al., 2002; Fergusson et al., 2002, Trim et al., 2007). As mentioned previously, even if we observe an association between marijuana use in Grade 7 and trajectories of elevated psychological distress, our study design does not allow to determine the presence of a causal link between the two phenomena. However, our results provide some evidence that marijuana use and psychological distress do co-occur and for some adolescents, marijuana use in Grade 7 is associated with following a trajectory of elevated psychological distress.

The association observed between marijuana use and psychological distress can be explained by various mechanisms. Neuropsychological research has provided evidence that marijuana use may trigger neuropsychological changes putting marijuana users at greater risk of depressive symptoms when compared to non-marijuana users (Wilson et al., 2000). Understanding how Delta (9)-tetrahydrocannabinol (THC) acts on the cannabinoid CB1 receptors in the adolescent brain is crucial and will help further understand the underlying mechanisms between marijuana use and psychological distress (Mato, Del Olmo, & Pazos, 2003). More research is needed to determine whether it is possible that the cannabinoid system, upon which THC acts, is related to the regulation of emotional experience, and as a result have an impact on the development of depressive symptoms (Eggan & Lewis, 2006; Witkin, Tzavara, & Nomikos, 2005; Iversen, 2003). More research is needed in order to determine if and how changes to the cannabinoid systems due to THC use, put adolescents at greater risk of developing symptoms of depression and psychological distress.

Animal studies have provided some preliminary evidence for this hypothesis. It has been observed animals exposed to THC during adolescence can disrupt the regulatory role of the endocannabinoid system, producing long lasting consequences for adult brain function (Rubino et al., 2012). In some studies, depression like symptoms such as reduced social behavior, despair and anehedonia have been observed following after adolescent exposure to both synthetic or natural cannabinoids (Bambico, Nguyen, Katz, & Gobbi, 2010; Realini et al., 2010; Rubino et al., 2008), suggesting the presence of a link between depressive phenotype in adult animals after adolescent exposure to cannabinoids (Rubino et al., 2012; Martin, Ledent, Parmentier, Maldonado, & Valverde, 2002).

Some studies have also focused on the structural brain changes associated with marijuana use among adolescents (Verdejo-Garcia, Lopez-Torrecillas, Gimenez, & Perrez-Garcıa, 2004). There is some evidence that marijuana use, even at a low and infrequent dosage, might impact the development of the brain structure and development (Giedd, 2004; Medina, Schweinsburg, Cohen-Zion, Nagel, & Tapert, 2007; Tarter et al., 2003). In the recent study conducted by Medina et al. (2007) involving adolescents ages 16 to 18, explored the relationship between white matter and hippocampal volumes and depressive symptoms among marijuana users and controls. The authors found some preliminary evidence that marijuana use and white matter volume were additive and interactive in predicting depressive symptoms among adolescents. They concluded that the relationship between smaller white matter volume and depressive symptoms was most prominent among the marijuana users. These research findings provide promising new venues to explore as we attempt to detangle the mechanisms explaining the co-occurrence of marijuana use and psychological distress.

There is also the possibility that marijuana use and psychological distress are indirectly related due to the effect of marijuana use on the interpersonal development of teens. Baumrind and Moselle (1985) have been influential forces behind the hypothesis that adolescents who use psychoactive substances are more prone to emotional distress due to their difficulties to develop healthy interpersonal, self-regulatory, and coping skills. According to the authors, substance use during the critical developmental period of adolescence enables individuals to remain egocentrically focused and prevent the need for dealing with challenges inherent to adolescence (Baumrind & Moselle, 1985). It is hypothesized that substance use may suppress growth in psychosocial maturity by limiting these processes of engagement and coping with normative developmental challenges encountered in school, family, and peer environments (Dmitrieva, Mohanan, Cauffman, & Steinberg, 2012; Brown et al., 2008). Stunted psychosocial maturity and the lack of necessary skills for proper functioning may put adolescents substance users at greater risk of having difficulties to cope with the demands of their environment and experiencing negative outcomes such as lower levels of education and academic achievement (Fergusson et al., 2003; Fergusson & Woodward, 2002; Lynskey et al., 2003), relational and marital difficulties (Brook et al., 2011) and as mentioned earlier, failure to make a transition to adult roles and behaviors (Brook et al., 2002). There is evidence that the experience of such negative life events increase the likelihood of experiencing depressive problems and emotional distress (Wills, Vaccaro, & McNamara, 1992; Wills, Sandy, Shinar, & Yaeger, 1999). This chain of events involving substance use, psychosocial immaturity, negative life events and emotional distress could explain why marijuana users are more at risk of experiencing elevated levels of psychological distress through adolescence to adulthood. The recent study by Marmorstein & Iacono (2003) have demonstrated that psychosocial

failure partially mediated the association between cannabis use disorder (CUD) in adolescence and later major depressive disorder (MDD). Our study focuses on the early years of adolescence and more research is needed to better understand the implications of marijuana use on psychosocial immaturity, the achievement of development tasks and subsequent psychological distress throughout adolescence.

Finally, it is also important to note that the differences emerging between High psychological distress and Low psychological distress provide further evidence that adolescents who report less psychological distress are also less likely to use marijuana (Hypothesis 4.1.2). This is consistent with previous research findings strongly suggesting that adolescents who experience low level of psychological distress are better adjusted and are less likely to use marijuana (Tucker et al., 2006; Degenhardt et al., 2003).

In sum, the first part of our study provides evidence that marijuana use and psychological distress are phenomena with great heterogeneity as they develop over time. It was also demonstrated that there is co-occurrence of marijuana use and psychological distress since adolescents who reported psychological distress at baseline were more likely to follow an elevated trajectory of marijuana use and the reverse of the association was also true since adolescents who reported marijuana use at baseline were also more likely to follow an elevated trajectory of psychological distress. While independently examining the developmental change of marijuana use and the developmental change in psychological distress has value, the examination of their joint occurrence as they both develop over time is also important. Hence, to further explore the association between marijuana use and psychological distress, we proceeded to examine the longitudinal co-occurrence of these two phenomena by conducting our joint trajectory analyses.

Joint trajectory analysis

The first part of our joint trajectory analysis involved examining of the probability of psychological distress based on following identified trajectories of marijuana use. It was hypothesized that if problematic trajectories of marijuana use (High Users and Increasers) were followed, there would be an increased probability of also following the more problematic trajectories of psychological distress (High and Rapid Increasers) (Hypothesis 5.1.1). Since we failed to find a Rapid Increasers trajectory of psychological distress, our problematic trajectory was solely defined as the High level of psychological distress trajectory. Our results showed that following a High Users marijuana use trajectory increased the likelihood of following Medium and High psychological distress trajectories. It was also observed that High Users were also less likely to follow a Low psychological distress trajectory. Hence, our results do not support our first hypothesis (5.1.1) since following the High User marijuana trajectory has almost similar probability of following a High level (problematic) and Medium level (non-problematic) trajectories of psychological distress. From these results, it can be concluded that higher level of psychological distress is not always conditional on the high frequency of marijuana use.

This research finding suggests the presence of different pathways linking psychological distress and marijuana use. For some adolescents, frequent marijuana use is associated with psychological distress and evidence reviewed has shown that this subgroup of teens is greater risk of negative outcomes. Studies have consistently shown that the combination of marijuana use and psychological distress put adolescents at risk of greater psychosocial adjustment problems (e.g. Juon et al., 2011; Brook et al., 2011). Evidence from comorbidity studies has consistently suggested that the co-occurrence of problems is linked to

greater stress and poorer outcomes (Aseltine, Gore, & Colten, 1998). Hence, there is a high probability that similar negative outcomes would be observed when adolescents report high level of distress conditioned on a high level of marijuana use.

For some adolescents, frequent marijuana use is not related to psychological distress but negative consequences have also been associated with this pattern of use. Studies have also shown that marijuana use alone in early adolescence is linked to negative consequences such as escalated use, abuse and dependence of marijuana and other substance use (Gruber & Pope, 2002; Kandel, 2003), impaired emotional functioning (Dorard et al., 2008) and poor health and psychosocial outcomes later on in life (Fergusson & Horwood, 1997; Hall & Degenhardt, 2009; Arseneault et al., 2002; Fergusson et al., 2002). This subgroup of frequent marijuana users without psychological distress is of great interest. Why would some frequent marijuana users experience lower levels of psychological? Adolescence is a time period where peers become increasingly important and a great deal of time is spent in their company (McMahan, 2009). Since using substances usually occurs while interacting with peers, some adolescents who use marijuana frequently (e.g. High Users trajectory) may demonstrate greater social competence, have more friends and be popular. Recent studies support such hypothesis by demonstrating that popularity may be associated with higher levels of health risk behavior, such as substance use (Mayeux, Sandstrom, & Cillessen, 2008). Hence, for some teens, the frequent use of marijuana in early adolescence is not necessarily associated with emotional distress but rather motivated by status and peer acceptance. Despite the frequent use of marijuana, these teenagers who are overall well-adjusted could experience more connectedness and peer support resulting in experiencing low level of psychological distress.

Furthermore, the differences observed between frequent marijuana users and the longitudinal co-occurrence with psychological distress in early adolescence also have implications for our understanding of the etiology of substance use. Since the High Users of marijuana trajectory is not necessarily associated with the high level of psychological distress over time, this suggests that specific risk factors and mechanisms are involved to explain the longitudinal co-occurrence of these phenomena. Our results also show the importance of understanding the differences in developmental patterns as to inform prevention practices in order to ensure that the particular needs of these teens following an elevated trajectory of marijuana use with or without psychological distress are properly addressed.

Our conclusions regarding the Increasers marijuana subgroup provided further evidence of the complexity of adolescence substance use behavior as it relates to psychological distress. The Increasers group is considered a problematic trajectory since the use of marijuana in this trajectory augmented over time to the point where it surpasses the marijuana level of high users at the end of our study. Hence, in order to find support for our hypothesis 5.1.1, Increasers would also have to be more likely to follow a high trajectory of psychological distress. Our results showed that Increasers are more likely to experience a moderate level of psychological distress but have similar probability to experience low or high levels of psychological distress. This provides evidence that increasing marijuana use is not necessarily associated with following a high level trajectory of psychological distress. This finding further support that longitudinally, psychological distress is not conditionally associated with following a more problematic marijuana use trajectories.

Finally, our results also confirm that light marijuana users are more likely to follow less problematic trajectories of psychological distress (Low and Medium trajectories)

(Hypothesis 5.1.2). These findings are congruent with the current body of the literature indicating that adolescents who abstain from marijuana use or use only occasionally (few times a year) are better adjusted and experience less emotional distress (Degenhardt et al., 2010).

Taken together, these results demonstrate that the ability to predict psychological distress trajectory based on marijuana use over time is very limited since each trajectory of marijuana use is strongly associated with moderate levels of psychological distress. These findings suggest that marijuana use and psychological distress do co-occur in early adolescence but the frequent use of marijuana is not always related to high level of psychological distress. Few studies have been able to provide some evidence of differences in the longitudinal patterns of co-occurring elevated marijuana users and psychological distress in early adolescence. Consequently, these results need to be replicated in order to further explore the long-term association between marijuana use and psychological distress as they both develop in middle and young adulthood and the associated developmental outcomes.

The second part of our joint trajectory analysis involved exploring the probability of following a specific trajectory of marijuana use based on following various psychological distress trajectories. It was hypothesized that adolescents who followed an elevated level of psychological distress overtime would also be more likely to also follow a more problematic trajectory of marijuana use (Hypothesis 5.1.3). We also expected to observe that following a low trajectory of psychological distress in early adolescence would also increase the likelihood of following a less problematic trajectory of marijuana use (Hypothesis 5.1.4).

Our results show support for hypothesis (5.1.3) since teens in our sample who followed a trajectory of high level of psychological distress (High) were also more likely to follow the

more problematic marijuana use trajectories (e.g. Increasers and High Users). These results are in line with the self-medication hypothesis since it appears that adolescents who experience higher level of psychological distress are at greater risk of using marijuana. The increased probability of marijuana use among distressed teens may be explained by such factors previously discussed such as outcome expectancies or the reinforcement effect of marijuana use of negative affect. Since adolescents following a high level of psychologically distress trajectory are more likely to also follow problematic trajectories of marijuana use, it is possible that this co-occurring pattern occurs because the distressed teens turn to marijuana as a way of cope with their distress.

The results in this section of our study also demonstrate that almost one third of our teens in our sample with elevated psychological distress also follow the Light Users trajectory of marijuana use. Despite the experience of psychological distress, these adolescents do not use marijuana. The design of this study does not allow to determine if other substances (e.g. alcohol, cigarettes) are used by this subgroup of teens. Nevertheless, this subgroup of teens should be the focus of more research in order to better understand the factors or strategies leading to abstinence and occasional marijuana despite elevated psychological distress.

Finally, our results clearly show that adolescents with less problematic psychological trajectory (Low and Medium) are more likely to also follow a less problematic trajectory of marijuana use (Light Users) (Hypothesis 5.1.4). This result is consistent with previous research findings and provides further support that well adjusted adolescents are less likely to turn to risky behaviors such as marijuana use (Tucker et al., 2006; Degenhardt et al., 2010). Our results provide strong evidence that healthy/unhealthy behavior and emotional state tend to co-occur and are developmentally intertwined.

When examining the first two components of our joint trajectory analysis, we found evidence that marijuana use and psychological distress do co-occur in adolescence. We were able to detangle some aspects of these co-occurring patterns: following an elevated trajectory of psychological distress is associated with following a more problematic trajectory of marijuana use but the reverse association is less likely. Our results clearly show that following a trajectory of high marijuana use is not necessarily associated with following a higher level of psychological distress. Our research findings provide evidence that problematic levels for either marijuana or psychological distress have different implications as they develop overtime. We also found evidence that less problematic trajectories of marijuana use and psychological distress co-occur suggesting the importance of fostering mental well-being and preventing the development of adolescent risk behavior such as substance us since health behavior and mental state appear to be strongly related in early adolescence.

Finally, the last section of our joint trajectory analysis helped determining the probability of membership for marijuana use and psychological distress. Our results showed that the most common pattern of behavior in early adolescence is no use or experimentation of marijuana use with low to moderate level of psychological distress. These results are in line with the patterns of co-occurrence between marijuana use and depressive symptoms observed in the study conducted by Otten et al. (2010). Our research findings also demonstrate that a small percentage of teens (4% of our sample) will experience both elevated psychological distress and high level of marijuana use in early adolescence, indicating co-occurrence. This confirms that in early adolescence, some teens will experience a developmental overlap between these two types of distinct but related phenomena. The small percentage of co-occurring problems is concerning considering the low prevalence rate of marijuana use during

adolescence. As adolescents transition from early to late adolescence, the prevalence of marijuana use increases and it is very likely that the percentage of teens exhibiting high levels of co-occurring problems will follow the increasing trend.

In sum, our joint trajectory analysis has clearly demonstrated that there is co-occurrence of the marijuana use and psychological distress in early adolescence and that the developmental patterns of co-occurrence are complex. Our study provides evidence that adolescents reporting high psychological distress are at an increased risk for marijuana use but adolescents with high and increasing marijuana use are not necessarily at greater risk for psychological distress. This highlights the presence of an asymmetrical relationship between marijuana use and psychological distress in early adolescence. We also found evidence that only a small percentage of adolescents had both a high psychological distress and high marijuana use but this is to be expected considering the low prevalence rate of marijuana use in early adolescence. These findings have important implications for our understanding of etiology and prevention.

Implications of research findings

Adolescence is a period of special significance for the emergence or intensification of various forms of emotional and at risk behaviors (Steinberg, 2004). In the past decade, the increase in popularity of growth mixture models has contributed to the significant advances in our understanding of the development course of various issues affecting teens as they transition from childhood to adolescence. Few studies have examined the question of co-occurrence of marijuana use and psychological distress in early adolescence by using this new

methodology. Therefore, a great deal still remains to be explored regarding the development of these phenomena, their uniqueness, their commonalities and their interrelationship.

The present study extends the knowledge of previous studies in a many ways. First, it confirms that there is great deal of heterogeneity in the development of marijuana use and psychological distress trajectories in early adolescence. The ability to identify specific trajectories of psychological distress and to confirm the existence of previously identified trajectories of marijuana use is important since it allows the orientation of future research efforts towards the identification of correlates, antecedents and outcomes associated with the developmental trajectories (e.g. Fergusson et al., 2008). Our results also provide some evidence that psychological distress is fairly stable in early adolescence and that the increase in distress might occur before the transition to secondary school. This finding needs to be replicated in order to determine if the rapid increase occurs in late childhood and is followed by stable patterns of distress. Understanding this developmental pattern has important implications regarding the timing of preventive interventions.

Second, our study results confirmed the co-occurrence of marijuana use and psychological distress in early adolescence by conducting two separate sets of analyses. Evidence of co-occurrence was first observed by distinguishing differences between trajectories based on the level of psychological distress or marijuana use reported at baseline. Exploring this association was a necessary first step in order to better understand the characteristics of teens at greater risk of developing substance use or emotional issues as they transition to secondary school. Our research findings contribute significantly to the literature by providing some evidence that adolescents who reported higher initial level of psychological distress in Grade 7 are more likely to follow a problematic marijuana use trajectory (High

Users) when compared to less distressed adolescents. Also, adolescents who report higher use of marijuana use in Grade 7 are also more likely to follow a more problematic trajectory of psychological distress (High psychological distress) as compared lower psychological distress level (Low and Medium). To our knowledge, few studies have simultaneously explored this association in a sample of teens in early adolescence, a period of increased risk of marijuana use and psychological distress. Many studies have explored the association between marijuana use and psychological distress by focusing their effort on understanding one only aspect of the association between these phenomena (e.g. depressive symptoms associated with later marijuana use or marijuana use is associated with later depressive symptoms).

Third, observing various developmental patterns of marijuana use and psychological distress confirmed the necessity to study these development patterns as they concurrently develop over time. Few studies have used this relatively new methodology of joint trajectory analysis to examine the development and co-occurrence of different behaviors such as marijuana use and psychological distress (Otten et al., 2010). Our results demonstrated that there is an interrelationship between marijuana use and psychological distress and that this co-occurrence is more pronounced for adolescents who report high levels of psychological distress while the reverse association involving high marijuana level is less likely. Our study is unique as it provides some evidence of an asymmetrical association between marijuana use and psychological distress. To our knowledge, this is the first study to demonstrate such patterns of co-occurrence. Since there is great deal of heterogeneity in the developmental trajectories of marijuana use and psychological distress, more research efforts are needed to replicate our study findings to help confirm the patterns of co-occurrence observed in this study.

Finally, even if our study provides strong evidence that marijuana use and psychological distress tend to co-occur in some teens, our study also shows that there is a large proportion of teens who do not use marijuana or experience elevated levels of psychological distress as they transition through early adolescence. Risky behaviors (e.g., substance use, delinquency, risky sex) and indices of distress (e.g., depressive affect) have been a longstanding concern in the literature and researchers and clinicians tend to focus on adolescents' problems since they are easier to identify, are better defined and conceptualized (Schulenberg, 2006; Benson, Mannes, Pittman, & Ferber, 2004). Fortunately, healthy and positive adolescent development has become an area of growing interest and efforts are made to better understand how to promote mental health and healthy behavior among adolescents (Seligman & Csikszentmihalyi, 2000). Studying adolescents who follow less problematic trajectories of marijuana use and psychological distress could provide valuable insight regarding the promotive factors contributing to their healthy development and well-being.

Preventive intervention

In the past decades, there has been a concerted effort by researchers and clinicians to develop effective preventive interventions (Catalano et al., 2012; Botvin, 2000; Gottfredson & Wilson, 2003). Evidence based preventive interventions have been implemented in schools, families and communities and can follow a universal, selective or indicated approach. Important distinctions exist among these different approaches. Universal prevention programs focus on the general population and aim to deter or delay the onset of a condition or behaviour. Selective prevention programs target subsets of the population believed to be at high risk due to membership in a particular risk group and indicated prevention programmes

are for those already showing early danger signs or engaging in related high risk behaviours (Botvin & Griffin, 2010a; Nehmy, 2010).

To our knowledge, preventive intervention programs tend to address substance use or depression issues separately with each targeting an array of individual risk and protective factors associated with their respective problems (Botvin & Griffin, 2010b). Drug prevention programs are also frequently delivered in school settings and usually target younger adolescents during the critical transitional period from elementary school to middle school (between ages 11 and 13 years) (Botvin & Griffin, 2010a). The aim of universal intervention is to reach adolescents before they have begun using tobacco, alcohol and marijuana. These substances are targeted because they are the most widely used substances among both teens and adults and they are typically the first substances that youth experiment with (Johnston et al., 2012). Overall, these programs focus on teaching drug refusal skills, correcting normative expectations regarding the prevalence of substance use, and enhancing general social and personal competence skills (Botvin & Griffin, 2007).

Universal interventions for preventing depression are also often conducted in schools (Spence, Sheffield, & Donovan, 2003; Shochet et al., 2001). A common format involves large-group presentations and a focus on learning cognitive and behavioral skills training such as cognitive restructuring, anxiety management, relaxation, problem-solving skills, anticipating consequences, and assertiveness. General strengths associated with universal interventions include avoiding the stigma of singling out individuals for treatment, the generally low cost of implementation and relatively low dropout rates (Horowitz & Garber, 2006). An important weakness of these universal preventive intervention programs is that they are unable to address the individual needs of their participants.

Our results demonstrate that prevention programs targeting marijuana use and/or emotional distress should consider the developmental course of the adolescent and his or her individual needs. Most substance use prevention programs are guided by the assumption that adolescents follow a general developmental progression that is typically characterized by onset during early adolescence, a peak in late adolescence, and a gradual reduction during young adulthood (Botvin & Griffin, 2010a). Our findings clearly indicate that using such model may be of limited relevance since there is a great deal of heterogeneity in the development of substance use behaviors. Similar patterns of heterogeneity were observed for the trajectory of psychological distress which also suggests that adopting selective or indicated approaches might be more effective in addressing the adolescents' needs.

The various developmental trajectories identified in our study also confirms that some teens are more likely to take a severe and chronic course thus requiring more extensive prevention interventions at an early age (Zucker et al., 2006). Conversely, trajectories showing a minimal or mild course may benefit from alternative, less extensive preventive programs (Clark et al., 2006). The results of our trajectory analyses also suggest that some teens experience high level of marijuana use and psychological distress before they transition to secondary school. Hence, prevention programs should be implemented in elementary school prior the entry to secondary school. Preventive intervention programs before the transition into adolescence could improve our ability to prevent or lessen the severity of co-occurrence of marijuana use and psychological distress in early and late adolescence (Hawkins, 2009).

The co-occurring developmental patterns of marijuana use and psychological distress and the asymmetry of the relationship also provide strong support for the use of selective or indicated preventive interventions. Our co-occurring patterns of psychological distress and

marijuana use show that in some instances, an adolescent presenting with psychological distress may also benefit from a prevention intervention targeting substance use behaviors. Our results also suggest that considering that some marijuana users are at greater risk of distress, combining substance use prevention with components addressing issues of psychological distress may be beneficial considering the increased risk of developing this co-occurring pattern. Such preventive intervention would address substance use but could also focus on emotional coping strategies and the development of social skills. This combined approach would address the concurrent development of emotional distress and marijuana use experienced by this subgroup of teens. In other cases, adolescents with marijuana use problems may benefit from more traditional prevention approach with an emphasis on drug refusal skills, correcting normative expectations regarding the prevalence of substance use, and enhancing general social and personal competence skills training since there are at lesser risk to emotional distress.

An important challenge faced by selective or indicated early intervention programs is to adequately target teens that are the most at risk of developing substance use problems or mental health issues. Since financial and human resources allocated to prevention intervention are finite, difficult choices need to be made regarding adolescents which adolescents would most benefit from the intervention. Our study results provide evidence that the screening process should be guided by empirical knowledge on development course of marijuana use and psychological distress. Since psychological distress appears to have great implication regarding the development of problematic marijuana use patterns, it might beneficial for prevention programs to target adolescents at risk of psychological distress.

Substance use is a very complex phenomenon and many variables not considered in this study might shape the developmental trajectories of marijuana use and/or psychological distress. Consequently, continued research efforts are needed to better understanding the co-occurring developmental course of marijuana use and psychological distress in order to better develop selective or indicated preventive interventions for teens. Furthermore, a better understanding of the interrelationship of these phenomena has implications on our ability to adequately identify children and adolescents at risk of engaging in more problematic developmental trajectories and to develop more effective prevention programs.

Even if our findings suggest that a selective approach to prevention might be beneficial for various subgroups of teens, it should not be overlooked that a large proportion of young teens do not exhibit significant problems linked to marijuana use and psychological distress throughout early adolescence. Most preventive intervention approaches tend to be deficit-oriented, emphasizing youth problems (Gottfredson & Wilson, 2003) but we believe that prevention efforts should also involve healthy and well-functioning teens. Our findings demonstrate that many teens do not encounter significant marijuana use and/or psychological distress issues, which means that these adolescents do possess the internal strength and resources to handle various challenges as they navigate the adolescent years. A lot can be learned from these teens and preventive interventions should place greater emphasis on promoting developmental strengths, honing healthy and prosocial behaviors, skills development and competences in addition to their usual focus on the reduction and prevention of unhealthy behavior such as substance use or emotional distress.

Study limitations

Although the present study is innovative and contributes to a better understanding of the co-occurrence between marijuana use and psychological distress in early adolescence, some limitations are important to mention. A first limitation is that all data collected in this study is based on self-report. Self-ratings may lead to bias and distorted responses and it is therefore possible that participants under or over reported the level of marijuana use and/or psychological distress. Social pressures associated with early adolescence may affect the quality of participants' responses. For example, some adolescents may believe that it is "cool" to use marijuana but less desirable to report experiencing emotional difficulties. A combination of multiple raters such as parents or teachers would help to compensate for the tendency for adolescents to either over- or under- report their behaviors (Connell, Dishion, & Deater-Deckard, 2006). A second limitation of this study is that we used a convenience sample. Consequently, the data collected is not representative of the adolescent population and limits our ability to generalize our research findings.

Another limitation worth mentioning is our measure of marijuana use, which is based upon a single survey item. It is widely recognized that substance use behavior is complex and includes not only the frequency of the behavior but also the quantity of the substance use and the duration of use (Day & Robles, 1989). The use of a validated assessment measures (e.g. *Drug Abuse Screening Test for Adolescents* (DAST-A), CRAFFT or DEP-ADO) would have provided a more comprehensive understanding of the substance use behavior (Martino, Grilo, & Fehon, 2000; Knight, Sherritt, Shrier, Harris, & Chang, 2002; Landry, Tremblay, Guyon, Bergeron, & Brunelle, 2004). Nevertheless, the use of a single item provided the necessary information to establish patterns of marijuana use over time.

Another limitation involves the time of follow-up of our study. Marijuana use and psychological distress were measured from Grade 7 to Grade 9, which covers a limited window to observe the evolution of these phenomena. A longer time frame ranging from childhood through adulthood would provide a more complete picture of the distinct longitudinal trajectories and might facilitate the identification of other trajectories such as early onset, late onset, rapid increasers or decreasers for marijuana use and/or psychological distress. Different co-occurring patterns between marijuana use and psychological distress might have also emerged.

Another important limitation to our study is the narrow focus adopted to explore the co-occurrence between marijuana use and psychological distress. There is evidence that this association is likely to involve a complex interaction of individual, family and social environmental factors, as well as genetic and biological influences (van den Bree & Pickworth, 2005; Best et al., 2005; von Sydow, Lieb, Pfister, Hofler, & Wittchen, 2002). The integration of all these potential variables was beyond the scope of this study. Our sample size required a careful selection of variables to include in our analyses in order to be able to detect any association among them. Therefore, even if certain variables were not included in this study, we recognize that they might have played a role in the association observed between psychological distress and marijuana use and should be the focus of subsequent research. For example, recent studies show that potential common variables include self-control (Otten et al., 2010) behavioral problems, antisocial behavior or delinquency (Marmorstein, Iacono & Malone, 2010; Pardini, White, & Stouthamer-Loeber, 2007) and peers (Dishion & Owen, 2002). It remains possible that the association observed between marijuana use and psychological distress is mediated or moderated by variables not accounted for in this study.

Finally, as observed in some studies (Capaldi and Stoolmiller, 1999, Fergusson & Woodward, 2002), it is also possible that the inclusion of certain variables not considered in this study would eliminate the association observed between marijuana use and psychological distress.

Finally, some limitations are inherent to group-based modeling as discussed previously in the methodology section. It should also be noted that, despite the longitudinal design, causality could not be determined due to our inability to determine the temporal sequencing of marijuana use and psychological distress or account for antecedents that might have contributed to both phenomena. There is strong evidence that psychological and behavioral conditions in childhood, such as conduct problems and depressed mood, increase the risk for the full range of substance involvement, including use, problem use, and substance-related disorders and depressive problems in adolescence (Mason et al., 2009; Glantz & Leshner, 2000). Including some of these variables should be considered in future research.

These limitations notwithstanding, we believe that this study provides important new insights regarding the development and the co-occurrence of marijuana use and psychological distress in early adolescence.

Future research

A better understanding of co-occurrence of marijuana use and psychological distress will require continued research efforts. Although early adolescence was the main focus of this study, we believe that research projects should extend their time frame in order to provide a more complete picture of the distinct longitudinal trajectory profiles of psychological and marijuana use. Replicating our study using a longitudinal design prior to Grade 7 and into young adulthood would permit to better understand the timing of onset of these phenomena,

their antecedents and outcomes and might help clarify the causal ordering of events. A number of studies have found that the relationship between depression-anxiety and drug use abuse is stronger for girls than for boys (Federman, Costello, Angold, Farmer, & Erkanli, 1997; Patton et al. 2007). Hence, there is also a need to study the developmental patterns and co-occurrence of marijuana use and psychological distress in boys and girls separately in order to determine the implications of gender differences in the joint developmental course of these phenomena. Few studies have specifically explored the developmental trajectories based on gender and focusing on these differences may help uncover unique patterns of development and associated risk factors and outcomes.

Our study also shows that the relationship between marijuana use and psychological distress is asymmetrical, with psychological distress having a greater effect on emergence of marijuana use problems in early adolescence than the reverse. However, our study only sheds modest light regarding the underlying mechanisms involved in explaining the co-occurrence between marijuana use and psychological distress. Few studies have explored the interrelationship of these phenomena during early adolescence (e.g. Otten et al., 2010) and there is a need to continue our efforts to identify those adolescents who are at heightened risk for developing marijuana use problems and elevated levels of psychological distress. Our study identified a small percentage of participants with this co-occurring pattern in early adolescence when marijuana use prevalence is relatively low. Therefore, it is very likely that the proportion of teens following this pattern of high distress and marijuana use may increase over time and therefore require our specific attention.

Furthermore, since the association between marijuana use and psychological distress is complex, more research is needed to explore the role of potential "common variable" in this

association while accounting for the heterogeneity. It is possible that for some subgroup of adolescents, the co-occurrence between marijuana use and psychological distress is non-causal and arises because of common risk factors and life processes associated with the development of both outcomes. Even if it is difficult to control for all the influence of potentially related variables associated with marijuana use and psychological, more efforts need to be made to achieve this goal. Failing to isolate the effects and contribution of variables makes it difficult to draw clear conclusions about the nature of the relationships (Degenhardt et al., 2003). In addition to controlling for certain variables, there is a need to build on the work presented in this study and the work of Otten et al., (2010) which involve understanding the role of self-control in this association. The role of conduct problems/delinquency, which is also associated with poor self-control should be further explored.

Using new analytical approach such as propensity score matching, would help control for confounding variables and better explore the association between marijuana problems with psychological distress. This technique mimics an experimental design and compares individuals with and without marijuana problems who are as similar as possible on the other measured covariates (Nagin & Odgers, 2010b; Harder et al., 2008). Using propensity score techniques with development trajectories will help to detangle the nature of the association between marijuana use and psychological distress.

The question of causality is an important aspect of the relationship that needs to be further explored and this cannot be answered with the analytical approach used in this study. Future research should focus on establish possible causal relationship from one behavior to another and statistical approaches, such as cross-lagged analyses, could be useful to address these questions.

Our study contributes to a better understanding of co-occurring patterns of marijuana use and psychological distress but eventually further research efforts should focus on exploring the co-occurrence of marijuana use with other substances, especially alcohol and cigarettes since they are the most commonly substance used in adolescence. It would be useful to investigate if polysubstance use, which is usually associated with more severe level of substance use, is more likely to co-occur with elevated levels of psychological distress. More research is also needed to test whether the co-occurring patterns observed between marijuana use and psychological distress is also observed with other co-occurring psychological problems such as anxiety (Ollendick, Seligman, Goza, Byrd, & Singh, 2003).

As highlighted in our discussion about the self-medication hypothesis, motives for marijuana use might be an important factor to consider in the development and interrelationship between marijuana use and psychological distress. Self-report studies exploring the motives for marijuana use in late adolescence and young adulthood have found the most common reasons for marijuana use include for enjoyment and fun, followed by conformity, experimentation, social enhancement, boredom, and relaxation (Lee, Geisner, Lewis, Neighbors, & Larimer, 2007; Arendt et al., 2007). Other common reasons were to relieve unwanted emotions such as depression and aggression (Clark et al., 2011). Common expectations associated with substance use include the reduction of negative affect, enhancement of positive affect, creativity and social cohesion (Skenderian, et al., 2008; Jones, et al., 2001; Hooshmand et al., 2012). Based on this evidence, further studies should explore substance use motives as it may provide some explanation for the underlying mechanism at play in the co-occurrence of marijuana use and psychological distress.

Conclusion

The importance of fully understanding the relationship between marijuana use and psychological distress cannot be overestimated. As mentioned in our first chapter, research is crucial as to inform clinical practice. Our results suggest that marijuana use and psychological are interrelated and tend to co-occur but there is asymmetry in the relationship with psychological distress having greater implications in the development of marijuana use trajectory.

Adolescence represents period of life when teenagers lay the foundations for the future career, develop social skills, establish friendships and romantic relationships and for some adolescents, marijuana use and psychological distress might reduce the likelihood of these tasks being completed successfully. Efforts need to be made to better understand who these teenagers are and factors can influence the shape of their trajectories. Consequently, a better understanding of the developmental course of marijuana use, psychological distress and the developmental interrelationship between these phenomena in early adolescence is important in order to determine the distinct processes involved and the implications for intervention.

Research efforts have helped understand this phenomenon in adolescence but many questions remain but unfortunately, the knowledge gained over the years has not transpired in our substance use policies. Our study provides additional evidence that a majority of teenagers in early adolescence do not use marijuana or are experimenters and experience low to moderate levels of psychological distress. Consequently, investing in prevention should be a priority and target these adolescent in the early years of secondary school. Current policies should be changed to achieve such objectives. Furthermore, our results show that a "one size fits all" approach is not indicated as resources for prevention and intervention should be

dedicated to help teens at greater risk of problematic developmental patterns of marijuana use and psychological distress.

We hope that our study have provided new elements to add to the knowledge base regarding the different patterns of behaviors necessary to improve preventive intervention services offered to teens. Our results show that more emphasis should be placed on addressing the psychological distress. Intervention should also focus on developing the internal strengths and competence of teens. Despite difficulties, adolescents demonstrate an incredible resilience and ability to cope. As researchers and clinicians, we have to continue our efforts to gain knowledge in order to offer new venues for intervention programs in order to change the developmental course children and adolescents.

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Internet sources

Centre for Addiction and Mental Health
http://www.camh.net/

Addiction Prevention Center / Centre québécois de lutte aux dépendances (CQLD)
http://www.cqld.ca

http://www.andrew.cmu.edu/user/bjones/

APPENDIX A

Consent Form

Université de Montréal

Faculté des arts et des sciences
Département de psychologie

Le questionnaire auquel tu viens de répondre va nous permettre de mieux connaître la vie et les problèmes des jeunes de 11 à 18 ans, en l'an 2000.

Notre projet est maintenant de poursuivre cette étude pour voir si les choses évoluent, si les problèmes changent et comment.

Ta collaboration est donc précieuse pour continuer cette recherche.

Pour cela nous avons besoin de tes coordonnées (nom et signature). Dans un an, nous te demanderons de répondre à un questionnaire assez semblable à celui-ci, auquel tu resteras libre de répondre ou non.

Comme pour cette année, la confidentialité des réponses sera totalement garantie. Aucun nom n'apparaît sur le questionnaire, seul apparaît le numéro de dossier qui t'a été attribué. Un fichier informatisé anonyme sera constitué comprenant uniquement tes réponses et le numéro de dossier qui t'a été attribué.

La liste des coordonnées et des numéros de dossier sera conservée dans un coffre fermé et sera détruite à la fin de l'étude. Seuls les membres de l'équipe de recherche de Michel Claes à l'Université de Montréal auront accès à cette liste.

Tu peux exercer ton droit d'accès à l'information et à la rectification de tes réponses en prenant contact avec:

Michel Claes
Département de Psychologie
Université de Montréal
C.P. 6128 Montréal (Qc.) H3C 3J7

J'accepte de participer au suivi de la recherche réalisée par l'équipe "Réseau Social des Adolescents" dirigée par Michel Claes, professeur au Département de Psychologie, Université de Montréal.

NON: ..... OUI: ..... (coche la case qui répond à ton choix)

Date.....

Ton nom: .....

Signature.....

0069

.....

C.P. 6128, succursale Centre-ville
Montréal QC H3C 3J7 Télécopieur : (514) 343-2285

APPENDIX B

Indice de Détresse Psychologique de l'Étude de Santé Québec (1992)

Q. Pourrais-tu dire si, **au cours de la dernière semaine**, tu as éprouvé les choses suivantes:

1 = jamais 2 = de temps en temps 3 = assez souvent 4 = très souvent

	Jamais	De temps en temps	Assez souvent	Très souvent
1. Je me suis senti(e) tendu(e) ou sous pression.....	1	2	3	4
2. Je me suis senti(e) désespéré(e) en pensant à l'avenir.....	1	2	3	4
3. Je me suis laissé(e) emporter contre quelqu'un ou quelque chose.....	1	2	3	4
4. J'ai eu des blancs de mémoire.....	1	2	3	4
5. J'ai ressenti des peurs ou des craintes.....	1	2	3	4
6. Je me suis senti(e) seul(e).....	1	2	3	4
7. Je me suis senti (e) négatif(ve) envers les autres.....	1	2	3	4
8. J'ai eu des difficultés à me souvenir des choses.....	1	2	3	4
9. Je me suis senti(e) agité(e) ou nerveux(se) intérieurement.....	1	2	3	4
10. Je me suis senti(e) découragé(e) ou j'ai eu les bleus.....	1	2	3	4
11. Je me suis senti(e) facilement contrarié(e) ou irrité(e).....	1	2	3	4
12.Je me suis senti(e) ennuyé(e) ou peu interessé(e) par les choses.....	1	2	3	4
13. Je me suis fâché(e) pour des problèmes sans importance.....	1	2	3	4
14. J'ai pleuré facilement ou je me suis senti(e) sur le point de pleurer.....	1	2	3	4

APPENDIX C

Substance Use

V. Des jeunes de ton âge fument, boivent ou prennent de la drogue. **Au cours des douze derniers mois**, **encercle le chiffre** qui correspond à ta consommation.

1. **= jamais**
2. **= quelquefois**
3. **= au moins une ou deux fois par mois**
4. **= au moins une ou deux fois par semaine**
5. **= tous les jours**

1. As-tu fumé la cigarette?…….	1	2	3	4	5
2. As-tu pris de la bière, du vin, ou d'autres boissons alcoolisées?……	1	2	3	4	5
3. As- tu pris de la marijuana, du pot, des joints du haschisch ou du cannabis……	1	2	3	4	5
4. As-tu pris des speeds, extasy ou autres stimulants?……..…..	1	2	3	4	5
5. As-tu pris des hallucinogènes : buvards, champignons, mescaline, PCP?…….	1	2	3	4	5

Si tu fumes plus d'une cigarette par jour, écris le nombre ici : ……..

(si tu ne fumes pas écris zéro)