EXPLORING THE RELATIONSHIP BETWEEN CANNABIS USE EXPECTANCIES AND THE INITIATION OF CANNABIS USE AMONG CANADIAN ADOLESCENTS

by

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B.Sc., The University of British Columbia, 2017

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

in

THE FACULTY OF GRADUATE AND POSTDOCTORAL STUDIES

(Population and Public Health)

THE UNIVERSITY OF BRITISH COLUMBIA

(Vancouver)

September 2017

Abstract

BACKGROUND: Canada has one of the highest reported rates of adolescent cannabis use among industrialized countries and plans to legalize recreational cannabis use for adults. However, research suggesting that cannabis use during adolescence may be associated with health risks has led to a call for monitoring the impact of legalization on use by adolescents. Based on evidence that identifies outcome expectancies (expectations regarding the effect of substance use) and intention to use as significant predictors of tobacco smoking and alcohol drinking among adolescence, monitoring efforts associated with the upcoming cannabis regulation may benefit from the use of similar predictors.

OBJECTIVE: This study aimed to examine the validity of the Marijuana Effect Expectancy Questionnaire-Brief (MEEQ-B) as a measure of cannabis use expectancies and then examine the relationship between expectancies and the intention to use cannabis, as well as their predictive utility as indicators of future cannabis use.

METHODS: Data were collected from 1592 high school students aged 14-16 years participating in British Columbia Adolescent Substance Use Survey during the 2011/2012 school year. Confirmatory factor analysis was conducted to evaluate the psychometric structure of the MEEQ-B, and generalized estimating equation (GEE) using logit link was used to examine the relationship between expectancies, intention to try, and initiation and lifetime use of cannabis.

RESULTS: The initial two-factor structure of MEEQ-B did not provide a good fit to the data. However, cross-loading item 6 onto both positive and negative expectancies factors resulted in a

good fit. After controlling for gender, ethnicity, age, and socio-economic status, results of the GEE indicated that positive expectancies were significantly and positively associated with lifetime cannabis use (AOR: 2.47), and initiation of cannabis within six months (AOR: 1.9), whereas the reverse trend was found for negative expectancies. Having at least some intention to try cannabis increased the odds of cannabis initiation by seven times (AOR: 6.91).

CONCLUSION: Revision to the MEEQ-B questions is needed to reliably measure expectancies related to adolescent cannabis use. In support of Integrative Model of Behavioral Prediction, expectancies and intention to use can be utilized as upstream indicators for future cannabis initiation.

Lay Summary

Research suggesting that cannabis use during adolescence may be associated with health risks has led to a call for monitoring of the impact of the legalization of recreational cannabis use by adults on use by adolescents. While adolescents' perceptions regarding the effects of substance use have been repeatedly shown to shape their intention and decision to try tobacco smoking and alcohol drinking, very little research has examined the relationship between these perceptions and adolescents' intention and decision to try cannabis. The results of this thesis contribute to our understanding and ability to monitor the cannabis expectancies held by adolescents and how they predict the intention to try cannabis as well as the initiation of cannabis use.

Preface

Chapter 2 and 3 were based on secondary data analyses of Wave 5 and 6 of British Columbia Adolescent Substance Use Survey (BASUS) that was funded by CIHR (MOP-86729). I was responsible for all analyses presented in this thesis and cleaning the relevant collected data. This thesis was written by me under the guidance and recommendations provided by my thesis supervisor, Dr. Chris Richardson, and my thesis committee members, Dr. Eugenia Oviedo-Joekes and Dr. Dan Werb. The study presented in Chapter 2 and 3 has been approved by the UBC Behavioral Research Ethics Board (H16-02034).

A version of Chapter 2 has been presented as a poster at the Society for Adolescent Health and Medicine (SAHM) Annual Meeting in New Orleans in March 2017. The poster abstract was published in the supplement issue of Journal of Adolescent Health: Hapsari AP, Pumarino J, Oviedo-Joekes E, Richardson C. Examining the relationships between cannabis use expectancies and the intention to use, the initiation of use, and frequency of cannabis use among Canadian adolescents. Journal of Adolescent Health. 2017;60(2, Supplement 1):S121. I conducted the testing, wrote the abstract, and created the poster.

A version of Chapter 2 will also be submitted for publication: Hapsari AP, Oviedo-Joekes E, Werb D, Richardson E. 2017. Examining the relationship between cannabis use expectancies, intention to use cannabis, and initiation of cannabis use among Canadian adolescents.

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Acknowledgements

I would like to offer my profound gratitude to my thesis supervisor, Dr. Chris Richardson whose wisdom, experience, commitment, and moral support have guided me throughout my entire training program. I am deeply inspired by the kindness and unwavering support that you showed to all of your students.

My sincere thanks is dedicated to Dr. Dan Werb for providing his expertise in health policy and valuable feedback that improve the relevance of my thesis to social context and public good. I also would like to thank Dr. Eugenia Oviedo-Joekes for helping shape the rationale of my study and encouraging me to challenge my assumptions in the thesis and to be critical in my approach to the literature.

I also wish a sincere thank you to all of the students who took the time to participate in this study, as well as the school staff and administrators who helped with the study promotion and implementation. Without them, the completion of this study would not have been possible.

I am greatly indebted by the friendships and help that my fellow students at the School of Population and Public Health offered both in my thesis and course work. I would like to thank Javiera Pumarino for teaching me how to use various software and answering all of my thesis-related questions and beyond. Thank you also to Scott Emmerson for providing feedback on any measurement-related conundrums. I am grateful to be part of a graduate cohort who are supportive of one another. I wish you all great success in your endeavours.

Finally, I would like to extend my gratitude to all of the faculty members, staff, and fellow students at SPPH who made my MSc journey an enjoyable and enriching one.

Dedication

I would like to dedicate my thesis to my parents, Bapak and Mama. Your enduring encouragement and support, even during a testing time, have motivated me to always struggle and strive for the better. Your work ethics and the sacrifice you have made for my brother and I are nothing short of inspirational. I love you both.

Chapter 1: Introduction

As discussion surrounding the legalization of recreational cannabis use for adults gained more profile in the mainstream media during the previous Canadian election cycle[1,2], the development of strategies to monitor the potential impact of legalization on a range of health and social outcomes has been prioritized by health policy makers, researchers, politicians, and the public alike[3]. Although legal access for adults to recreational cannabis served as one of the key platforms endorsed by the current Prime Minister during the election campaign[2,4], cannabis remains a Schedule II drug under the Controlled Drug and Substances Acts, which restricts the production, possession, and distribution of cannabis to medical cannabis that is regulated by Health Canada[5]. It is still considered a criminal offence to possess and distribute cannabis under the current law[5]. While Cannabis Act bill that proposes legalization and regulation of distribution of recreational cannabis use is planned to move through the legislative process to become a federal law by July 2018[6], the initial ambiguity in the implementation timeline[7,8] and continued media coverage on the debates around the pros and cons of the legalization[3,9] have resulted in debates on the best approach to implementation at provincial level and limited an open and honest discussion on the potential impacts of the new policy on cannabis use outcomes, especially among young people[10,11].

Despite uncertainties related to the implementation of the proposed legalization, the Government of Canada has recognized the benefits of and voiced their commitment to legalizing, regulating, and restricting access to marijuana[12]. An exhaustive report by the Task Force on Marijuana Legalization and Regulation commissioned by the Government of Canada provided an overview of key objectives associated with the new policy and encouraged continued discussions and consultations with diverse stakeholders comprised of community leaders and

regulatory bodies across Canada[13]. It is important to note that the discussion paper also underlined the shortcomings of the current policy based on cannabis prohibition, such as the failure to reduce cannabis use by Canadian youths[13].

Current investigations into the effects of cannabis use during adolescence have been met with some challenges, given that the potential effects of cannabis are governed by both their dosage and potency, which are hard to estimate as the amount of active ingredients in the cannabis, substance content, and mode of administration may differ between each use[14,15]. While many studies have found associations between psychological disorders and cannabis use during adolescence, the nature of the methodological approaches often could not confirm a causal relationship in which cannabis use precedes the development of psychological disorders[16]. Results from studies also indicate that abnormal brain connectivity and behavioral disorders during childhood may influence cannabis use trajectory and are associated with a higher risk of regular cannabis use during adolescents and later life stages[17,18], thus suggesting that the risk for mental illnesses may have existed prior to cannabis initiation.

Regardless of the uncertainty, emerging evidence indicates that some risk factors in adolescence are associated with particularly high vulnerability to both early initiation of cannabis use and its harmful effects. For example, adolescents with family history of mental illness and those who have poor cognitive functioning are at a heightened risk of using cannabis regularly and are more likely to develop dependence[19,20]. Additionally, emerging epidemiological evidence from longitudinal studies show that higher frequency and earlier initiation of cannabis use are associated with a higher risk of depression and other mental health issues[21,22]. New evidence also indicates that approximately one in six people who initiate cannabis use during adolescence will go on to develop dependency[23]. This association is also supplemented by the findings that

adolescents who use cannabis regularly often do so to cope with difficult or stressful situations, such as overcoming social anxiety and coping with child maltreatment[24,25]. These reports underline the variability in vulnerability of adolescents to problematic use of cannabis and its potentially harmful effects, and support further investigation into the mechanisms that underlie the pathways of risk for cannabis use during adolescence to inform prevention of regular use at an early age.

Currently, the rate of cannabis use among Canadian youths is reported to be one of the highest among industrialized countries, with up to 32% of Canadians aged 12-18 years reporting past-year cannabis use according to the survey conducted by Canadian Centre on Substance Abuse in 2015[15]. This large scale survey has also reported that on average, cannabis users in Canada first tried cannabis at the age of 14 years[15], with some high school students reporting high frequency of cannabis use, amidst growing evidence showing a significant association between longer and frequent use of cannabis with increased risk of harmful health effects[14]. Furthermore, cannabis is reported to be the most commonly used illicit substance among Canadian youths (aged 15-19 year old), making up over 20% of illicit substances used in the past years[26]. In 2013, about 19% of high school students (Grades 7-12) in Canada reported use of cannabis in the past year with the rate of use increasing with grade level across all provinces[27]. These reports highlight the need for creating a legalization policy that addresses cannabis use among Canadian adolescents and incorporates the objectives outlined in the policy framework proposed by the special Task Force, including protecting public health safety by applying similar restrictions for advertising and promotion of cannabis items as tobacco products, and ensuring that the public is well informed of the risks of cannabis use, particularly among youths[13].

Despite the seeming popularity of cannabis, a steady decline in the proportion of Canadian youths who had ever used cannabis has been observed in the past decade[26]. A similar decreasing trend in cannabis use has also been observed among adolescents (Grades 7-12 students) in British Columbia (BC), in which the rate of past month cannabis use decreased from 21% in 2003 to 15% in 2013, according to results from the 2013 McCreary Centre Society's Adolescent Health Survey[28]. The prevalence of lifetime cannabis use by adolescents also dropped by 9% in 2013 from 37% in 2003[28]. Additionally, the results of the Adolescent Health Survey indicated that although the national average age of cannabis use initiation was similar to that in BC at 14 years old[29,15], the proportion of adolescents who waited until the age of 15 to try cannabis for the first time increased two-fold over the past decade, signaling a trend towards a slight delay in the age of initiating cannabis use[29]. While BC has experienced decrease in overall use of cannabis among its adolescent population, it remains the province with the highest prevalence of reported past-year cannabis use across Canada[30]. It is therefore important to further inform the public health approach to regulation of cannabis by continuing to conduct research that assists in monitoring the trend of adolescent cannabis use and identifies potentially important determinant of problematic use that can be targeted by intervention.

The following sections of the first chapter of this thesis provide a brief overview of adolescence as a period of vulnerability, the theory that summarizes pathways to cannabis use, and political forces that frame the current discussion around cannabis use. The rationale and objectives of this thesis are then presented at the end of this chapter.

1.1 Adolescence as a vulnerable period for initiation of cannabis use and associated risk of adverse consequences during this developmental period

The heightened risk of substance use during adolescence has been attributed to the significant psychological and physiological changes during puberty that coalesce with the dramatic changes in the social environments of adolescents[31]. For example, adolescents who are having difficulties coping with stress from an increasing work load in secondary school or the work place have been shown to be more likely to try cannabis and other substances[32]. During this developmental period, adolescents also begin to place more values on their relationship with their peers[33,34], and the peer pressure for engaging in risky behaviors can influence their decision to remain abstinent from using substances[35,36]. The risk of substance use initiation is even greater for adolescents who mature more rapidly than their contemporaries as they begin to socialize with older peers who tend to consider substance use experimentation as a normative behaviour[37,38]. This rapid intensification of environmental stressors is accompanied by relatively slower maturation of the pre-frontal cortex that does not reach completion until early adulthood[39]. As this brain region is responsible for many emotive-cognitive processes, such as impulse control, complex decision-making, self-regulation, and reward-sensitivity, adolescents may find it more challenging than adults to resist the social and emotional stimuli to try or use cannabis as they place higher value on rewards associated with cannabis use than the assessed risk[40,41].

While the reported effects of cannabis use among adult users have been mixed[42–44], a growing amount of scientific literature shows that the initiation of cannabis use during adolescence is associated with an increased risk of many behavioral and psychological issues[45]. Examples include anxiety and eating disorders[46], delinquent behaviour, depression[47], and in some studies an increased risk of suicidal thoughts, especially among young females[48]. Several

longitudinal studies have also suggested that regular and heavy cannabis use during adolescence is associated with higher risks of mortality, cannabis dependence[49], and long term negative risks on academic performance and cognitive ability[50,51].

Due to a number of integral neurodevelopmental phases that occur during this life stage, adolescence has frequently been thought of as a period of biological vulnerability to the initiation of substance use. The brain, particularly the pre-frontal cortex region, undergoes significant architectural changes, which renders it more susceptible to the neurotoxic effect of chronic use of cannabis that can impede its complete maturation[52]. In addition, the endocannabinoid system in the brain has a significant role in the maturation process of brain network and cell growth during adolescence, and the delta-9-tetrahydrocannabinol (THC) chemical in cannabis disrupts this system by competing with the endocannabinoid transmitters for binding regions in the brain[53]. This disruption has been shown to lead to many long-term negative effects, such as decreased emotional and cognitive functioning[52].

Findings from several longitudinal studies also support possible causal relationships between the early initiation of cannabis use and a higher risk of cannabis dependence[54], and potential risk of long-term impairment of cognitive ability[30]. Even more concerning is the growing evidence showing potential relationship between adolescent use of cannabis with increased risk of psychosis in later life stages for a minority of the population[55]. For instance, a prospective cohort study that was conducted among 14 to 24-year-old participants demonstrated that the cumulative incidence of psychotic symptoms as a function of cannabis use at four years after baseline assessment was higher among youths with above average scores on paranoid ideation and psychoticism at baseline than those without predisposition for psychosis[20]. Collectively, this evidence highlights key aspects of adolescence that increase vulnerability to

both the initiation of cannabis use, as well as the adverse effects of cannabis use that may occur during this developmental stage. This vulnerability provides strong support for the development of programs that can be specifically tailored to target adolescents, especially with respect to factors that are known to increase the early uptake of cannabis use. Given that it has been repeatedly shown that effective health behaviour interventions should be grounded in evidence-based theories, the development of such interventions accompanying the legalization of recreational cannabis use need to be based on currently established theories of health behaviour[56].

1.2 Theoretical framework

As the guiding theoretical framework, this thesis adopts the Integrative Model of Behavioral Prediction (IMBP) developed by Fishbein and Yzer[56] that integrates Theory of Planned Behavior (TPB) and Social Cognitive Theory (SCT). TPB identifies intention as the most immediate determinant for a particular behaviour[57]. Within the context of my thesis, "intention" is defined as an adolescent's perceived likelihood of initiating or continue using cannabis, and can be interpreted as a measure of the adolescent's readiness to initiate or continue using cannabis. Likert scales are commonly used for self-reported assessment of intention strength[58]. For example, an adolescent who selects "strongly disagree" to a statement "I plan to try cannabis" is considered to be reporting a resolute intention to abstain from using cannabis, whereas those who respond "somewhat disagree" to "strongly agree" demonstrate weak to no intention to abstain from using cannabis. The significance of intention as an indicator of vulnerability to future substance use has been supported by research findings showing that youths who presented resolute intention to refrain from trying cannabis and cigarette smoking

are more likely to maintain abstinence than those who presented a weaker intention during follow-up periods up to a year later[59,60].

While intention has been generally accepted as a proximal predecessor to substance use, less attention has been given to investigating the upstream determinants of intention. The planned behaviour theory proposes three major factors that influence behavioural intention: normative beliefs about a given behaviour, attitudes towards the behaviour, and perceived behavioural control. Our study is specifically focusing on the attitudes, which is described as the degree to which performance of the behavior is positively or negatively valued. Within the cannabis use framework, attitudes have been operationalized as the outcome expectations that inform either the positive or negative attitude towards using cannabis, and are shaped by learning, experiencing the effects or consequences of use, and the contexts of the substance use[61]. These expectancies have been categorized into: 1) positive outcome expectancy, described as a belief regarding the positive consequences of using cannabis, which include social and sexual facilitation, perceptual and cognitive enhancement, and relaxation and tension reduction; and 2) negative outcome expectancy, described as a belief regarding the negative consequences of using cannabis and are comprised of cognitive and behavioral impairment, global negative effects, and craving and physical effects[62].

Compared to the depth of research on adolescents in the field of alcohol consumption and tobacco smoking, the extent of cannabis research is still at its infancy. The utilization of the IMBP as the guiding theoretical framework in this thesis was based on the extensive research that confirmed the strong associations between elements of IMBP, such as self-efficacy to resist substance use and beliefs about benefits of substance use, and outcomes in alcohol consumption and smoking among adolescents[63–65]. These elements have also been shown to be effective

targets for programs that aim to prevent or reduce consumption of alcohol as well as tobacco smoking[66,67]. Expectancies were chosen as the main predictor of cannabis use in this thesis because of the potential confusion among adolescents surrounding health benefits and risks associated with cannabis use, as well as heterogeneity in the evidence on the effects of cannabis use[68,69]. It is possible that the diverse strains of cannabis and the varying ratios of psychoactive components in cannabis, such as the tetrahydrocannabinol and cannabidiol, contribute to substantial heterogeneity in the experiences of cannabis use and the associated health impacts[70]. For example, while studies have demonstrated the beneficial property of cannabidiol in alleviating symptoms associated with schizophrenia[71], other findings stressed the potential roles of cannabis on exacerbating symptoms of psychosis[72,73]. The forthcoming legalization and regulation of recreational cannabis use in Canada therefore needs to take into consideration the lack of conclusive evidence on and clear understanding of the health risks of cannabis, especially among adolescents. As research assessing the effects of cannabis use on adolescents continues to progress, prevention efforts targeting vulnerable adolescents to developing problematic use of cannabis will need to be implemented and informed by continued monitoring of the adolescents' perceptions on the effects of cannabis. The results of this thesis will provide evidence on whether attitudes, as represented by outcome expectancies, and intentions may be used as indicators for adolescents' susceptibility to cannabis use. The thesis will also examine the IMBP's utility in the context of cannabis use.

While this thesis identifies expectancies under the IMBP theoretical framework as the primary determinant of cannabis use for the proposed research, other determinants of cannabis use among adolescents also need to be acknowledged to inform readers of the potential limitations of the generalizability of the findings to different sub-populations. For instance,

understanding the motivations or reasons to use cannabis have been helpful in understanding the social context or situation in which cannabis use takes place, the patterns of use, as well as the consequences of the behavior[74]. The five broad motives in the context of cannabis use include using the substance to enhance positive emotions, to obtain social rewards, to avoid social confrontation, to attenuate negative emotions, and to alter perceptual and cognitive experiences[75]. There are also other exogenous factors that have been shown to increase the risk of cannabis use among adolescents, including parental attachments, peer drug use, and cannabis availability[76], which are not controlled for in this thesis. The variety of factors that influence decisions associated with cannabis use therefore necessitates the understanding that decisions related to the use of illicit drugs may operate via a range of mechanisms with varying levels of alignment with the original IMBP framework and that application of this thesis' findings to inform behavioral intervention programs needs to consider the role of how these additional factors may influence the decisions of the target population.

1.3 Political context

Because regular cannabis use during adolescence appears to pose health risks, specifically on those with higher predisposition to and family history of mental health issues, a few editorials have been written expressing concerns that legalization of recreational use of cannabis for adults could create an assumption of safety regarding cannabis use, and be misinterpreted as support for the common misconception that cannabis is a harmless substance that promotes the health of adolescents (i.e., positive expectancies), which in so doing contribute to increased initiation and frequency of cannabis use among adolescents[10,77]. On the other hand, evidences suggest lack of association between cannabis use outcomes among adolescents and the

implementation of cannabis use legalization and regulation. For example, a large multi-year study based in the United States (US) that compared the change in the rate of cannabis use among high school students in states with the implementation of medical cannabis policy to that in other geographically similar states without the policy found that the policy change did not appear to have any impact on the difference in the level of self-reported marijuana use[78]. Similarly, another US-based study that used longitudinal national data and considered state-specific characteristic differences found that medical cannabis legislation did not increase the rate of cannabis use in the past month among adolescents[79], although the authors noted significant difference in the perception of the availability of cannabis and severity of punishment for cannabis possession between the states that implemented the legislation and those that did not. Another study that compared the attitude of Californian high school students with students from other states following the decriminalization of recreational cannabis use in California, found that Californian youths were 20% less likely to perceive cannabis as imposing health risk and to disapprove regular cannabis use, but its effect on the prevalence of cannabis use was not examined[80].

The main goal of the upcoming law that legalizes and regulates recreational use of cannabis in Canada is to protect public health and public safety, which includes minimizing the risks associated with patterns of use and developmental harms to youths[13]. The Canadian Task Force argued that strict regulation that occupies the middle ground between prohibition with harm reduction, which is currently applied to cannabis, and a light market regulation approach, which is imposed upon tobacco and alcohol, will achieve the minimum social and health harms associated with cannabis consumption in the population[13]. Another argument for the legalization of recreational cannabis use is to further support harm reduction, whereby cannabis is often used

as substitute for more harmful drugs, such as opiates and alcohol[42,81]. The current position assumed by Canadian public health organizations, such as the Canadian Public Health Association[82] and Canadian Psychiatric Association[83], support the Canadian's government plan for regulation of recreational cannabis that is grounded in public health approach that includes evidence-based strategies to reduce risk of problematic use and harms associated with use, to assist vulnerable population who have developed problems with cannabis, to evaluate impact of implemented programs and policies related to cannabis use, and to conduct continuous surveillance on the potential impact of the substance. They also recognize the potentiality of substance use as symptomatic of existing health issues and inequalities, and strongly recommend that the new cannabis use regulation consider effective strategies to address these core issues. In line with the recommendation by these public health agencies to evaluate the effect of the upcoming policy on cannabis use outcomes among adolescents, the potential shift in acceptance of recreational use of cannabis following the new regulation highlights the need for a clear understanding of the perceptions or expectancies that are endorsed by adolescents, and how they might affect the trend of cannabis use in this population.

1.3.1 Current efforts targeting adolescent cannabis use

There are several programs that have been implemented to manage or reduce cannabis use in the population. One common approach is the utilization of criminal laws to deter, punish, or rehabilitate cannabis users, although such approach has been criticized for their ineffectiveness in deterring use and the burden that non-serious offences may place on the justice system[84]. Several public health approaches that target adolescents have also been introduced, such as an anti-drug media campaign in the US that encouraged anti-drug behaviour in youths

through the improvement of youths' skill and confidence to avoid drug use, addressing the benefits of abstaining from drugs, and emphasizing the negative consequences of drug use[85]. However, an evaluation of the program found that the program advertisements did not have any favorable impacts on youth as intended[85]. A meta-analysis on the effectiveness of anti-illicit-drug public service announcement (PSA) also found the absence of significant benefits of PSA in curbing illicit drug use and use intention among youths, despite its widespread utilization in the US[86]. Even more concerning, this meta-analysis also noted several studies that saw an increase in illicit drug use among youths after exposure to the PSA compared to that at baseline, which may indicate the unintended harmful consequence of the existing PSA[86].

In Canada, the Canadian Centre on Substance Use adopted a more inclusive public-health engagement approach by developing a guide to facilitate discussions with youths about cannabis use that can be adapted by local health communities[87]. The guide encompasses discussions on the facts about cannabis use prevalence, motivations behind cannabis use, and effects of cannabis use with the intention of informing any misconceptions community members may have. The effectiveness of this particular program, including its uptake in different communities has not been evaluated. Recently, Conrod and colleagues also pointed out the importance of regulating cannabis use, such as setting a legal age for use and imposing reasonable tax and minimum pricing laws on cannabis products, creating mass media knowledge translation campaigns promoting health literacy related to cannabis use, and the staging of risk taking based on the findings from the evaluation of alcohol regulations[88]. This research group has also reported on the effectiveness of programs that target the personality of high-risk high-school students on reducing their cannabis use and frequency of use[89].

Given the growing interest in the development of health programs that can effectively address adolescent cannabis use, the findings of this thesis have the potential to inform and improve the effectiveness of programming by providing useful insights into the type of expectations adolescents have regarding the impact of cannabis use and in so doing identify specific opportunities where interventions might be targeted. For example, the personality-targeted interventions developed by Conrad et al[89] might be combined with the alteration of cannabis expectancies that adolescents might have to further reduce cannabis use by adolescents with high-risk personality profiles.

1.4 Study rationale and objectives

The growing evidence highlights the potentially harmful effects of chronic cannabis use on adolescent brain functioning and mental health[23]. Literature also identifies adolescence as a significant period for brain maturation and changes in psychosocial functioning and executive processes[41]. Regular use of mood-altering drugs such as cannabis to cope with change and other stressors during this crucial developmental period poses a risk of underdeveloped adaptive behavior that can remain for the entire life and exacerbate symptoms of mental illnesses in the long run[90,91]. In the presence of this evidence, researchers and public health experts welcome the legalization of recreational cannabis in Canada as an opportunity to improve the currently ineffective preventive efforts against problematic use of cannabis that rely heavily on severe punishment and exacerbate stigmatization, and to improve the monitoring of the trends of cannabis use and attitudes towards such use[92,93]. This monitoring effort may benefit from further knowledge of youths' expectancies related to the effects of cannabis as a means of improving our understanding of youths' vulnerability to initiating and using cannabis. Given the limited data on

cannabis use intentions and initiation among adolescents as they relate to cannabis outcome expectancies, my M.Sc. thesis therefore aims to evaluate the relationship between cannabis expectancies and the intention to use, as well as their predictive power in forecasting future cannabis use. The exploration of these relationships is described in detail in Chapter 3 of this thesis. Additionally, it is important to note that recommendations for epidemiological studies involving health behavior typically emphasize the importance of using validated assessment tools[94]. The validity of the tool used to measure cannabis-specific expectancies in this thesis, the Marijuana Effects Expectancy Questionnaire-Brief (MEEQ-B), has only been investigated once prior to its use in incarcerated adolescent population[62]. To ensure that the data on expectancies collected by the MEEQ-B is analyzed and interpreted appropriately in this thesis, the psychometric properties of MEEQ-B are evaluated in Chapter 2. A more detailed description of the MEEQ-B and its psychometric evaluation is presented in Chapter 2. Lastly, this thesis is concluded by Chapter 4 that provides a brief summary of the research approach and key findings presented in Chapters 2 and 3, and discusses the limitations as well as potential implications of the research study.

Chapter 2: Evaluation of the Psychometric Properties of the MEEQ-B

2.1 Existing Scales to measure outcome expectancies

A range of survey instruments have been developed to measure cannabis outcome expectancies and evaluate the relationships between expectancies and cannabis use and/or other potential determinants of use. For example, survey instruments have been developed for use in specific target populations, such as youth[95] and men who have sex with men[96], while more generic instruments have been created by adapting existing instruments developed to measure expectancies associated with the use of other substances[97,98].

One of the most frequently used scales to measure cannabis-specific expectancies is the 48-item Marijuana Effect Expectancies Questionnaire (MEEQ)[99–103]. This scale was developed from a content analysis of qualitative interviews with over a hundred individuals (50% women) aged 19 to 77 years old[100]. The initial 70-item scale produced from the interviews was then administered to 704 university students with a mean age of 19 years, and psychometric analysis of the resulting data was used to reduce the scale length down to 48-items[104]. These items were identified as representing the following six components of cannabis outcome expectancies: Relaxation and tension reduction, social and sexual facilitation, perceptual and cognitive enhancement, which represent a higher-order concept of positive expectancies, and cognitive and behavioral impairment, craving and physical effects, and global negative effects, which are the representations of a higher-order concept of negative expectancies. Because the MEEQ can be completed by those who have not tried cannabis, this scale has been used frequently to assess the expectancies held by adolescents on their perceptions of the effects of cannabis use even though they have never personally used cannabis[99,101,105]. In addition to the aforementioned studies, the

MEEQ has been validated in a several distinct adolescent populations, including non-clinical French-speaking adolescents[105], and American adolescents involved in alcohol and drug treatment programs[101].

2.2 Development of MEEQ-B scale

Although the 48-item MEEQ has been shown to provide a reliable and valid measure of cannabis expectancies among adolescents, the length of the scale prevents its use in many research settings. For example, studies on cannabis expectancies that collect data in fast-paced clinical environments or those that involve administering a large epidemiological survey incorporating numerous concepts of interest require a brief version of the MEEQ to minimize respondent burden. To address this feasibility issue, Torrealday and colleagues[62] developed and evaluated the psychometric properties of Marijuana Effect Expectancies Questionnaire-Brief (MEEQ-B), a shortened version of MEEQ that contained six items representing the six dimensions identified in the MEEQ. Using a Principal Component Analysis (PCA), two dimensions were identified from the MEEQ-B items: Positive and Negative Expectancies associated with the effect of cannabis. Three items that evaluated the positive expectancies were grouped under MEEQ-B positive subscale (MEEQ-Bp), and the other three items that assessed the negative expectancies represented MEEQ-B negative subscale (MEEQ-Bn). PCA is a statistical technique that identifies the smallest number of dimensions, or principal components, that explain the maximum amount of variance of a larger set of individual variables[106], which in the case of the MEEQ-B was six items. In other words, PCA is used to reduce the dimensionality of a set of data by identifying principal components that represent one or more original variables or scale items[107].

Although the 6-item MEEQ-B has been used in multiple studies involving adolescents and young adults[108–110], the initial MEEQ-B development via PCA remains the only comprehensive evaluation of the measurement structure of the scale[62]. Although the PCA provided useful inference about the two-factor structure of MEEQ-B and factor loadings of the items, a formal validation of the psychometric properties of the scale using the widely recommended approach of confirmatory factor analysis (CFA) has yet to be completed[111]. Contrary to the exploratory nature of PCA, CFA explicitly tests whether the a-priori hypothesized measurement model (i.e. the two-factor structure of MEEQ-B) fits the item data (ideally using responses from a new sample of respondents) and therefore, has been proposed as the gold standard for assessing the psychometric performance of a scale prior its utilization in scientific studies[111].

The only validity testing of MEEQ-B that I was able to identify took place in a state juvenile correctional facility involving 130 incarcerated youths which consisted of mostly males who exhibited a range of problem behaviors[62]. Given that this population group may differ significantly from mainstream counterparts in regards to their attitudes towards and behaviours surrounding substance use[19,95,100], there is a need to validate MEEQ-B prior to its application in adolescent populations that may comprise individuals who have never tried any illicit substances (i.e., the MEEQ-B should be validated in each new population in which it is applied). Additionally, the original study on the development of the MEEQ-B reported internal consistencies of MEEQ-B that were lower than that of MEEQ[62], underscoring the need for further independent evaluation of the psychometric properties of MEEQ-B.

To address the knowledge gap attributed to the absence of an explicit confirmation of the factor structure of the MEEQ-B and the lack of in-depth assessment of the functioning of

MEEQ-B items, this chapter describes the application of confirmatory factor analysis to examine the psychometric properties of MEEQ-B. The resulting information will inform the use of the MEEQ-B in subsequent chapters of this thesis and contribute to the academic literature on the development of this tool and its reliability and validity as a measure of cannabis expectancies for adolescents in the general population.

2.3 Research approach

The aim of this chapter is to present the results of an evaluation of the psychometric properties of MEEQ-B when administered to mainstream secondary school students in British Columbia, Canada using confirmatory factor analysis (CFA). This application of CFA will test whether the MEEQ-B measurement structure containing positive and negative expectancies factors described in the original development study holds in our study population and can therefore be used as a measure of the positive and negative cannabis expectancies in this population. The results of the analysis also directly inform the calculation and interpretation of scores of MEEQ-B in subsequent multivariate analyses evaluating the relationship between cannabis expectancies and cannabis use, and between cannabis expectancies and the intention to try cannabis, which are presented in Chapter 3.

2.3.1 Source of data

All of the data analyzed in this thesis is derived from the British Columbia Adolescent Substance Use Survey (BASUS), a multi-year prospective cohort survey that included a detailed assessment of the attitudes of British Columbian adolescents related to the use of tobacco, cannabis, alcohol, and other illicit substances, as well as associated psychosocial health

outcomes[112]. The survey was administered using an online platform once every six months for a total of seven waves, beginning in October 2009 and ending by the end of 2012.

To recruit the participants, the members of BASUS research team first contacted School District Superintendents to gain permission to directly contact the principals of public secondary schools. Promotion of the study was then conducted at participating school through presentations by the research team, dissemination of informational packages as part of the school orientation materials, distribution of other promotional items, such as flyers and locker magnets with the website link to the study, and advertisements on school newspaper and posters.

Students who were interested in taking part in the study were invited to register online at the BASUS website (www.basus.ca)[16] using their email or alternative username. Once registered, they were presented with consent form to review and sign, followed by screening questions to determine their eligibility for participating. To be eligible, participants needed to be at least 13 years old and attended a secondary school in BC at the time of the survey.

Participants would have the options to receive notifications on the opening of subsequent BASUS surveys as well as reminders to complete the surveys before the closing time via e-mail, Facebook message, short-message service (SMS) text, and postal mail. Using their registered email or username and password, the participants would then log on to the BASUS website to access the survey. They were also able to complete the surveys in multiple sessions with all data saved from each session and reminders to log on and complete the survey sent prior to the closing of the survey. At the end of each survey period, all participants received a $25 gift card for full or partial completion of each survey. The development and administration of BASUS was funded by Canadian Institute of Health Research (MOP-86729), and the analysis presented in this thesis has been approved by UBC Behavioral Research Ethics Board (H16-02034).

For this thesis, all psychometric and cross-sectional analyses were performed on data collected during Wave 5 of the study, which was administered in October to December of 2011 as this was when the Marijuana Effect Expectancies Questionnaire-Brief (MEEQ-B)[62] was initially incorporated into the ongoing assessments. Longitudinal analyses presented in this thesis were performed on data collected in both Wave 5 and Wave 6 of the study with the latter wave taking place between April and June 2012. Among participating high-schools, the average participation rate in eligible grades was 20% with school-specific response rates for individual students ranging from 0% to 80%.

2.3.2 Measures

2.3.2.1 MEEQ-B

The MEEQ-B was used to measure cannabis outcome expectancies among the adolescent participants in this present study because of its short length which minimized the respondent burden associated with participating in the study. Participants indicated their level of endorsement for each item's statement using a 5-point Likert scale ranging from "*Strongly agree"* to "*Strongly disagree"*. Following the prescribed method by Torrealday et al[62] for computing the total score, an average score (ranging from one to five) for each expectancies dimension was calculated by adding up the responses for each item and dividing by the total number of items in that dimension. On MEEQ-Bp subscale, which represents the positive expectancies dimension, a score closer to five indicates higher potential for expecting positive effects of cannabis use. On the MEEQ-Bn subscale, which represents the negative expectancies dimension, a score closer to five reflects higher likelihood of endorsing negative expectations

about the impact of cannabis use. The MEEQ-Bp was calculated by calculating the average score of items 2, 3, and 4 and the MEEQ-Bn was calculated by averaging items 1, 5, and 6. The MEEQ-B item numbers and wording are presented in Table 2.1.

Table 2.1. Marijuana effect expectancies questionnaire – brief (MEEQ-B)[62]

The following questions are about the effects of marijuana. Answer each statement according to your own personal thought.
1. Marijuana makes it harder to think and do things (harder to concentrate or understand; slows you down when you move)
2. Marijuana helps a person relax or feel less tense (helps you unwind and feel calm)
3. Marijuana helps people get along better with others and it can help you feel more sexual (talk more; feel more romantic)
4. Marijuana makes a person feel more creative and perceive things differently (music sounds different; things seem more interesting)
5. Marijuana generally has bad effects on a person (you become angry or careless; after feeling high you feel down)
6. Marijuana has effects on a person's body and gives a person cravings (get the munchies/hungry; have a dry mouth; hard to stop laughing)

Note: The response options are: (1) Disagree Strongly; (2) Disagree Somewhat; (3) Uncertain; (4) Agree Somewhat; (5) Agree Strongly; (6) No answer. MEEQ-Bp subscale measures positive expectancies and consists of items 2, 3, and 4. MEEQ-Bn subscale measures negative expectancies and consists of items 1, 5, and 6.

2.3.2.2 Sociodemographic variables

Age, perceived socio-economic status, gender, and ethnicity were considered as key covariates to be included in analyses that evaluated the relationships between expectancies and cannabis use, as well as the intention to try cannabis presented in Chapter 3. All of the covariates were captured in Wave 5 of BASUS.

Age: Studies have shown that among adolescents, the risk of initiating or using substances increases with age[113,114]. Pubertal status also varies with age and several studies revealed that stage of pubertal development is associated with different profiles of substance use and initiation[38,115]. Researchers have speculated that pubertal development influences the psychosocial functioning of adolescents, including cognitive processes related to decision making and risk-taking that may be associated with substance use[116,117]. Age of participants in this study was assessed by asking "How old are you today?".

Perceived socio-economic status (SES): Perceived SES was measured by assessing each adolescent's subjective perception of the financial situation of their household in comparison to other households. Participants were asked to rate their perceived SES using seven options ranging from *far below average* to *far above average* by responding to the question "How would you describe your household's financial situation (how much money your family has)?" To avoid empty cells, the responses were aggregated into three categories of *below average*, *average*, and *above average*. Perceived SES was selected in this study over traditional measures of parental education or income because adolescent participants are often unaware of their parents' education and/or income level which can result in many missing or "don't know" responses[118]. Researchers have reported that there is a robust association between subjective perceptions of family SES and adolescent health status[119,120].

Ethnicity: Ethnicity was included in the analyses because of its widespread recognition as a potential influence on substance use among adolescents[121]. To capture ethnicity, participants could select all ethnicities that they identified with from a list of 12 racial descriptors. If none of the descriptors fully represented the participant's racial background, they could choose "other" and specify their ethnicity in text. To improve the sample size of racial minorities and to avoid empty cells, the descriptors were collapsed into four categories: White, Indigenous, Asian, and Others. Indigenous category was assigned to participants who selected "Aboriginal/First Nations (for example, North American Indian, Metis, Inuit)" from the racial descriptors. Participants who concurrently selected Aboriginal and other racial descriptors were categorized as Indigenous.

Gender: Based on the recommendations by the Canadian Institutes of Health Research (CIHR) Institute of Gender and Health to consider the impacts of gender during evaluation of psychosocial and health outcomes[122], we decided to include gender in our descriptive analysis and as a covariate in our regression models in subsequent chapter. Gender was captured in this study by asking participants to identify as male or female.

2.3.3 Statistical analysis

2.3.3.1 Demographics and univariate analysis of expectancies

The distribution of age, ethnicity, and perceived SES were stratified by gender. Differences in the frequency distribution were evaluated using Pearson's chi-square for age and ethnicity, and Student's t-test was used to compare the average age of participants between gender groups. Average positive and negative expectancies scores were compared across different categories of

each covariate using one-way ANOVA for perceived SES, ethnicity, and age groups, and Student's t-test for gender.

2.3.3.2 Missing values and full information maximum likelihood (FIML)

A total of 1592 students participated in Wave 5 of the study. Of those, 1538 students who were between 14 to 16 years old at the time of Wave 5 completion were retained for further analysis. Forty-nine participants who were either 13, 17 or 18-plus years of age were excluded from analysis due to the potentially significant differences in their cognitive and physiological processing compared to the retained age groups[114,123]. In addition to removing these older or young respondents, 137 cases with more than one missing response (i.e., more than 30% of a MEEQ-B subscale) in either the positive and negative expectancies subscales were excluded. This resulted in an effective sample size of 1401 participants who were eligible for inclusion in the descriptive and confirmatory factor analyses.

To minimize any additional loss of cases associated with the list-wise deletion of cases with missing data, which can reduce statistical power and introduce bias in estimating the effect size[124], Full Information Maximum Likelihood (FIML) estimation was used[125]. This method is often used in Structural Equation Modelling because it uses all of the available data from all cases in calculating the parameter estimates of the model by using a likelihood function for each case based on data from variables that are present[125]. This process was chosen over imputation methods because the missing cells were treated as a distribution of possible values by FMIL as opposed to a single value by MI that tends to underestimate standard errors[126]. Given that FIML requires the missing data to be either missing completely at random (MCAR) or missing at random (MAR)[127], Little's MCAR test was conducted to evaluate the missing data pattern on

IBM SPSS[128]. MCAR is observed when the propensity of data items to be missing is independent of both the observable and unobservable variables, and occur entirely at random. Little's test on both MEEQ-Bp and MEEQ-Bn revealed non-significant p-values, indicating that the missing values patterns on both subscales were completely at random (Appendix A.2, χ^2=4.55, p=0.60 for MEEQ-Bp, and χ^2=4.55, p=0.92 for MEEQ-Bn). Both FIML and CFA were conducted in Mplus Statistical Software because of its ability to perform CFA with maximum likelihood estimation[129,130].

2.3.3.3 Confirmatory factor analysis (CFA)

Confirmatory factor analysis (CFA) is used to evaluate the validity of the measurement structure of a psychometric scale that has been hypothesized a-priori by assessing the mathematical fit of correlations observed in the data (i.e. item responses) with that expected by the specified measurement model that describes the number of latent factors in the model and their associated indicators[111]. In this thesis, the MEEQ-B was hypothesized to have two correlated factors (or subscales) – the MEEQ-Bp and MEEQ-Bn that were each measured by three continuous item responses[62]. Given the continuous nature of the subscale scores, the relationships between the factors and factor indicators were described by a set of linear regression equations[131]. The relationship between the latent factors (theta) and observed factor indicators (X) is described in the measurement model below[111]:

$$X = \lambda_X \Theta + \varepsilon$$

Where λ is the matrix of standardized or unstandardized factor loadings and ε is the measurement error matrix. Unstandardized loadings represent the slopes of regressing the

responses on the factor *X*, whereas the standardized loadings are the slopes in a correlation metric and can be thought of as the correlation between each item and the latent factor onto which it loads.

Assumptions associated with the application of CFA include the use of a relatively large sample (preferably 300 participants with ten to fifteen participants per item)[132,133], an inter-item correlation matrix that is not an identity-matrix, which can be met when at least 20% of the observed inter-item correlations are $|\geq 0.3|$, and indicates that at least 1 factor explains the observed variations in the data[134]. Another common recommendation for CFA is for items to use a response format with at least 3 response options on the rating scale to reflect the underlying continuous variable of agreement when using some estimators[104,135]. For the purpose of this thesis, Robust Maximum Likelihood method was chosen to estimate the factor loadings of the measurement model, because it attempts to identify parameter values that maximize the probability of sampling the observed correlation matrix[111,136]. Another desirable strength of this estimation procedure is its ability to produce standard errors of the estimates that are robust to violation of the normality assumption[130]. All parts of CFA were conducted on Mplus[129].

Several indices were used to evaluate the fit of the proposed models. Brown and Cudek suggested that the appropriate value for the Root Mean Square Error of Approximation (RMSEA) is less than 0.05 with a lower and upper 90% Confidence Interval (CI) bounds that do not exceed 0.05 and 0.1, respectively[137]. Another widely used index is the Standardized Root Mean Square Residual (SRMR), and it is recommended that the value must be less than 0.08[138]. Additionally, the Comparative Fit Index (CFI) value should be close to 0.95 to signify very good model fit.

If the indices showed poor fit, then Modification Indices associated with the initial CFA model are usually evaluated to guide post-hoc revisions to the model. Any modified models would then be compared to one another and to the original model using several measures of model fit. In addition to the previously specified measures, the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) of the models were reported and compared. Lower values of AIC and BIC signifies improvement in fit[139]. Chi-square (χ^2) model fit criterion were also compared between models using the Satora and Bentler's scaled chi-square difference test (TR_d)[140] as follows:

$$TR_d = (T_0 * c_0 - T_1 * c_1)/c_d$$

Whereby T_0 and T_1 are the MLM chi-square values of the nested and the comparison models, respectively, and c_0 and c_1 are the scaling correction factor for the nested and comparison models, respectively. The difference in the test scaling correction between models, c_d can be calculated using the following equation:

$$c_d = (d_0 * c_0 - d_1 * c_1)/(d_0 - d_1)$$

in which d_0 and d_1 are the degree of freedoms of the nested and comparison models, respectively.

Although the χ^2-difference test was reported, this test has been shown to be hyper-sensitive to large sample size with increased power to detect small difference in χ^2 estimates that may not be clinically relevant[133]. Therefore, the other model fit indices took precedence over χ^2 in evaluating the goodness of fit of the models presented in this thesis.

2.3.3.4 Reliability index and item correlations

Several reliability indices are available to measure the discrepancy between the observed and predicted scores of a scale[104]. For single-administered scales, internal consistency reliability that evaluates the correlations between different items on the same scales or subscales is often reported[104]. In this chapter, the Cronbach's alpha of MEEQ-B was calculated, following the current recommendation for measuring internal consistency in behavioral studies[104,142]. Cronbach's alpha estimates the proportion of variability in the scores that is attributable to the true differences between the subjects, and as such, is unique to the population that is tested[143]. The calculation of Cronbach's alpha is based on the variance of each item and the covariance for each item with every other item on the subscale[143]. The equation to calculate the Cronbach's alpha coefficient is as follows:

$$\alpha = \frac{k}{k-1}\left[1 - \frac{\sum \sigma_i^2}{\sigma_T^2}\right]$$

k= # of items

σ^2_i = variance of items

σ^2_T = Variance of total test

The acceptable range of alpha coefficient is between 0.80 to 0.95[144,145]. Alpha coefficient that exceeds 0.95 may not necessarily be desirable as it may imply redundancy between the items[146].

However, one major disadvantage of alpha coefficient is that it requires the assumption of the same true-score variance across all items in a scale, which is rarely met in structural equation models where item loadings are typically not forced to be equal (tau-equivalence)[147]. It has also been shown that outliers on Likert item responses can inflate Cronbach's alpha[148]. Therefore, another commonly reported reliability indicator in scale development, composite reliability, was

also calculated because it incorporates any variation in factor loadings[149]. Composite reliability was calculated using the following equation[150]:

$$CR = \frac{(\sum \lambda_i)^2}{(\sum \lambda_i)^2 + (\sum \epsilon_i)}$$

Whereby λ is the standardized factor loading for item i, and ε is the associated error variance for item i. The equation for error variance is $\varepsilon_i = 1-\lambda^2_i$.

Inter-item correlations and item-total correlations evaluating the relationship strength between a particular item and the average score of the entire subscale were also examined. Nunnaly and Bernstein[144] suggested that a correlation of less than 0.20 signifies little commonality between the items in the same subscale, whereas a correlation above 0.8 may indicate redundancies between the items. The reliabilities and correlations of MEEQ-Bp and MEEQ-Bn were assessed using SPSS[128]. These correlations provide guidance on determining which items require further evaluation in terms of its content and relevance to the subscale. In deciding to retain, exclude, or modify the item, these correlations must be considered together with the theory that frames the development of the subscale.

2.4 Results

2.4.1 Demographics and univariate results of expectancies

Demographic characteristics of 1401 participants who met the inclusion criteria are presented in Table 2.2. Post Hoc Analyses (Appendix A.1) showed that only the proportion of sex and race differ between participants who were retained in the study and those excluded due

to missing responses to the expectancies items. Though statistically significant, the overall pattern of ethnicity across the excluded group remained similar to that of the retained group, in which White adolescents made up the largest proportion of ethnicity group among both the retained and excluded participants, followed by Asian, Indigenous, and Other. While there were more females than males in the retained group, the number of females and males who were excluded was similar. Since only 10% of the males and 7% of the females were excluded from the analysis, their risk to bias the outcomes of the analyses is assumed to be minimal[151].

There was no difference in the proportion of participants who reported lifetime cannabis use and expressed some intention to initiate cannabis use within the next three years between the excluded and retained participants. The distribution of frequency of cannabis use was also equal between the two groups. Of eligible participants, 836 (59.7%) identified as female. The mean age of participants was 14.8 years old (SD=0.59). Almost half of the participants identified as white (49.8%, n=683), and the proportion of participants who identified as Asian and Indigenous were 35.2% (n=482) and 12.3% (n=168), respectively (see Table 2.2). About 2.8% of the participants were classified as belonging to the "Other" race category. The majority of the participants (78.2%, n=904) perceived their household financial situation as average or above the average, Additionally, the average scores of MEEQ-Bp and MEEQ-Bn were 3.36 (SD=1.03) and 3.97 (SD=0.92), respectively, out of the maximum score of 5. Participants' demographics after stratification by gender along with statistical analysis comparing the values between males and females are also presented in Table 2.2. Among the demographic indicators, only the distribution of perceptions regarding financial situation in individual's households differed significantly between males and females.

Table 2.2. Demographic characteristics of retained participants, stratified by gender

	Overall Study Sample	Sex	
	N (%)	Male (N =565; 40.3%)	Female (N = 836; 59.7%)
Perceived Socio-Economic Status[a]			
Below	280 (21.81%)	97 (18.73%)	183 (23.89%)
Average	451 (35.12%)	158 (30.50%)	293 (38.25%)
Above	553 (43.07%)	263 (50.77%)	290 (37.86%)
Result of Association		$\chi 2 = 21.03$, $p < 0.001$*	
Ethnicity[a]			
White	683 (49.82%)	285 (52.58%)	398 (48.01%)
Indigenous	168 (12.25%)	70 (12.92%)	98 (11.82%)
Asian	482 (35.16%)	170 (31.37%)	312 (37.64%)
Other	38 (2.77%)	17 (3.14%)	21 (2.53%)
Result of Association		$\chi 2 = 5.79$, $p = 0.12$	
Age of participants on wave 5[b]			
Mean (Standard Deviation)	14.81 (0.59)	14.82 (0.59)	14.81 (0.59)
Result of Association		$t = 0.12$, $p=0.91$	

a: Distribution of perceived SES and ethnicity between gender were compared using Pearson's Chi-square test.
b: Average values of age in wave 5 was compared between gender using Student's t-test.
*: values are statistically different between males and females.

Table 2.3 presents the average positive and negative expectancies scores among adolescents who belonged in different demographic groups. Average scores for positive expectancies were significantly different between adolescents with different ages and ethnicities, whereas average scores for negative expectancies were significantly different between genders and ethnicities. Perceived SES was the only demographic descriptor without significant difference in the average scores of at least one of the expectancies measures.

Table 2.3. Average expectancies' scores between different demographics and modalities of cannabis use

	Overall Study Sample		Average Expectancies Score in Wave 5	
	N	**%**	**Positive (Standard Deviation)**	**Negative (Standard Deviation)**
Age (categorical)[a]				
14	399	28.48%	3.24 (1.10)	3.95 (0.10)
15	864	61.67%	3.4 (1.01)	3.98 (0.88)
16	138	9.85%	3.47 (0.95)	3.97 (0.91)
Result of Association (ANOVA)			F=4.186 p=0.02*	F=0.196 p=0.82
Ethnicity[a]				
White	683	49.82%	3.51 (0.04)	3.99 (0.89)
Indigenous	168	12.25%	3.31 (0.08)	3.79 (1.03)
Asian	482	35.16%	3.19 (0.05)	4.03 (0.88)
Other	38	2.77%	3.27 (0.17)	3.89 (0.96)
Result of Association (ANOVA)			F=9.16 p=0.00*	F=4.186 p=0.03*
Perceived Socio-Economic Status[a]				
Below Average	280	21.81%	3.45 (0.99)	3.92 (0.91)
Average	451	35.12%	3.40 (1.01)	4.05 (0.82)
Above Average	553	43.07%	3.34 (1.06)	3.98 (0.94)
Result of Association (ANOVA)			F=1.161 p=0.31	F=2.065 p=0.14
Gender[b]				
Male	565	40.33%	3.34 (1.07)	3.83 (1.00)
Female	836	59.67%	3.38 (1.00)	4.07 (0.84)
Result of Association (student's t-test)			t = -0.628 p=0.53	t = -4.580 p<0.001*

a: Average expectancies' scores were compared between two groups using Student's t-test.
b: Average expectancies' scores were compared between multiple groups using Analysis of Variance (ANOVA).
*: values are statistically different between groups.

2.4.2 Mean, reliability indices, and inter-item correlations

The mean and standard deviations for the items that belong to MEEQ-Bp and MEEQ-Bn subscales are presented in Table 2.4. The means for the MEEQ-Bn items ranged from 3.70-4.16, which was quite similar to the range of the means of MEEQ-Bp items of 3.08 to 3.61. The standard deviations of the mean scores were similar across all items in MEEQ-B scale and did not suggest extreme variation around the means, ranging from 1.06 to 1.27.

At 0.82, the alpha coefficient of MEEQ-Bp was situated within the acceptable range, whereas the alpha coefficient of MEEQ-Bn of 0.695 fell slightly below the lower limit of the range, indicating moderate reliability of the subscale. The composite reliabilities of the subscales of MEEQ-Bp and MEEQ-Bn subscales were 0.824 and 0.695, respectively, which were similar to the alpha coefficients.

Table 2.4. Summary of item statistics of MEEQ-B

Items	Mean	Standard deviation	Cronbach's alpha if item is deleted	Corrected item-total correlation
Negative Expectancies				
Item 1: Marijuana makes it harder to think and do things	4.05	1.15	.56	.54
Item 5: Marijuana generally has bad effects on a person	3.70	1.27	.56	.55
Item 6: Marijuana has effects on a person's body and gives a person cravings (i.e. get the munchies/hungry; have a dry mouth; hard to stop laughing)	4.16	1.06	.67	.45

Items	Mean	Standard deviation	Cronbach's alpha if item is deleted	Corrected item-total correlation
Positive Expectancies				
Item 2: Marijuana helps a person relax or feel less tense	3.61	1.19	.76	.68
Item 3: Marijuana helps people get along better with others and it can help you feel more sexual	3.08	1.18	.77	.66
Item 4: Marijuana makes a person feel more creative and perceive things differently	3.39	1.24	.74	.70

All of the inter-item and item-total correlations of both subscales were also within the acceptable range of 0.2-0.8 (Tables 2.5 and 2.6). The correlations among the MEEQ-Bp items ranged from 0.58 to 0.63, and the inter-item correlations of MEEQ-Bn were from 0.39 to 0.51. Lastly, the correlation between the two factors of positive and negative expectancies was 0.19.

Table 2.5. Inter-item correlation matrix for MEEQ-Bp

	Item 2	Item 3	Item 4
Item 2	1.00	.58	.63
Item 3	.58	1.00	.61
Item 4	.63	.61	1.00

Table 2.6. Inter-item correlation matrix for MEEQ-Bn

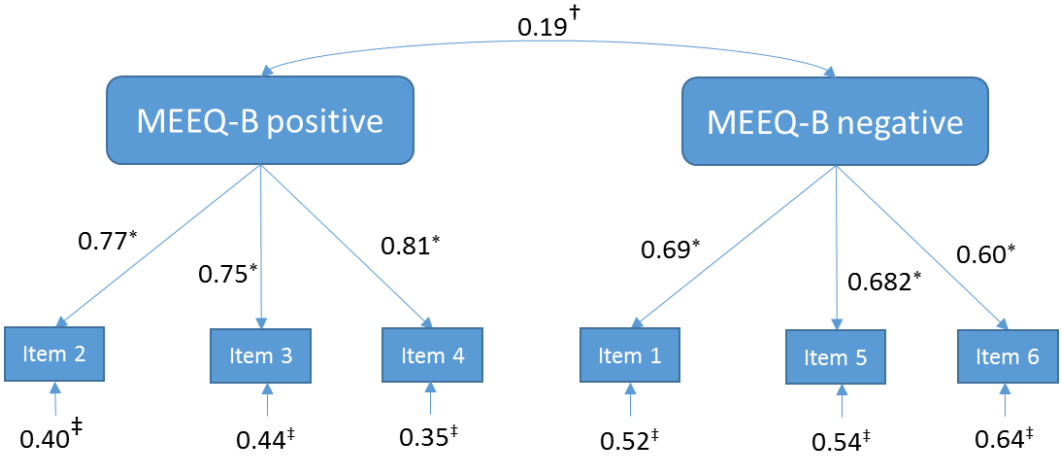
	Item 1	Item 5	Item 6
Item 1	1.000	.51	.39
Item 5	.51	1.00	.40
Item 6	.39	.40	1.0

2.4.3 Factor loadings and uniqueness

With an effective sample size of 1401 for all of the items, the recommended sample size for CFA was met. Matrices presented in Tables 2.5 and 2.6 also showed that all inter-item correlations within each subscale exceeded 0.3, which confirmed their difference from identity matrices.

The standardized factor loadings for each of the items assigned to the MEEQ-Bp and MEEQ-Bn subscales are presented in Figure 2.1 and were above the recommended value of 0.3. Overall, the factor loadings of MEEQ-Bn items were lower than that of MEEQ-Bp items. The uniqueness (i.e., unexplained error variance) of each item is also presented in Figure 2.1. In this context, each uniqueness can be thought of as the percentage of variance in the item responses that cannot be explained by the proposed two factor model of the MEEQ-B[104]. Our results indicate that the MEEQ-Bn items had higher uniqueness compared to the MEEQ-Bp items.

Figure 2.1. Standardize factor loadings, uniqueness, and correlations of MEEQ-B scale containing two subscales examining positive and negative expectancies



∗ Statistically significant factor loading at p<0.1
† indicates the correlation between the MEEQ-B positive and MEEQ-B negative subscales
‡ indicates the uniqueness of each item

2.4.4 Model fit indices and modification indices

Table 2.7 presents the model fit indices for the hypothesized 2-factor model (Model 1) as well as the revised models (Models 2 and 3) developed according to modification indices (appendix A.3) and theoretical considerations. Note that the modification indices associated with the model results identify potential improvements in model fit that could be obtained by adding new relationships between items and/or factors. Changes to the measurement model based on the modification indices were implemented incrementally and model fit indices of each revised model was compared to the initial two-factor model (Model 1, Table 2.7). When modifying the model, it is pertinent to provide a sound theoretical justification for any modifications made[139,152]. Modification based on the modification indices should also be kept at a minimum and be made according to one indicator at a time to reach a parsimonious model[153]. Any modifications that result in substantive changes in other parameters should be examined with a great deal of caution[135].

According to the model fit indices, Model 1 (Table 2.7) seems to have a poor fit. It's SRMR was higher than the recommended 0.08 and the RMSEA exceeded the maximum recommended value of 0.05. The CFI and TLI indices were also well below the recommended value of 0.95. The modification indices suggested that two separate modifications could be applied to significantly improve the fit of the present model. The first modification was correlating the error terms of item 1 and 5, which would reduce the χ^2 by 206.311 (Model 2, Table 2.7). The second suggestion was allowing item 6, which is an MEEQ-Bn item, to cross-load on MEEQ-Bp, which would approximately reduce the χ^2 by 206.292 (Model 3, Table 2.7). In the current model, the loading of item 6 to MEEQ-Bp was set to 0 (i.e., this item did not load onto MEEQ-Bp). According to the modification fit indices, allowing the loading on MEEQ-Bp

to be freely estimated would result in a standardized loading of 0.42, which surpassed the minimum recommended value of 0.3 (Appendix A.3).

Overall, the model fit improved after each of the modifications, as seen in the decreasing of AIC, BIC and χ^2 values (Table 2.7). The SRMR of models 2 and 3 also fell below the recommended 0.05, and the CFI surpassed the recommended 0.95. Although the RMSEA (0.069, Table 2.7) and TLI (0.934, Table 2.7) of models 2 and 3 did not meet the recommended values, they were very close to meeting the maximum threshold of 0.05 for RMSEA, and the minimum threshold of 0.95 for TLI.

The Satorra-Bentler chi-square difference test produced a difference test scaling correction (cd) of 2.03. The chi-square difference test (TRd) value was 153.95 with 1 degree of freedom difference. From the chi-square distribution table, the critical p-value for 1 degree of freedom is 3.841, and any chi-square value that exceeds that critical value will have a p-value of <0.05. Since the TRd of 153.95 exceeded 3.841, the p-value of TRd was confirmed to be <0.05 and therefore, we could reject the null hypothesis that the nested model (2-factor CFA model) has the same fit as the comparison model (cross-loading item 6). Specifically, it was confirmed that the model with the larger parameters, or the comparison model, fit the data better than the nested model. Calculations for the Satorra-Bentler chi-square difference test are can be found in Appendix A.4.

While the model fit indices of Models 2 and 3 are quite similar (Table 2.7), Model 2 indicates some instability given that the residual covariance matrix was not positive definite as noted on the warning message produced by Mplus output (Appendix A.5). This result may be attributed to the negative residual variance for item 6, which is also known as *Heywood case* that may point to model misspecification due to some measurement error correlations or missing

links in the model[154]. In addition, the R-square of item 6 was undefined by the software and the standardized factor loading of item 6 exceeded the threshold of 1 with very low factor loadings for item 1 and 5, further supporting the potential misspecification of the model[154]. Therefore, Model 3 was chosen as the best model for future data interpretation and analysis.

Table 2.7. Summary of model fit indices

	Model 1: 2 factor-structure	**Model 2: Correlating items 1 and 5**	**Model 3: Cross-loading item 6 onto MEEQ-Bp**
AIC	24331.289	24117.088	24117.088
BIC	24430.943	24221.986	24221.986
χ^2	χ^2 = 282.12 df = 8; p=0.00	χ^2 = 53.402 df = 7; p = 0.00	χ^2 = 53.394 df = 7; p = 0.00
SRMR	0.085	0.024	0.024
RMSEA (90% CI)	0.156 (0.141-0.172)	0.069 (0.052-0.087)	0.069 (0.052-0.087)
CFI	0.843	0.973	0.973
TLI	0.706	0.943	0.943

2.5 Discussion

The aim of this chapter was to evaluate the psychometric properties and functioning of the six-item MEEQ-B, and test the validity of the two-factor structure of MEEQ-B using confirmatory factor analysis (CFA). Based on the principal component analysis conducted by Torrealday et al[62], MEEQ-B was hypothesized to comprise two correlated factors: MEEQ-Bp that measures positive outcome expectancies and MEEQ-Bn that measures negative outcome expectancies. Each of these factors was represented by three items.

The proposed two-factor model of MEEQ-B was found to have a relatively poor fit, given that the majority of the fit indices did not meet the recommended values. The CFI and TLI values

were well below the recommended minimum of 0.95, while SRMR and RMSEA values exceeded the suggested upper limits. The Cronbach's coefficients of MEEQ-Bp (0.82) and MEEQ-Bn (0.695) in present study were higher than those found in previous study (0.6 and 0.42 for MEEQ-Bp and MEEQ-Bn, respectively)[62]. Despite the improved reliability, the coefficient of MEEQ-Bn still fell below the recommended value of 0.8. This suggests the lack of appropriate interrelatedness among the items in the negative expectancies subscale. This notion is also supported by the relatively low inter-item correlation of the negative expectancies items that only marginally surpassed the recommended value of 0.2 and the relatively high uniqueness among these items.

Modification indices associated with the initial model tested in the CFA identified two potential changes that could be made to the model to improve its fit to the data. Cross-loading item 6 from negative expectancies factor to positive expectancies factor as well; or correlating the error terms of item 1 and 5. A single modification made by loading item 6 to both positive and negative expectancies factors resulted in a good model fit as evidenced by the model fit indices that met or closely approached the criteria for acceptable model fitness. This particular modification also appeared to make theoretical sense in that item 6 states that "Marijuana has effects on a person's body and gives a person craving (get the munchies/hungry; have a dry mouth; hard to stop laughing)". It seems plausible that each of the examples given in the statement on the effect of cannabis for item 6 could be interpreted as either positive and negative consequences of using cannabis. "Hard to stop laughing", for instance, might be interpreted as a positive consequence while having a dry mouth may be interpreted as a negative consequence. Additionally, studies evaluating the psychometric properties of the 48-item version of MEEQ

reported that perceptual enhancement and cravings were associated with the higher-order positive expectancies factor[99,155].

Given that the cross loading of item 6 significantly improved the model fit and was supported by theory, it appears that including the impact of this cross-loading should be incorporated into the calculation of both MEEQ-B factors scores. However, using the traditional average score approach to calculate MEEQ-B factors scores will not incorporate the cross-loading of item 6. One approach to incorporating a factor structure that incorporates the cross-loading of item 6 is by using latent factor scores that are derived from a CFA model that includes the cross-loading.

The factor score in Mplus is estimated by the maximum a posteriori (MAP) method that is also known as the regression method[156]. Using this approach, the latent score of each case is determined as the maximum or the mode of the posterior distribution, or the probability distribution of the unobserved factor based on the observable parameters calculated using Bayes' theorem that yields the following equation:

$$f_{X|Y}(x|y) = \frac{f_{Y|X}(y|x) f_X(x)}{f_Y(y)}.$$

Whereby $f_{X|Y}(x|y)$ is probability density function of unobserved/latent random variable X (i.e. the expectancies factors) given observed parameters Y, and f(y|x) is probability density function of observed parameters Y given the latent variable X. The MAP estimate will be the value of *x* that maximizes $f_{X|Y}(x|y)$. Because function $f_Y(y)$ does not depend on the value of x, MAP can be estimated by the value of *x* that maximizes $f_{Y|X}(y|x)\, f_X(x)$. In this way, the MEEQ-Bp and MEEQ-Bn factor scores that take into account the cross loading of item 6 can be estimated and saved for each respondent.

2.5.1 Conclusion and future directions

The MEEQ-B is a potentially useful scale to measure cannabis outcome expectancies among adolescents, however, there appear to be several areas where the performance of scale could be improved. The relatively low reliability of negative expectancies subscale may be attributed to the low factor loading of item 6 to that subscale that in turn, may be due to the dual interpretation of the item's content (i.e., the item is associated with both positive and negative expectancies). Future research could therefore further evaluate the content and face validity of item 6 and identify potential modifications to this item or subscale that improve the reliability of MEEQ-B. This assessment of face validity is pertinent to ensure that the items measure the concept they purport to measure, and that the items are interpreted by the intended respondents in the same way by the researchers/experts who developed the scale. Because item 6, which was originally assigned to MEEQ-Bn subscale cross-loads to both positive and negative outcome expectancies, the content validity of the item needs to be assessed by content experts to estimate the extent to which this item reflects the conceptualization of the negative expectancies construct in regard to cannabis use. Additionally, item 6 may be considered a double-barreled item that contains more than one idea (i.e. two separate expected effects of cannabis use) but only allowed for one response to the item[157]. Since the participant may have different opinions about each idea, the respondent may select a response option that is based on one of the ideas or a response that represent the middle ground between the two ideas. Due to this potential difference in the responses to the two ideas, future utilization of the MEEQ-B can consider teasing apart the potential cannabis effects presented in item 6 into two separate items.

Also of importance, given the lower uniqueness and higher reliability of MEEQ-Bp than the MEEQ-Bn, it is plausible that the positive expectancy items might be more conceptually relevant

than the negative expectancy items. The participants of the BASUS survey used in this thesis did not know a-priori which items were considered by the researchers to be positive or negative effects of cannabis, so response bias that is originated from feeling pressured to provide answers that were more socially acceptable might have been mitigated. However, the original conceptual analysis that was the basis of MEEQ, which subsequently was simplified to MEEQ-B, was conducted almost three decades ago in the US[100], which might present extremely different common perceptions from the present days on what constitutes negative and positive effects of cannabis. Harsher punishment on cannabis consumption and possession that was accompanied by stigmatization and propaganda against cannabis use through exaggeration of its negative effects on health might influence the types of perceptions endorsed by the participants during the original MEEQ development. Another conceptual study therefore may be needed to update the expectancy factors to be more relevant to the current political and social contexts.

In conclusion, the results indicated that the current MEEQ-B items should be scored using an approach that incorporates a cross-loading for item 6. For the purposes of this thesis, a modified version of MEEQ-B measurement model (that allowed item 6 to cross-load) was used to generate MEEQ-Bp and MEEQ-Bn factor scores for each participant for use in subsequent analyses presented in Chapter 3.

Chapter 3: Examining the Relationship between Expectancies and Cannabis Use and Intention to Use Among Adolescents

3.1 Adolescents' perceptions on cannabis use

The perceptions of Canadian youths about cannabis use and its potential health risks have been examined in two qualitative studies conducted by the Canadian Centre on Substance Abuse that each included more than 70 youths from different provinces or territories across Canada[158,159]. Among the most common perceptions identified is the view that cannabis is less harmful than alcohol, tobacco, and other 'hard drugs', such as ecstasy and heroin[159]. While this perception is aligned with the literature[160], some of the interview participants were adamant that cannabis pose no risk of harmful effects, despite the accumulating evidence that ascertains the short- and long-term adverse impacts of regular cannabis use during adolescence when the brain is undergoing major development[15]. Some of the adolescents interviewed, for example, were under the impression that cannabis is not addictive and therefore does not lead to withdrawal[159], although one in six adolescent non-medical cannabis users has been reported to develop dependence in adulthood[23]. Because of the invisibility of impairments caused by cannabis use, some youths also felt that driving under the influence of cannabis is safe, if not resulting in a more focused and safer driving[159]. This assertion is contradictory to the current evidence, which suggests that driving under cannabis influence is still associated with increased risk of collision and injury[161,162]. These misconceptions are accompanied by confusion surrounding the legality aspects related to cannabis possession and distribution; such as the belief that cannabis possession up to a certain amount is not illegal. Furthermore, a qualitative research that studies

polysubstance use of cannabis and tobacco among adolescents in British Columbia found that some young people who opted against tobacco use or co-use both substances were more well-versed on the harmful effects of tobacco than on cannabis, and viewed tobacco as more stigmatized[163]. The authors of this study suggested that harm-reduction efforts need to be cognizant of the increased risk of cannabis dependence among those who co-use cannabis and tobacco, and therefore, separate risks between the two substances need to be articulated clearly and that health messaging to reduce cannabis use prevalence among smokers need to differentiate the risks associated with recreational cannabis smoking from the medical use, with an overarching goal of minimizing total harms[163].

Amidst the misconceptions, the perceived and actual positive effects of cannabis use that have been reported by adolescent users should not be dismissed, as they influence adolescents' decisions to initiate and or sustain cannabis use. Cannabis' ability to help some youth focus, especially among those with neurodevelopmental disorder such as ADHD, to relief pain, calm the mind, and improve the ability to sleep[158] have been cited as positive effects of cannabis use that serve as adolescents' reasons to use cannabis. Even among cannabis never-users, media and anecdotal accounts from peers have shaped their expectations about the effects of cannabis use, such as the medical benefits of cannabis (i.e. curing cancer)[158], and normalized the use of cannabis that detached it from any potential consequences[159,164]. A few study results also pointed out the potential significance of policy in shaping the attitudes towards and use patterns of cannabis among youths. In Canada, where medical cannabis is legally accessible, cannabis is largely perceived by registered patients to be an effective treatment for coping with pain and minimizing symptoms of mental health issues[165]. This perception is coupled with high proportion of the patients reporting cannabis as a substitute for other prescription drugs, such as opioids and

antidepressants. A similar trend also emerged from the US, whereby a time series analysis on a ten year worth of data that compared states with and without medical cannabis laws revealed association between regulated use of medical cannabis and lower mortality rate from opioid overdose, which seemed to strengthen over time[166]. Another US-based study highlighted the association between cannabis policy and adolescents' perceptions towards the health effects of cannabis use, in which there was significantly fewer proportion of Californian adolescents who believed that regular cannabis use posed a great health risk compared to those from other states after the legalization of medical cannabis use[80].

Based on the multitude of factors that can shape the perceptions of the general population in regards to the health effects of cannabis consumption, it is possible that there exists an inadequate understanding among adolescents on the evidence-based facts associated with cannabis use that may result in uninformed judgements that influence their decisions to use cannabis, which in turn, can lead to unexpected harms[159,167]. Additionally, given that many commonly reported therapeutic effects of cannabis on alleviating mental health issues are associated with inconclusive research, especially in adolescent population, it is pertinent to encourage discussion with adolescents to address the risks of using cannabis as a coping strategy to self-medicate mental health issues[15,168]. This recommendation is also supported by the results of an ethnographic study by Moffat et al[68], in which adolescents grappled with various evidence on the effects of cannabis use. The interview results revealed that adolescents were capable of understanding scientific literature on cannabis use impacts, and highlighted the importance of involving adolescents in creating evidence-based public health messages, as opposed to positioning them solely as targets of a knowledge translation, especially in a societal climate that contains conflicting information about the potential impacts of cannabis use[68]. For this reason,

relevant evidence from epidemiological research that characterizes the types of expectancies that adolescents have regarding the effects of cannabis, and how these expectancies influence their cannabis use will provide guidance for interventions (e.g., dialogues with youth) that address specific expectancies that are yet to be supported by scientific evidence.

3.2 Existing research on outcome expectancies

Early work on cannabis use expectancies was often focused on comparing the expectancies held by current cannabis users with those of non-users, and generally found that positive expectancies were more often endorsed by cannabis users, whereas non-users were more likely to endorse negative expectancies associated with the undesirable effects of using cannabis[100,101,169]. More recently, the potential role of expectancies in predicting initiation or influencing cannabis use and cessation patterns[103,110] has gained the interest of policy makers developing a set of implementation strategies to accompany the legalization of cannabis and by researchers investigating the impacts of cannabis use on adolescents' mental health and psychosocial functioning[19,48]. Among cannabis users, for example, higher adherence to positive expectancies and lower level of negative expectancies have been associated with increased frequency of use, and higher degree of difficulties in cutting down or quitting cannabis use[95,103]. Among adolescents, this pattern of expectancies has also been found to be associated with a higher likelihood of marijuana abuse and risk of developing marijuana dependence [170]. Researchers studying adolescents have also reported that having strong positive expectancies is associated with increased risk of negative outcomes, such as poor academic performance and getting into trouble at school or at home, especially among at-risk adolescents who suffer from anxiety or depression[19]. This evidence points to the potential role of expectancies in

understanding the behaviours and associated adverse consequences of cannabis use experienced by some adolescents, and inform efforts to prevent and/or reduce cannabis use among adolescents.

When researchers have examined the individual components of both positive and negative expectancies simultaneously with other cannabis use risk factors, the expected relationships are inconsistent and include complex interaction effects. For example, in a study with high school student participants, social anxiety was found to be positively related to global negative expectancies but negatively related with expectancies involving craving and negative physical effects[108]. The same study also found that social and sexual facilitation, a component of positive expectancies, was a dissuasive reason to use cannabis among socially anxious adolescents, which contrasted with the trend reported for mainstream adolescent populations. Another study found that cannabis-related negative expectancy, specifically global negative effect, moderated the impact of coping motive, or the need to attenuate negative emotions, on cannabis use frequency[171]. Another modification effect was also reported in a recent study conducted by Kristjansson et al on adolescents[172], whereby negative expectancy related to cognitive-behavioral impairment reduced the frequency of cannabis use among participants who had high familial risks, such as alcoholic or abusive parents.

One of the key discussion points associated with the planned legalization of cannabis in Canada has been the need to identify and target resources towards the implementation of interventions that prevent the early initiation of cannabis use among adolescents[173,174]. Building on research involving cigarette smoking and alcohol drinking that has repeatedly demonstrated that the outcome expectancies of these substances predict both the intention to use and future use[60,63,65], researchers have proposed that targeting the cannabis use expectancies of adolescents

represents a potentially promising means of preventing the early initiation of cannabis use in adolescence. For example, a study that focused on teenage cannabis users found that positive expectancies related to medical benefits in the form of relaxation and relief from both emotional and physical pains were stated as reasons for using cannabis, and that cannabis was the only available means to address their health problems[175]. Physical and mental health benefits of cannabis have also been cited as reasons for using cannabis in other studies[159,176,177]. In contrast, studies focused on adolescent non-users that explore the role of negative expectancies as protective factors against cannabis initiation are relatively sparse and inconclusive. For example, a study by Schmits et al[99] found that higher expectancies of negative behaviour resulting from cannabis use decreased the probability of cannabis initiation in the following year. However, this finding was not replicated in a study by Perez et al[178], which failed to find significant differences in the odds of initiating cannabis use between adolescents who did and did not report positive expectancies about the effects of cannabis consumption.

While the relationship between expectancies and cannabis use has been examined among cannabis users, the relationship between adolescents' expectancies and their intention to initiate cannabis use has not been explored extensively. The two studies examining this relationship found that expectancies are significantly associated with the intention to use cannabis in the near future[59,179]. More specifically, one of the studies reported a cross-sectional positive relationship between lower perceived risk of cannabis and stronger intention to use cannabis within the next year[179]. A longitudinal study by Skenderian et al also reported a significant relationship between a change in expectancies and a shift in intention to try cannabis among non-users or to sustain use among those who had already tried cannabis over the course of one year[59]. In this study, the highest correlation between changes in the level of expectancies and degree of intention was

found in the cannabis-naïve adolescent group who went on to try cannabis within a year, compared to other groups such as those who remained abstinent from using, suggesting a causal linkage between expectancies, intention to use, and cannabis initiation. The aforementioned studies indeed provide informative insights on the potential role of expectancies in influencing adolescents' intention to use cannabis; however, none utilized a validated scale to measure cannabis expectancies. Furthermore, the predictive strengths of both expectancies and the intention to use cannabis in the future have not been thoroughly assessed in the literature longitudinally, which is one of the main criteria for establishing a causal relationship[180].

In contrast to the gap in research that directly evaluates the importance of reporting an intention to use when predicting cannabis initiation and use behavior among adolescents, many studies have examined the importance of intention in predicting other substance use, such as cigarette smoking and alcohol drinking among adolescents. For example, a longitudinal Australian study evaluated the plausibility of shaping adolescent participants' intentions to smoke to assist with smoking intervention programming[181]. This study found that the behaviour of non-smokers was more consistent with their intention to not smoke stated in previous year than that of the current smokers, highlighting the potential value of maintaining the intention to abstain from smoking in adolescent substance use prevention programs. Another European study underscored the effectiveness of exercises that helped form and reinforce the intention to reduce alcohol consumption in various social situations[182]. Given the evidence on the relationship between intentions and substance use found in other substances, monitoring adolescents' intentions to use cannabis appears to represent a useful means of tracking the risk to initiating cannabis use as well as supporting the targeting of upstream prevention efforts addressing

substance use intentions and the factors (e.g., expectancies) potentially associated with their change over time.

3.3 Hypothesis and research design

In light of the growing evidence highlighting the potentially harmful effects of cannabis on adolescent brain functioning and mental health, combined with the expanding literature suggesting adolescence as a period of heightened vulnerability for initiating cannabis, the impending legalization of recreational cannabis has prompted a need for knowledge on youths' expectancies related to the effects of cannabis to inform the development of interventions that reduce adolescents' risk to initiating and using cannabis. Given the limited data on cannabis use intention and initiation among adolescents, this chapter aims to examine the relationship between cannabis use expectancies and the intention to use cannabis, as well as their predictive power in forecasting future cannabis use.

My thesis research questions are embedded in two timeframes: cross-sectional (research questions a and b) and longitudinal (research question c). Using cross-sectional data, I will address the following research questions:

a) How do the expectancies of adolescent cannabis users differ from the expectancies of adolescents who have never tried cannabis (cannabis never-users)?

   Research on adolescents indicates that lower severity of perceived adverse risk of cannabis use and reduced expectations on the harmful consequences of cannabis use are associated with ever having used cannabis [95,179]. Alternatively, positive expectations of the effect of cannabis use, such as feeling relaxed or funny, were more often endorsed by cannabis-using adolescents[95]. I therefore hypothesized that positive expectancies of cannabis

use will be greater among adolescent users than among the never-users. Negative expectancies of cannabis use, on the other hand, will be greater among cannabis never users compared to current users (Hypothesis 1).

b) Among cannabis never-users, how do the expectancies of adolescents reporting a robust intention to not try cannabis in the next three years differ from the expectancies of those reporting some intention to try cannabis use in the next three years?

In a previous study, perceiving cannabis as having low risk of harmful psychological and physical impacts was associated with a stronger intention to try cannabis within the next 12 months among adolescent never-users[179]. On the contrary, a shift in perceiving cannabis as less harmful by adolescent never-users was found to be more strongly correlated with a more positive shift in the intention to try cannabis[59]. Therefore, I hypothesized that positive expectancies of cannabis use would be associated with reporting some intention to try cannabis, whereas negative expectancies of cannabis would be associated with a more resolute intention to not try cannabis (Hypothesis 2).

To better explore the plausible causal relationship between expectancies, intentions to use and risk of initiating cannabis use, I will utilize longitudinal data to answer the following questions:

c) Among cannabis never users at baseline, how do expectancies and use intentions predict the initiation of cannabis use in 6 months?

Researchers examining the longitudinal relationship between expectancies and cannabis initiation among high school students have reported a significant increase in the odds of cannabis initiation among those with higher expectancy of perceptual enhancement associated with cannabis use and a significant decrease in the odds of cannabis initiation

among adolescents who thought that cannabis use could result in negative outcomes[183]. Based on these findings, I expected to find a significant positive association between the risk of initiation and positive expectancies, and a protective effect against cannabis use initiation elicited by possessing stronger negative expectancies (Hypothesis 3).

Having the intention to conduct a specific behavior has been persistently shown to predict the actual enforcement of that particular behavior in adolescents in a wide range of research ranging from physical activities to substance use[60,184]. Assuming that similar mechanism is at play within the context of cannabis use in adolescents, I hypothesized that the lack of a robust intention to remain abstinent will be associated with an increased risk of initiation of cannabis use by adolescents over the following six months (Hypothesis 4).

3.4 Methods

3.4.1 Study sample

All data used for analysis in Chapter 3 were collected from BASUS (see Chapter 2 section 2.3.1 for details). Cross-sectional analysis was conducted on data extracted from Wave 5 of BASUS. For the longitudinal analyses, the explanatory and outcome variables were taken from Wave 5 and Wave 6 of BASUS, respectively.

3.4.2 Analytic approach

To test the four hypotheses associated with the research questions, four separate explanatory regression models were tested. Explanatory models differ from predictive models in that they do not aim to improve the accuracy of the outcome estimates by reducing its residuals

or errors[185]. Rather, an explanatory model aims to identify and evaluate the strength of the association between specific explanatory (i.e., predictor) and outcome variables of interest[185]. To account for the potential clustering of responses by participants who belonged to the same school, generalized estimating equations (GEE) regression models will be used for both the longitudinal and cross-sectional analyses. More details on the use of GEE is presented in section 3.4.4.2.

GEE models that were constructed for the longitudinal and cross-sectional analyses included socio-demographic covariates that are routinely reported in the literature on adolescent substance use and that could potentially bias the results by confounding effects. These potential confounders included gender, perceived level of socio-economic status, age, and ethnicity. The rationale for their selections as covariates, as well as questions to measure these variables, have been described in detail in Chapter 2.3.2.2.

3.4.3 Measures

3.4.3.1 MEEQ-B latent factor score

The latent factor scores for the positive and negative expectancies factors of MEEQ-B were calculated based on the CFA model of MEEQ-B that included a cross-loading of item 6 to both the positive and negative expectancy latent factors (See results of the CFA on Section 2.4.4). The model was constructed based on the Wave 5 responses of the MEEQ-B on BASUS. According to this model, the aggregate score of positive expectancies were informed by items 2, 3, 4 and 6 of the MEEQ-B, whereas the aggregate score of negative expectancies were informed by items 1, 5, and 6 of MEEQ-B. As previously described in Chapter 2.7, latent scores for the

MEEQ-B were calculated using the Maximum a Posteriori (MAP) method in MPlus. The positive and negative factor scores on the MEEQ-B served as the main explanatory variables in both the cross-sectional and longitudinal analyses (research questions a and c).

3.4.3.2 Intention to try cannabis

Self-reported intention to try cannabis was captured in Wave 5 of BASUS by presenting the question "*Do you see yourself trying marijuana sometime in the next 3 years?"* to cannabis never-users. Four responses to the question were grouped into two categories: 1) Some intention, which consisted of *"definitely yes"*, *"probably yes"*, and *"probably not"*, and 2) No intention, which consisted of *"definitely not"*. This dichotomization was based on the findings of multiple studies examining the role of intention on behavior, in which those with a well-informed intention to perform a specific behaviour expressed higher degree of certainty and was more likely to follow through with their intention than those with poorly-formed intention[58,186]. Systematic differences in the risk of substance use initiation among adolescents naïve to using substances have also been found between those who were certain about their continued abstinence (resolute-non-users) and their counterparts who were unsure about sustaining their abstinence (vulnerable non users)[181,187]. Intention to try cannabis served as one of the explanatory variables in the longitudinal analyses of this thesis, where I examined the relationship between intention to try cannabis expressed in Wave 5 and self-reported cannabis use in Wave 6 (research question c). Intention to try cannabis reported in Wave 5 also served as outcome variable in one of the cross-sectional analyses that examined its relationship with outcome expectancies associated with cannabis use (research question b).

3.4.3.3 Self-reported lifetime use of cannabis

Participants were asked to select *"yes"* or *"no"* to the questions *"Have you ever used marijuana (also called cannabis, weed, pot, hash?)"*. Cross-sectional analyses were based on responses collected in Wave 5. Participants who selected "no" at Wave 5 were classified as "cannabis never-users" and followed over time in the longitudinal analyses. To gather information on the incidence of cannabis use among those who were cannabis-naïve by Wave 5, similar question and response options were presented to participants of Wave 6 that was administered six months after completion of Wave 5. The validity of self-reported use of cannabis by adults and adolescents alike has been tested and shown in multiple studies[188,189]. Furthermore, by using the internet as a platform to administer the survey, the participants were also provided with a sense of anonymity that has been shown to promote honest response to sensitive questions, such as use of illicit substance[190].

3.4.4 Statistical Analysis

3.4.4.1 Bivariate analysis of cannabis use, cannabis use initiation and intention to try cannabis based on expectancies

Bivariate analyses between expectancies and various outcomes associated with cannabis use were conducted to provide an overview of the distribution of expectancies across different cannabis-use related behaviours and determinants. Relationships between expectancies with outcome variables that are categorical in nature, such as self-reported use in both wave 5 and 6 and intention to try cannabis, were assessed using Student's t-tests. Assessment of the relationship between Wave 6 cannabis use and the intention try cannabis were limited only to

respondents who had never tried cannabis during Wave 5. To support comparisons with existing literature using the MEEQ-B, these bivariate analyses utilized the average expectancies scores instead of the of latent scores derived from the CFA presented in Chapter 2. More specifically, positive expectancies were measured by averaging the responses to items 1, 5, and 6, while negative expectancies were derived from the average of the responses to items 2,3 and 4 (see Chapter 2, Table 2.1 for MEEQ-B items).

3.4.4.2 Generalized estimating equation (GEE)

In assessing the relationship between expectancies, intention to try cannabis, and reported use of cannabis in both longitudinal and cross-sectional analyses, general estimation equation (GEE) regression models using a logit link were used. The logit identity link was used to support interpretation of the results for a binary, categorical outcome. GEE was used as this approach provides effect size estimates with standard errors that have been adjusted for the effect of clustering of the responses provided by students who attended the same school. Because this model assumes that the response from students (cases) are dependent within the same school (i.e. within subjects), but independent between different clusters/schools (i.e. between subjects), the working correlation matrix that represents the within-subject dependencies needs to be specified. For this study, an *exchangeable* matrix was selected as it assumes homogenous correlations between the students' responses within each school. To estimate the parameters, *robust* or *sandwich variance estimator* was selected for its consistency in providing covariance matrix of the parameter estimates in large samples, even when the correlation structure is mis-specified.

The general structure of the hypothesis-testing GEE regression models are as follows:

$$g\left(E[Y_{ij}|X_{ij}]\right) = \beta_0 + \beta_1 X_{ij} + \varepsilon_{ij}$$

Where g is the link function with logit link for binary data (i.e. g(a)=log(a/(1-a))). Y_{ij} denotes the j^{th} school for subject i, and ε_{ij} represents the correlated error terms. X_{ij} is the vector of covariates, and β is the regression of the parameters of interest.

The adjusted odds and odds ratio (OR) were calculated as a measure of the effect of expectancies on intention and cannabis use. To support interpretation, the latent scores of expectancies were standardized to a Z-score of a normal distribution, and therefore, the OR is interpreted as the increase in odds of using cannabis or showing some intention to try cannabis when the latent score of expectancies was increased by one standard deviation from the average score. In one of the longitudinal analyses, the OR represents the increase in odds of trying out cannabis in Wave 6 when the subjects showed some intention to try cannabis at Wave 5. A p-value <0.05 was used as the cut-off for statistical significance. Below is the formula for calculating the odds and odds ratio:

$$\text{Odds (cannabis use or showing some intention)} = e^{\beta 0} + \beta_1 X_{ij}$$

$$\text{Odds Ratio} = e^{\beta 1}$$

3.4.4.3 Hypothesis-testing regression models

Relationships between the sociodemographic covariates and cannabis use in both waves, as well as intention to try cannabis, were first evaluated using bivariate GEE analysis with the associated Unadjusted Odds Ratio's (UOR) reported to convey the magnitude of these associations. Although some researchers have suggested that multivariate regression models need only to contain covariates with a p-value of less than 0.25 in their initial bivariate associations with the outcome variable of interest[191], I included all of the a priori specified covariates (i.e. age, perceived SES, gender, and ethnicity) in the hypothesis-testing models

regardless of their levels of statistical significance in bivariate tests. These covariates are core socio-demographic characteristics that are often reported in the field of substance use[192,193] and they are included in the analyses in this thesis to provide information on their influence, or lack thereof, on cannabis use-related behavior and attitude among adolescents.

According to the CFA model (Chapter 2, Figure 2.1), positive and negative expectancies showed a very low correlation, implying independence between these two factors. Stated otherwise, the level of positive expectancies held by an individual does not necessarily predict the level of negative expectancies held by the same individual, and vice versa. It is therefore pertinent to examine the effect size of either positive or negative expectancies on cannabis use and intention to try cannabis independent of, or controlling for, the effect of the other expectancies on those two outcome variables. To allow for the independent assessment of positive and negative expectancies, the latent scores of both expectancies were therefore included in the same model.

To evaluate whether the positive and negative expectancies modify each other's relationship with cannabis use and intention to try cannabis, the interaction terms between the two expectancies variables were tested for their significance using Wald Chi-Square test. Interaction terms were initially added to each of the regression models, and if they did not show statistical significance at p-value of <0.05, they were subsequently removed from the model.

Given that gender has been shown to interact with many psychosocial determinants of health, and acting upon the recommendation from Canadian Institute of Health Research-Institute of Gender and Health[122], we also tested the significance of interaction terms involving gender and expectancies, as well as gender and the intention to try cannabis in the longitudinal analysis. Statistically significant interaction terms involving gender were to be retained in the model as

they indicate plausible effect modification of gender on the relationship between expectancies, intention to try, and self-reported cannabis use (i.e. the relationship between these factors differs across gender).

3.5 Results

The presentation of results has been broken down into four sections. Section one provides a description of the sample including level of cannabis use and sociodemographic characteristics by expectancies. Section two describes the extent of cannabis use, intention to try cannabis, and cannabis initiation across various sociodemographic descriptors. The third section presents the results of the hypothesis-testing regression models. Lastly, post-hoc evaluation of the fit of the regression models are presented in the fourth section.

3.5.1 Univariate and bivariate analyses of cannabis use and intention by expectancies

Among the 1401 adolescents who were included in the analyses, 59.7% identified as females (N = 83.6%). Most of the respondents were 15 years old at the time of Wave 5 administration (61.7%, N = 864), while 28.5% and 9.9% of the participants were 14 and 16 years old, respectively. Approximately 20% of the adolescents surveyed had used cannabis in the past (i.e. lifetime use) (Table 3.1).

Among the never-users, approximately 25% expressed some intention to try cannabis within the next three years, of which 6% went on to report trying cannabis 6 months later. There was a significant difference in the average negative expectancies scores across subgroups of all outcome variables (cross sectional and longitudinal). However, statistically significant differences in average scores of positive expectancies was only found in cross sectional analyses

of cannabis use and the intention to try cannabis reported in Wave 5. Table 3.1 also compared the expectancies endorsed by different groups of the participants according to their socio-demographic descriptors. Older and White adolescents reported higher levels of positive expectancies compared to other age and ethnicity groups. On the other hand, Asians generally upheld a more negative view regarding cannabis use than their other counterparts. While positive expectancies were endorsed equally across genders, females also tended to assign more negative expectations to cannabis use than the males.

Table 3.1. Distribution of overall sample and average scores of expectancies across variables

	Overall Study Sample		**Average Expectancies Score in Wave 5**	
	N	**%**	**Positive (Standard Deviation)**	**Negative (Standard Deviation)**
Lifetime Use of Cannabis by Wave 5 (*n* = 1401)				
No	1107	79.01%	3.28 (1.02)	4.13 (0.83)
Yes	284	20.27%	3.70 (0.98)	3.39 (0.95)
Result of Association (student's t-test)			*t: -6.38 (p: 0.00)**	*t: 13.00 (p: 0.00)**
Intention to Try within the Next Three Years (*n* = 1098)				
No Intention	821	74.77%	3.17 (1.06)	4.22 (0.81)
Some Intention	277	25.23%	3.58 (0.85)	3.89 (0.83)
Result of Association (student's t-test)			*t: -6.55 (p:0.00)**	*t: 5.81 (p:0.00)**
Cannabis Use Initiation by Wave 6 Reported by Never-Users in Wave 5 (*n* = 966)				
No	911	94.31%	3.27 (1.02)	4.15 (0.82)
Yes	55	5.69%	3.5 (0.91)	3.90 (0.79)
Result of Association (student's t-test)			*t: -1.65 (p:0.10)*	*t: 2.276 (p:0.02)**

	Overall Study Sample		Average Expectancies Score in Wave 5	
	N	**%**	**Positive (Standard Deviation)**	**Negative (Standard Deviation)**
Age (categorical)				
14	399	28.48%	3.24 (1.10)	3.95 (0.10)
15	864	61.67%	3.4 (1.01)	3.98 (0.88)
16	138	9.85%	3.47 (0.95)	3.97 (0.91)
Result of Association (ANOVA)			*F: 4.186 (p: 0.02*)*	*F: 0.196 (p: 0.822)*
Ethnicity (categorical)				
White	683	49.82%	3.51 (0.04)	3.99 (0.89)
Indigenous	168	12.25%	3.31 (0.08)	3.79 (1.03)
Asian	482	35.16%	3.19 (0.05)	4.03 (0.88)
Other	38	2.77%	3.27 (0.17)	3.89 (0.96)
Result of Association (ANOVA)			*F: 9.16 (p: 0.00*)*	*F: 4.186 (p: 0.03*)*
Perceived Socio Economic Status (categorical)				
Below Average	280	21.81%	3.45 (0.99)	3.92 (0.91)
Average	451	35.12%	3.40 (1.01)	4.05 (0.82)
Above Average	553	43.07%	3.34 (1.06)	3.98 (0.94)
Result of Association (ANOVA)			*F: 1.161 (p: 0.314)*	*F: 2.065 (0.127)*
Sex				
Male	565	40.33%	3.34 (1.07)	3.83 (1.00)
Female	836	59.67%	*3.38 (1.00)*	*4.07 (0.84)*
Result of Association (student's t-test)			*t = -0.63 (p: 0.53)*	*t = -4.58 (p: 0.00*)*

*shows statistically significant p-value<0.05

3.5.2 Univariate and bivariate analyses of cannabis use, intention to try, and initiation across sociodemographic covariates

Self-reported lifetime cannabis use in Wave 5 was significantly different across ethnicity, age, and perceived SES (Table 3.2). Those who self-described as Asians were less likely to

report lifetime cannabis use than their white counterparts, while Indigenous adolescents showed the opposite trend. Age was also correlated with past cannabis use, in which the older the adolescents, the higher the odds of having initiated cannabis use. Furthermore, household SES that was perceived to be below average was found to be a potential risk factor for having initiated cannabis use.

Table 3.2. Frequency of self-reported lifetime use of cannabis by Wave 5 across socio-demographic characteristics

Covariates	**Overall Study Sample**		**Lifetime Use of Cannabis by Wave 5 (N = 1391)**		**Unadjusted Odds Ratio (95% Confidence Interval)**	**p-value**
	N	**%**	**Yes (N = 284)**	**No (N = 1107)**		
Ethnicity						
White/Caucasian	673	50.45%	151	530	*Referent*	
Indigenous	163	12.22%	67	99	2.31 (1.54-3.46)	0.00*
Asian	465	34.86%	46	431	0.66 (0.43-1.03)	0.07
Other	33	2.47%	8	29	1.02 (0.30-3.46)	0.97
Total	1334		272	1089		
Age						
14	396	28.47%	51	345	*Referent*	
15	858	61.68%	190	668	1.99 (1.41-2.80)	0.00*
16	137	9.85%	43	94	3.02 (1.65-5.54)	0.00*
Total	1391		284	1107		
Gender						
Male	561	40.33%	121	440	*Referent*	
Female	830	59.67%	163	667	0.95 (0.70-1.29)	0.76
Total	1391		284	1107		
Perceived Socio-Economic Status						
Above Average	547	42.90%	105	442	*Referent*	
Average	449	35.22%	76	373	0.92 (0.68-1.24)	0.57
Below Average	279	21.88%	70	209	1.46 (1.08-1.99)	0.02*
Total	1275		251	1024		

*shows statistically significant p-value<0.05

Only ethnicity was significantly associated with the odds of showing some intention to try cannabis within the next three years among the cannabis never-users in Wave 5 (Table 3.3). Similar to the trend in lifetime-cannabis use, students who identified as Asian were less likely to show some intention to try cannabis compared to White students.

Table 3.3. Frequency of never users in Wave 5 expressing intention to try cannabis within the next three years across socio-demographic characteristics

Covariates	**Overall Never-Users in Wave 5**		**Intention to Try Cannabis within the Next Three Years (N = 1098)**		**UOR (05%CI)**	**p-value**
	N	**%**	**Some Intention (N = 277)**	**No Intention (N= 821)**		
Ethnicity						
White/Caucasian	526	48.70%	164	362	*Referent*	
Indigenous	98	9.07%	26	72	0.81 (0.49-1.34)	0.41
Asian	428	39.63%	74	354	0.43 (0.31-0.61)	0.00*
Other	28	2.59%	7	21	0.65 (0.32-1.32)	0.23
Total	1080		271	809		
Age						
14	343	31.24%	73	270	*Referent*	
15	662	60.29%	174	488	1.25 (0.93-1.69)	0.13
16	93	8.47%	30	63	1.36 (0.81-2.27)	0.24
Total	1098		277	821		
Gender						
Male	436	39.71%	100	336	*Referent*	
Female	662	60.29%	177	485	1.26 (0.95-1.66)	0.11
Total	1098		277	821		
Perceived Socio-Economic Status						
Above Average	437	43.05%	113	324	*Referent*	
Average	371	36.55%	86	285	0.87 (0.59-1.29)	0.50
Below Average	207	20.39%	56	151	1.06 (0.80-1.40)	0.68
Total	1015		255	760		

*shows statistically significant p-value<0.05

In contrast to the trend in lifetime-cannabis use, there was no significant difference in the reported initiation of cannabis use in Wave 6 across various socio-demographic groups (Table 3.4).

Table 3.4. Frequency of cannabis use initiation by Wave 6 across socio-demographic characteristics

Covariates	Overall Never Users in Wave 5		Cannabis Use Initiation by Wave 6 (N = 966)		UOR (95% CI)	p-value
	n	%	Yes (N = 55)	No (N= 911)		
Ethnicity						
White/Caucasian	456	47.75%	29	427	*Referent*	
Indigenous	75	7.85%	7	68	1.49 (0.52-4.26)	0.46
Asian	399	41.78%	17	382	0.61 (0.34-1.10)	0.10
Other	25	2.62%	2	23	1.43 (0.38-5.43)	0.60
Total	955		55	900		
Age						
14	310	32.09%	20	290	*Referent*	
15	584	60.46%	30	554	0.77 (0.43-1.38)	0.38
16	72	7.45%	5	67	1.22 (0.40-3.69)	0.73
Total	966		55	911		
Gender						
Male	374	38.72%	22	352	*Referent*	
Female	592	61.28%	33	559	0.90 (0.56-1.43)	0.64
Total	966		55	911		
Perceived Socio-Economic Status						
Above Average	389	42.94%	20	369	*Referent*	
Average	335	36.98%	20	315	1.14 (0.63-2.04)	0.67
Below Average	182	20.09%	12	170	1.38 (0.81-2.33)	0.23
Total	906		52	854		

*shows statistically significant p-value<0.05

3.5.3 Hypothesis-testing regression models

None of the interaction terms including positive and negative expectancies, as well as interaction terms that tested the difference in the relationship between the explanatory and outcome variables across gender were found to be statistically significant. As a result, all of the final hypothesis testing models only contained the main explanatory and outcome variables along with the four socio-demographic covariates of perceived SES, gender, age, and ethnicity.

Both positive and negative expectancies were found to be significantly associated with all the outcome variables tested in both cross-sectional and longitudinal analyses. In the cross-sectional analyses, a shift of one standard deviation (SD) away from the average latent score of positive expectancies corresponded to 2.47 times increase in the odds of reporting life-time cannabis use by Wave 5, while an increase of one SD from the average latent score of negative expectancies was accompanied by a 70% decrease in the odds of having tried cannabis (Table 3.5, Model 1). Similarly, one SD increase from the average of positive expectancies latent score multiply the odds of showing some intention to try cannabis by about two times, whereas one SD increase in negative expectancies reduced the odds by 55% (Table 3.5, Model 2). Indigenous status and older age, were still significantly associated with higher risk of reporting past cannabis use by Wave 5. Identifying as Asians, however, seem to offer protection against report of past use. Similarly, Asians also reported lower odds of expressing some intention to try cannabis within the next three years compared to their white counterparts. On the other hand, females were found to be at higher odds of expressing some intention than males.

A similar trend was also observed in the longitudinal analysis, although at a lesser magnitude. As the positive expectancies' latent score changed by 1 SD from the mean, the odds of reported cannabis use by Wave 6 increased by about 1.4 times, while the same shift in the

negative expectancies reduced the odds of reporting cannabis use by Wave 6 by about 0.6 times (Table 3.5, Model 3). The result also highlighted significant relationship between previous intention and eventual cannabis use. Those who expressed some intention to try cannabis use within the next three years were almost seven times more likely to go on to try cannabis within the next six months than those who showed absolutely no intention (Table 3.5, Model 4). None of the socio-demographic variables were significantly associated with reported cannabis use by Wave 6 in the longitudinal analyses.

Table 3.5. Results of cross sectional and longitudinal GEE models predicting lifetime cannabis use, initiation of cannabis use, and intention to try cannabis within the next three years

	Model 1 Cross-sectional predicting lifetime use *n* = 1248	Model 2 Cross-sectional predicting intention to try *n* = 995	Model 3 Longitudinal predicting initiation of use *n* = 884	Model 4 Longitudinal predicting initiation of use *n* = 877
DEPENDENT VARIABLES				
Expectancies				
Positive	2.47 [1.94-3.13]*	1.91 [1.56-2.33]*	1.38 [1.01-1.88]*	NA
Negative	0.30 [0.24-0.38]*	0.45 [0.36-0.57]*	0.62 [0.46-0.84]*	NA
Intention to try within the next three years				
No intention	NA	NA	NA	Referent
Some intention	NA	NA	NA	6.91 [3.83-12.47]*
SOCIO-DEMOGRAPHIC COVARIATES				
Gender				
Male	Referent	Referent	Referent	Referent
Female	1.29 [0.84-1.96]	1.67 [1.24-2.26]*	0.96 [0.60-1.54]	0.68 [0.38-1.21]
Ethnicity				
White	Referent	Referent	Referent	Referent
Indigenous	2.34 [1.44-3.82]*	0.93 [0.53-1.65]	1.42 [0.52-3.88]	1.66 [0.59-4.32]
Asian	0.66 [0.45-0.98]*	0.50 [0.36-0.69]*	0.77 [0.46-1.27]	1.31 [0.59-1.72]
Other	1.16 [0.31-4.29]	1.09 [0.51-2.34]	1.91 [0.51-7.19]	2.16 [0.41-8.38]
Age (treated as continuous)	1.95 [1.39-2.73]*	1.23 [0.97-1.56]	0.85 [0.49-1.47]	0.72 [0.42-1.25]
Perceived SES				
Above Average	Referent	Referent	Referent	Referent
Average	0.88 [0.59-1.31]	0.84 [0.52-1.35]	1.19 [0.66-2.14]	1.33 [0.72-2.47]
Below Average	1.38 [0.86-2.12]	1.08 [0.76-1.52]	1.38 [0.82-2.35]	1.40 [0.75-2.64]

*p-value < 0.05. Note: Model 1 evaluates cross-sectional relationship between expectancies and lifetime cannabis use by Wave 5; Model 2 evaluates cross-sectional relationship between expectancies and intention to try cannabis expressed in Wave 5; Model 3 evaluates longitudinal relationship between expectancies in Wave 5 and cannabis use initiation by Wave 6 among those who never tried cannabis by Wave 5; Model 4 evaluates longitudinal relationship between intention to try cannabis expressed in Wave 5 and cannabis use initiation by Wave 6 among those who never tried cannabis by Wave 5.

3.5.4 Post-hoc testing of model fit

The residuals of the of the four hypothesis-testing models were evaluated to provide an overview of the model fit. Because logit link was used in the general estimating equation (GEE) to accommodate the binary outcome variables, and given that the coefficients produced by logistic regressions were relatively similar to the ones produced by GEE, the residual statistics were applied to the data that had been fitted to logistic regression models that also controlled for the same sociodemographic covariates as examined in the GEE. The residual statistics were based on the recommendation by Field[194] and included Cook's distance, leverage statistics, DF Beta, and studentized residuals. For Models 1 to 3 of Table 3.5, Levene's test was conducted to assess the homogeneity of variance of the expectancies residuals across the groups of the outcome variables. Although GEE was robust to violation of normality assumption[130], QQ-plots for Models 1 to 3 were also created to better understand the distribution of the expectancies residuals. Finally, the Pearson's residuals of all GEE models were plotted against the predicted value of the mean response to examine the distribution and potential skewness of the residuals after the data had been fitted by the GEE models.

The leverage statistics gauges the influence that some observed values of cases have over the predicted values and is calculated by (k+1)/n, in which k is the number of predictors in the model and n is the number of total cases. Stevens[195] recommended three times of the leverage value as the cut-off value to identify cases with undue influence. None of the cases in Model 1 exceeded the cut-off value, whereas 2.5% and 2.6% of cases in Models 2 and 3, respectively, were above the cut-off value. Approximately 6% of the cases in Model 4 also have undue influence. However, all of the leverage values were well below one and very close to 0, indicating that their influence was negligible[194]. Another residual statistic, Cook's distance,

measures the overall influence on the model and a value above one may be cause for concern[196]. None of the cases in all four models exceeded one, and the plots could be found in Appendix B.

Dfbeta measures the difference between a parameter estimated using all cases and estimated without a particular case, and it is recommended for the absolute difference to be below one[194], which all of the cases in all models subscribed. Studentized residuals was calculated by dividing the difference of the predicted value from the observed value by the standard deviation. To ensure good model fitness, it is recommended that less than 5% of the cases' residuals lie outside |+/- 1.96|[194]. All of the models had higher proportion of cases with residuals beyond the recommended range, with up to 29.6% of residuals in model 2 situated beyond |+/- 1.96|. However, the influence that these cases with extreme residuals exerted on the estimation of the models' coefficients is expected to be negligible, as signified by the leverage and DFbeta values of all cases in all four models that were well under one.

According to the Levene's test, all expectancies score in Models 1 and 3 had equal residual variance, whereas residual variance of positive expectancies score in Model 2 was unequal. The QQ-plots of Model 1-3 showed that generally the residuals were normally distributed around the central values with relatively large deviations around the extreme values (Appendix B.2). The distribution plots of Pearson's residuals against the predicted value revealed that the residuals in Models 1, 2, and 4 were positively skewed, while the residuals in Model 3 had negative skewness.

3.6 Discussion

This chapter set out to explore the association between outcome expectancies and cannabis use, intention to try cannabis, and cannabis initiation. Additionally, the potential

predictive strength of intention to try cannabis on the reported initiation of cannabis use within the next six months was also evaluated. To address these research objectives, the data were analyzed using four separate explanatory general estimating equation (GEE) regression models that tested each of the associations of interest. The statistical significance of interaction between positive and negative expectations, as well as interaction of gender with both factors of expectancies were also tested to assess the potential modifying effects brought upon by expectancies and gender. The results indicate that cannabis use expectancies are associated with current self-reported initiation of cannabis use, the intention to try cannabis as well as the future initiation of cannabis use among adolescent never-users. The findings also provided further support for the strong association between having an intention to try cannabis and the subsequent initiation of cannabis use over the following 6 months.

Comparable to previous findings, and in support of our hypothesis, adolescents who reported that they had already initiated cannabis use were more likely to report higher levels of positive expectancies than those who had never tried cannabis. In contrast, the negative expectancies were more strongly endorsed by adolescents who were cannabis-naïve. Attitudes, which were operationalized by perceived risks associated with substances, have been shown to influence concurrent substance use behaviour in adolescents, ranging from cannabis use, smoking, to excessive alcohol use. For example, previous research indicates that adolescents who believe that cannabis use could result in adverse consequences, such as poor performance in school and cognitive impairment, are less likely to report lifetime or current use of cannabis[95,100,172]. On the contrary, the findings in the literature on the association between reported use of cannabis and positive expectancies is mixed. For example, Kristjansson et al[172]

found that components of positive expectancies, such as global positive changes, were not associated with lifetime use, although relaxation or tension reduction, and enhancement of cognitive-motoric performance were positively associated with lifetime use. Vangsness et al[97] also showed that positive outcome expectancies were not significantly correlated with reported cannabis use. Nevertheless, positive expectations associated with cannabis use were often shown to be positively associated with higher frequencies of use among users in different adolescent groups, such as those with ADHD and youth showing symptoms of anxiety or depresion[19,98].

The mixed results found in previous research may be due to the use of unstandardized instruments scales that described positive expectancies differently from this thesis and contained different item content than the MEEQ-B. The presence of an association between positive expectancies and cannabis use in this thesis that is in contrast from some of the previous research findings may also be explained by the different extent in which individual elements of positive expectancies (i.e. marijuana helps a person relax, marijuana helps people get along better) influence adolescents' behaviour surrounding cannabis use, and that this difference may be masked when the positive expectancies were measured at a higher factor-level. Previous studies also reported that some components of positive expectancies were more strongly endorsed than the others due to fundamental difference in the characteristics of the youth populations that were studied[97,170,172]. The heterogeneity in perceptions towards cannabis use may also be attributed to varying social contexts that differ across countries or socio-economic backgrounds. In countries with relatively huge disparity in socio-economic status, for example, cannabis use was more prevalent among adolescents from lower socio-economic background than those with a more affluent family background, partly due stigma that associates cannabis users with indigents[197]. In

this thesis, it is important to note that the research participants were sampled mainly from the general population and included adolescents who most likely attended school regularly, whereas several of the aforementioned studies sampled adolescents with a specific mental health issue or from a marginalized population, such as incarcerated adolescents [62,98].

Intention to use cannabis among the never-users was described in this study as the adolescents' perceived likelihood to initiate cannabis use within the next three years and it can be viewed as an indicator or marker of their vulnerability to try using cannabis in the future. In line with the research hypothesis, the intention to try cannabis among adolescent never-users within the next three years was also strongly associated with the cannabis expectancies held by participants. Furthermore, positive expectancies were associated with having an intention to try in the future and negative expectancies were associated with having a resolute intention to abstain from initiating cannabis use in the future (see Table 3.5, Model 2) suggesting that positive and negative expectancies help shape substance use intentions. This interpretation is supported by the findings of Skenderian et al[59], whereby changes in expectancies were accompanied by changes in intentions, and that a shift to perceiving cannabis as less harmful was associated with greater positive change in intention. The study also showed that the correlations between changes in expectancies and intentions were stronger among never-user adolescents who became users within a year compared to those who maintained abstinence, underscoring the important role of expectancies in both intention and future use.

Expectancies were also found to be associated with the subsequent initiation of cannabis use in our study (Table 3.5, Model 3). Specifically, a higher level of positive expectancies was associated with higher risk of cannabis use initiation within six months, while the reverse trend

was true for negative expectancies. This result implies that expectancies' influence on cannabis use may be sustained over a six-month period. It is possible, however, that the previously held expectancies reported in Wave 5 had changed during the six-month interval when the cannabis use initiation occurred, and as such, this possibility warrants further research.

The sustainability of the impact of expectancies on cannabis use was also shown in a longitudinal study that followed high school students for a year, in which expecting cannabis use to result in negative behaviour significantly reduced the odds of cannabis use initiation over the following year, while believing that cannabis use can enhance perceptual experience increased the likelihood of initiating cannabis use within a year[183]. This result also parallels the findings from studies on other substances, such as the initiation of tobacco smoking. For example, in a study by Cremers et al [198], boys living in neighbourhood with high socioeconomic status were more likely to develop an intention to smoke if they associated smoking with positive consequences, whereas girls in similar neighbourhood were more likely to smoke if they perceived lower adverse risks associated with smoking.

In addition to examining the role of expectancies, we looked at the role of intention in determining future cannabis initiation. Echoing the findings from Skenderian et al[59], where changes in intentions were largest among adolescents who became users within one year period, our study also found that intention to try cannabis was a very strong predictor of the initiation of cannabis use. In our study, adolescent never-users who expressed some intention to try cannabis in the next three years were almost seven times more likely to end up trying cannabis within six months than those who expressed absolutely no intention (Table 3.5, Model 4). While the direct relationship between intention and cannabis use is rarely examined, especially among cannabis-

naïve adolescents, the importance of targeting adolescents' intention as a means of modifying or preventing future behaviours related to substance use has been shown in research on smoking and alcohol consumption among youths. For example, intention has been shown to be a significant predictor of quitting smoking among youths[60] and reductions in the amount of alcohol consumption in a sample of undergraduate students[182]. Hornik et al also speculated on the potential evidence for the predictive strength of intention on future cannabis initiation[85]. Although no statistical tests were reported, the study found that the proportion of adolescents who became cannabis users within the next 12-18 months were lower among those who presented robust intention to remain abstain from cannabis than those who showed some intention to try cannabis.

To evaluate whether positive expectancies influence the relationship of negative expectancies with cannabis use and cannabis use intention, the interaction terms between these expectancies were tested in all of the hypothesis-testing regression models. None of the interaction terms between positive and negative expectancies was statistically significant. This finding implies that the relationship between positive expectancies and cannabis use and cannabis use intention in an individual was not modified by the level of negative expectancies they held. Viewed from the opposite angle, the impact of negative expectancies on cannabis use and cannabis use intention was not modified by the individual's endorsement of positive expectancies associated with the effect of cannabis. Additionally, the result of the confirmatory factor analysis in the previous chapter demonstrated a weak correlation between positive and negative expectancies. Collectively, these findings strongly suggest that positive and negative expectancies have independent effects on cannabis use behaviours, which may indicate that

adolescent's decision process surrounding cannabis use may involve assessing the risk and rewards associated with the effects of cannabis, and that their final choice could be a result of assigning higher values on a specific expected outcome over another. Given previous findings suggesting adolescents susceptibility to seeking for immediate rewards without careful consideration of consequences[116], the previously stated implication may add another layer of complexity on the relationship between outcome expectancies and decision to use cannabis. More research therefore needs to be done on understanding the linkages between outcome expectancies, risk and reward appraisal, and cannabis-related behavior among adolescents.

The potentially modifying effect of gender on the relationship between expectancies and cannabis use, and between expectancies and intention to try cannabis was also evaluated by interacting gender with expectancies in each of the regression models. The lack of significant interaction terms between gender and expectancies in all of the regression models indicates that the impact that expectancies may have on cannabis use risk and the risk of developing the intention to try does not differ across gender. While in the past male adolescents have been found to have higher rates of cannabis use than females, recent research suggests a narrowing of the gap in cannabis use trends across genders[199]. Bivariate analysis of data reported in this thesis supports this finding in that I found that lifetime cannabis use, intention to try cannabis, and cannabis initiation did not differ between male and female adolescents (Table 3.2-3.4), although females generally endorsed more negative cannabis use expectancies than males (Table 3.2). Another potential reason for the absence of difference across genders may also be due to the limited capacity of the dichotomous gender descriptors of male and female in capturing the complex nuances of gender identity that is shaped by societal expectations, which may have a

more potent influence on behaviours surrounding substance use. A validated measure that considers gender identity as a social construct and is inclusive of gender non-conforming, such as the Gender Expression measure[200], could therefore be used in future research on the disparities of cannabis use risk across genders.

In this thesis, only 20% of the adolescents survey reported lifetime cannabis use, which is slightly lower than the reported prevalence of lifetime cannabis use among British Columbian and Canadian youths in 2013 (26% and 31.1%, respectively)[28,30]. The lower rate found in this thesis could perhaps be attributed to the different age range of the participants included in this thesis from that in the provincial and national surveys. The participants of the larger surveys included youths who were up to 19 years of age who possibly had much higher risk of substance use than the participants of this thesis (aged 14 to 16 years), given that the risk has been shown to increase with age[114]. Nevertheless, the distribution of other sociodemographic descriptors captured in this thesis were comparable to that of the larger surveys, such as the BC Adolescent Health Survey conducted by McCreary Centre Society[28]. For example, the proportion of White and Indigenous students in our thesis were about 50% and 12.3%, respectively, similar to the ethnicity break-down in the larger survey that included 53% and 10% White and Indigenous students, respectively.

Although not the focus of our study, this chapter also notes the significant difference in the risk of cannabis use and use intention between different ethnic groups. Generally, the reported lifetime use of cannabis by Indigenous adolescents was higher than other ethnicities (Table 3.2). This result is supported by previous findings, in which Canadian Indigenous youths who lived off-reserve were more likely to have tried cannabis and other substances or illicit drugs than non-Indigenous youths[201]. The widespread social acceptance of cannabis within this

population group has also been speculated by previous research in which peer use was found to be a significant determinant of cannabis use by Indigenous adolescents[202].

Despite the heightened risk of lifetime cannabis use, the risk of cannabis use initiation in Indigenous adolescents did not differ from other ethnic groups (Table 3.4). This discrepancy could perhaps be attributed to the earlier age of onset of cannabis use among Indigenous adolescents compared to other adolescent populations. While on average British Columbian adolescents started using cannabis at 15-year old[29], it is plausible that the initiation age among Indigenous adolescents is lower than the age range captured in my thesis (14-16 year old). Thus, objective data on average initiation age specific to this population is needed. The pervasiveness of cannabis use among Indigenous adolescents could also perhaps be rooted in the intergenerational trauma brought upon by colonialization and forced assimilation to Euro-western society that have been recognized as distal determinants of health disparities that marginalize Indigenous communities[203,204]. Given that many youths reported using cannabis for coping with high level of stress and anxiety or managing anger, it is possible that Indigenous youths may resort to cannabis use when seeking for relief from negative emotions[175].

Although the odds of reporting lifetime cannabis use did not differ between Asian and White adolescents, being of Asian origin is a protective factor against developing some intention to try cannabis use (Table 3.3). Several studies offer potential explanations on this association, such as strong familial bonding and the integral role of family as a source of socialization for Asian American adolescents that shape a collective cultural attitude against substance use[205]. Maternal monitoring and parental influence in controlling different areas of children's lives, such

as academic, social and extracurricular activities have also been noted as potential barrier against early initiation of substance use among Asian American adolescents[206].

The differential risk of cannabis use and intention across ethnicities found in this thesis therefore contributes to the growing recognition of the need for research that considers cultural perspectives on research design and interpretation, as the potential influence of ethnic identity and cultural relation on decisions surrounding cannabis use in adolescents need to be further elucidated. The result also highlights the importance of preventive measures against cannabis initiation that are culturally-specific, especially for adolescents who belong to ethnic minority groups.

3.6.1 Limitations and future studies

This study was administered to adolescents who attended public schools in BC that excluded alternative schools and was available only to English speakers. The patterns of cannabis use and the associated psychosocial functioning of at-risk adolescents who did not have or only had limited access to formal education, such as homeless or street-entrenched youth, were therefore most likely not captured by this present study. The survey questions associated with this thesis also did not differentiate between the use of recreational and medical cannabis among the participants. However, given that medical marijuana legalization was introduced after the survey was administered, and that the application process to possess cannabis for medical purposes is limited to adults[26], the number of medical marijuana users involved in the study is estimated to be negligible.

Based on the recommendation of the validation study presented in Chapter 2, the six-item MEEQ-B appears to provide a valid measure of expectancies in accordance with the conceptual framework composed of separate positive and negative expectancy factors. Based on this psychometric evidence supporting the use of the tool, we did not examine the effect of individual expectancy items (i.e. perceptual enhancement, craving) on cannabis use and intention to try. Given that some researchers have found that individual components of positive and negative expectancies may affect adolescents' cannabis use behaviours differently[155,183], future studies should investigate the relationship of individual expectancies (i.e. cannabis use causes craving or cannabis use makes me feel relaxed) with the risk of cannabis use, cannabis use initiation, and developing intention to try cannabis. For example, the more comprehensive 48-item MEEQ that contains three expected main positive and negative consequences of cannabis use could be utilized to measure the level of endorsement of a wide range of individual expectancies by adolescents[100].

Given the importance of both cannabis use expectancies and intention in determining future use, public health initiatives attempting to prevent or delay the use of cannabis by adolescents might benefit from further research that closely examines the relationship over time between expectancies and intention on future use. For example, a path analysis could be conducted to map out the pathway of cannabis use initiation through expectancies and intention. Furthermore, the significance of intention in influencing smoking and alcohol cessation highlights the opportunity to better understand the potential of modifying unsupported or inaccurate expectancies to support prevention or cessation programs. Other known risk factors of cannabis use, such as familial risks[172], perceived norm of cannabis use, and as a coping strategy to manage

stressful events (i.e. motives) should also be examined concurrently with expectancies as they may interact with one another to influence the decisions surrounding cannabis use and initiation in adolescents. For example, a previous study by Kristjansson et al. suggested that negative cannabis use expectancies mediated the association between familial risk and cannabis use[172]. Another potential research direction is a profile analysis that considers these different risk factors to isolate adolescent population who are particularly vulnerable to substance use, and can therefore be specifically targeted by and benefit the most from cannabis use prevention efforts.

3.6.2 Conclusion

Chapter three examined the relationship between expectancies and reported lifetime cannabis use, intention to try cannabis among the never-users, and cannabis use initiation within the next six months. It also assessed the longitudinal association of intention to try cannabis with cannabis use initiation. The findings suggested that higher level of positive expectancies was associated with a greater likelihood of reporting lifetime cannabis use and expressing some intention to try cannabis in the near future, while the reverse trend was seen for negative expectancies. Greater degree of positive expectancies and showing some intention to try cannabis in the future were also strongly associated with cannabis use initiation within six months. Although the mean score of negative expectancies differs between male and females, the associations between expectancies and cannabis use were not modified by gender in this study. The relationship between intention to try cannabis and eventual initiation cannabis use was also not modified by gender. The longitudinal nature of this study implies that expectancies and intention to try are potential determinants of cannabis initiation; however, mediation or path analysis is needed to more carefully investigate this hypothesized psychological process.

Overall, our findings, combined with similar evidences on both cannabis and other substance use reinforce the potentially important roles cannabis expectancies and intention to use play in understanding how the risk for cannabis use initiation develops among adolescents.

Chapter 4: Conclusion

Canada is one of the few countries that regulates access to medical cannabis[5], and the current government is preparing for a new policy that legalizes recreational use of cannabis[6]. In discussions related to the proposed legalization, minimizing cannabis use among adolescents was identified by the Task Force on cannabis legalization commissioned by the Canadian Government as one of the key aims that need to be considered by the new regulation, given the prevalent use of cannabis in this age group[6]. A 2013 report by the WHO identified Canada as having the highest percentage (28%) of children aged 11, 13, and 15 years who reported of having used cannabis in the last 12 months compared to other developed countries[207]. Past-year use of cannabis among young people in Canada has also been reported to be three times higher than the rate of use in adults in Canada (24.4% VS. 8%)[26].

The spotlight on adolescent cannabis use brought upon by the impending policy has therefore created an opportunity for researchers and policy makers to discuss and develop effective surveillance system on adolescents' behavioural trends associated with cannabis and measures to minimize the risk of initiation and continued use of cannabis in this particular age group. Considering that successful interventions addressing health behaviours should be supported by rigorous evidence, this thesis aimed to shed light on two potential factors, namely outcome expectancies and intention to use, that may put adolescents at a higher risk of using cannabis. Operationalizing the Integrated Model of Behavioral Prediction (IMBP)[208] described in Chapter 1, intention in the context of adolescent cannabis use is theorized as a measure of readiness of adolescents to use cannabis, and is thought to be shaped by positive and negative outcome expectancies. Also discussed in Chapter 1, outcome expectancies (henceforth referred to as expectancies) relating to cannabis use can be described as perceived positive and negative

consequences of using cannabis. Positive expectancies encompass three major perceived consequences, including social and sexual facilitation, perceptual and cognitive enhancement, and relaxation and tension reduction. The consequences related to negative expectancies are cognitive and behavioral impairment, global negative effects, and craving and physical effects. Several tools exist to measure expectancies[101,105,209]; however, to our knowledge, MEEQ-B is the only tool that has a relatively a small number of items that support its utility in a large epidemiological study and has been validated in adolescent population[62].

Given the relative novelty of the research area, there is a lack of literature on the validation of tools that measure cannabis outcome expectancies in adolescents. Furthermore, based on the recommendation to use validated tool to measure research outcomes[94], this thesis evaluated the psychometric properties of the MEEQ-B using Confirmation Factor Analysis (CFA)[111]. This tested whether the positive and negative expectancies factors identified in the original development study holds in the adolescent population sampled in my thesis[62]. The result of the CFA was then used to guide the scoring and interpretation of the MEEQ-B for subsequent regression analyses presented in Chapter 3. To accomplish the overarching aim of evaluating expectancies and intentions as potential determinants of adolescent cannabis use, this thesis then examined the relationships of: 1) expectancies and lifetime use of cannabis, 2) expectancies and intention to try cannabis, 3) expectancies and initiation of cannabis use, 4) intention and initiation of cannabis use. All of these relationships were assessed using regression models in Chapter 3.

From the CFA analysis, I found that the data did not fit the proposed two-factor model of the MEEQ-B items, as many of model fit indices fell short of the recommended values. To improve the model fit, the CFA results suggested modifying the model by cross-loading item 6 of the

MEEQ-B ("Marijuana has effects on a person's body and gives a person cravings (get the munchies/hungry; have a dry mouth; hard to stop laughing))", which was initially presumed to load exclusively onto the negative expectancies factor, onto both the positive and negative expectancies factors. Based on the modification, it is postulated that item 6 may inspire dual interpretations, in that "hard to stop laughing" may be interpreted by participants as a positive consequence of cannabis use, whereas "have a dry mouth" may be construed as a negative consequence. This inference is also supported by previous studies' mixed interpretations of cravings as either positive or negative consequence of cannabis use. For example, the evaluation of the French-version of MEEQ, the longer version of MEEQ-B, merged craving and perceptual enhancement into a single factor and described them as a part of the positive expectancies[105,155]. In contrast, MEEQ-B separated perceptual enhancement from cravings, with the former contributing to positive expectancies and the latter was inferred as part of negative expectancies[110].

Due to the potentially dual interpretation of item 6 of MEEQ-B, this thesis therefore applied latent scoring that incorporates the cross-loading of item 6 in the expectancy scores[156]. In other words, the latent scores for both positive and negative expectancies would be informed by item 6. It is recommended that future research utilizing the MEEQ-B opt for a statistical approach that supports incorporating a cross-loading for item 6, such as structural equation modelling, and that researchers further clarify the conceptual interpretation of positive and negative expectancies in adolescents, and assess the content validity of MEEQ-B items to improve the reliability of MEEQ-B.

As reviewed in this thesis, expectancies have been identified in previous research as contributing to patterns of various substance use, including initiation[183], frequency[170], and

cessation of use[110]. While in the past most of the research on expectancies has been focused on alcohol consumption and tobacco smoking in adults, recent studies have reported significant associations between expectancies and trajectories of cannabis use in adolescents. For example, among offspring of parents with history of alcohol dependence and abuse, negative expectancies and reported use during adolescence was found to mediate the association between parental risk and current use of cannabis during young adulthood, with users perceiving lesser impacts of cannabis use on cognitive performance than non-users[172]. Researchers have also reported that female youths with depressive symptoms hold stronger positive expectancies associated with the effect of cannabis use and that they also reported increased levels of negative consequences of cannabis use, such as getting into trouble in school or doing something regrettable because of using cannabis[210]. Grade 7-11 students who expected more positive outcomes associated with cannabis use and showed more preference towards these outcomes were more likely to report past use and intensify their frequency of use over time[211]. Collectively, this evidence supports the need to further explore expectancies as a potential indicator for monitoring adolescents' risk for problematic cannabis use and its harmful consequences.

In support of my initial hypothesis, this thesis found that adolescents who endorsed high level of positive expectancies were more likely to be cannabis users, or to report lifetime use of cannabis. The inverse relationship was seen among adolescent never-users, who were more likely to score higher on the negative expectancies and lower on the positive expectancies. These results are in agreement with previous studies that identified the high prevalence of cannabis users who retained different types of positive expectations regarding the effect of cannabis, and the high proportion of cannabis never-users who held various negative expectations regarding cannabis use effect[95,170,171]. Longitudinally, expectancies in this thesis also appeared to be

potential determinants of cannabis use initiation among the never-users, potentially forming an important pathway linking expectancies with initiation and use over time. The only longitudinal investigation of the relationship between expectancies and cannabis use initiation among adolescents found in the literature also supported the findings of the thesis, whereby perceptual enhancement and craving effects, as well as relaxation and social facilitation increased the probability of cannabis initiation within a year[105].

Expectancies, or perceptions about the effect of cannabis use, and their influence on adolescent's decision to try cannabis has also been evaluated qualitatively. The Canadian Centre of Substance Abuse (CCSA) recently reported the results of a study that interviewed Canadian youths to gather their perceptions on cannabis use[159]. Generally, participants viewed cannabis as less harmful than alcohol and other substances, and some cited health benefits of cannabis that can help alleviate physical and mental health issues as reasons to try cannabis. Increased appetite was also cited as a reason for using cannabis, especially among participants who suffer from eating disorders or have to undergo chemotherapy. This view is in contrast with the thesis' initial understanding that cravings or munchies was contributing exclusively to negative expectancies that could deter adolescents from using cannabis[62]. Similar to the research presented in this thesis that considered cognitive impairment as a potential deterrent to using cannabis, many of the youths in the CCSA report also understood that cannabis use may have detrimental impact on their brain development[62]. However, they believed that the effect on the brain is restricted to heavy use of cannabis that was described as more than a joint a day[159].

Additionally, the CCSA report also noted the diverse opinions about the negative effect of cannabis use, largely because of the pervasive notion that cannabis affects people differently[159]. These youths also cited various factors such as the cannabis strain, the THC level, the frequency

of the use, and individual biological differences as causing different negative effects based on their own experience or their peers' use. Targeting expectancies as part of intervention efforts to prevent or discourage cannabis use therefore needs to consider the different nuances of the positive and negative expectancies that may drive use, which my thesis was unable to cover because of the short length of the MEEQ-B. Due to the differing opinions and the lack of clarity surrounding the perceived effects of cannabis, any messaging to youths must also be cognizant of the experiences and other factors that shape expectancies, be grounded in scientific evidence and facts that are presented clearly, and encourage youths to examine their misconceptions of the harms of cannabis use.

In line with our hypothesis, and subscribing to the IMBP theory on which the hypothesis was based upon[57], expectancies were also highly associated with intention to try cannabis in this thesis. The finding of a previous study that captured longitudinal data from youths also supported the thesis finding, in that a shift in expectancies towards a more positive tone was also accompanied by the change in the intention to try cannabis use[59]. Anticipating positive or negative expectancies have also been shown to influence expectancies in tobacco smoking and alcohol consumption, further emphasizing the importance of expectancies as predictor for intention in regards to substance use[182,212].

The result of this thesis also indicates that intention is a strong predictor for initiating cannabis use, in that adolescent never-users who reported some intention to try cannabis in Wave 5 of the study were almost seven times more likely to try cannabis within 6 months compared to those who expressed no intention to try. It is important, however, to be cautious when trying to extrapolate this association to current cannabis users, since the intention to use captured in this thesis may not necessarily predict continuation or cessation of cannabis use among current users.

Evidence from research on tobacco smoking found that intention was only a borderline significant predictor of quitting smoking[60]. In another tobacco smoking study, intention was a positive predictor for subsequent quitting attempts, but its predictive value disappeared when combined with other intention predictors[213]. Consequently, separate studies should be carried out to examine the role of intentions on other cannabis use behaviours not captured in this thesis, such quitting or reducing the frequency of cannabis use.

Overall, the findings in this thesis provide evidence that the IMBP framework and variables are applicable to the context of cannabis use in adolescents. Particularly, attitude that was represented by expectancies were found to be important determinant for both cannabis use intention and initiation. Additionally, intention was found to be a strong predictor of cannabis use initiation. The longitudinal nature of the relationship between the expectancies and cannabis initiation, and between intention and cannabis initiation also support the IMPB theory that encompasses the forward direction of intention and expectancies in instigating behavioral outcome. As specified in the discussion portion of chapter 3, however, this thesis is unable to confirm whether expectancies affect cannabis use outcome through its influence on intention formation, since intention and expectations were not analyzed simultaneously in a single model. More advanced statistical methodology, such as path analysis and mediation analysis, is available to investigate this relationship further. Due to the limited data, other components of IMPB that are presumed to influence intention to try cannabis, such as perceived norm about cannabis use and self-efficacy to refuse cannabis were also not included in this thesis. A complete picture on the efficacy of IMBP as a cannabis use predicting model in adolescent population therefore needs to be supplemented with additional research observing other IMBP components' relationships with intention and subsequent cannabis use and/or initiation.

Nevertheless, the thesis findings provide preliminary support for the potential of IMPB variables as useful tools for prediction and monitoring of cannabis use behaviors among adolescents.

4.1 Limitations

Although the results of this thesis provide support for the importance of expectancies in influencing cannabis use outcomes among adolescents, several limitations of the study need to be noted. First, because the survey was conducted during the province-wide teacher's work to rule action, and some schools with limited supports were not able to participate, there is some concern over the representativeness of the study participants. Beyond school differences, volunteer bias may result in differences between individual participants and non-participants. A review by Rosenthal and Rosnow found that research volunteers tended to be more educated, more intelligent, and of higher socio-economic background than non-volunteers[214]. In medical research, volunteers were also more likely to be healthier and were less likely to smoke and abuse alcohol[214], so there is a plausibility that the participants in this thesis were less likely to use cannabis than the non-participants. To examine the potential impact of these limitations, the representativeness of the study participants was examined by comparing the socio-demographic characteristics of BASUS participants with the adolescents who participated in the larger BC Adolescent Health Survey administered by McCreary Centre Society in the same year as Wave 5 and 6 of BASUS[28]. Generally, the ethnicity distribution of the thesis' participants was similar to that of the larger survey. In terms of substance use, the prevalence of cannabis and alcohol consumption in Wave 5 of BASUS were also comparable to that of the provincial survey. In BASUS, 19.5 % and 45% of the participants had ever tried cigarette and cannabis, respectively, compared to 21% and 45% found in the provincial survey. However, only 12.3% of the BASUS

participants reported past tobacco smoking, which is much lower than the 26% prevalence found in the provincial survey. This difference may be attributable to the larger age range that was included in the provincial survey that captured students from grade 8 to 12, whereas the majority (99.4%) of Wave 5 BASUS participants belonged to grade 9.

4.2 Implications

The finding that expectancies and intention are strongly associated with current cannabis use and future initiation underscore the potential of using both expectancies and intention as indicators for monitoring vulnerability to emerging cannabis use and initiation among Canadian adolescents prior to and after implementation of the new recreational cannabis regulation that legalizes use for adults. Based on previous research that found persistent relationships between expectancies, intention, and smoking and alcohol drinking among adolescents even in the presence of tobacco and alcohol regulation[67,171,215], it seems feasible that expectancies and intention will remain useful predictors for adolescent cannabis use trends in post-legalization environment. However, it is necessary to continually assess whether the shift in expectancies and intention is indeed followed by actual increase or decrease in the prevalence of use and rate of initiation. If such relationship persists, then intention and expectancies can be treated as an early indicator that can help policy makers to anticipate future needs in regards to preventing problematic use of cannabis and other drugs.

Because expectancies were found to have a strong relationship with cannabis use that may be causal in nature, intervention efforts to prevent, delay or reduce cannabis use among adolescents may benefit from the inclusion of messaging about the effects of cannabis use. However, it has been shown that condescending anti-drug messages that advise youths to just

abstain from using substances are ineffective. For example, a qualitative study conducted by Canadian Centre of Substance Abuse found that the "just say no" campaign that encouraged adolescent to simply refuse cannabis that is presented to them was not effective[159]. The participants in the study instead highlighted the need to initiate honest and open discussion that is evidence-based, not exaggerated, and being delivered in a respectful and non-patronizing manner. This suggestion has also been echoed by large health organizations. In their presentation on strategies to plan for effective prevention of drug use and substance use using the media, the United Nations Office of Drugs and Crime identified the characteristics of a successful media campaign, which included creating a campaign that is based on rigorous theory, uses non-threatening language, educates parents, and involves parental and community monitoring[216]. On the other hand, a campaign that is based on fear mongering and logical assumption that is not supported by evidence, is manipulative and does not involve parents and/or community, often fails[216]. The Government of Canada also supports the involvement of parental/guardian monitoring of substance use by providing a guidance to initiate discussion about substance use with teenagers[217]. A similar approach was also adopted by the Canadian Centre of Substance Abuse which recently released a guide to facilitate discussions about cannabis use in the community[87].

Experts associated with the development of mental health resources in British Columbia have also emphasized the importance of creating an opportunity for adolescents to have an honest and non-judgmental discussion about substance use [218]. These experts believe that by engaging adolescents in a meaningful dialogue, an opportunity for adults is created to identify potential knowledge gaps that the adolescents may have, and for the adolescents to reflect upon their own personal use of cannabis. Such discussion is intended to empower adolescents to weigh

the harm and benefits of cannabis use (i.e., their expectancies) and make an informed decision about whether to use or not use cannabis.

It is also worth noting that while the prevalence of tobacco smoking and alcohol consumption has decreased in the past three decades[30], complete abstinence related to substance use among adolescents remains a futile end goal. As such, it is necessary to set a realistic and more relevant public health goal, in that overall minimization of harms associated with substance use should take precedence. As an example, policy makers need to consider the plausibility that the popularity of cannabis among adolescents may be attributed to the use of cannabis as a substitute for other drugs that can pose more adverse health risks[219]. Core social or behavioral issues that increase an adolescent's risk to using substances as a coping strategy need to also be addressed.

Lastly, it is important to understand that reducing the prevalence and incidence of cannabis use among adolescents will likely require a long running and multi-pronged approach. Learning from efforts associated with tobacco use, it took about two decades to reduce the smoking rate among Canadian youths from 35% in 1985 to 18% in 2010[220], with many different initiatives contributing to this decline, including the creation of tobacco-free public places[221], media promotions[222], and increased taxation on tobacco products[223]. Therefore, modifying adolescents' expectations on the effects of cannabis use through an educational intervention that is associated with the implementation of a policy of legalized recreational use represents only one of the many possible prevention efforts that need to be considered. A multi-concerted and sustainable approach that is continuously informed by research is necessary to combat the early initiation of cannabis use among adolescents.

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Appendices

Appendix A Appendices from Chapter 2

Appendix A contain appendices from Chapter 2.

A.1 Post-hoc analyses comparing retained and excluded participants

DESCRIPTIVE TABLE BY EXCLUSION

			EXCLUSION		Total (N: 1537)	Result of Association
			Retained (N: 1401)	Excluded (N: 137)		
Wave 5 reported life-time cannabis use	No	Count	1107	79	1186	$\chi2$ =0.0.003, p = 1.00
		% within groups	79.6%	79.8%	79.6%	
	Yes	Count	284	20	304	
		% within groups	20.4%	20.2%	20.4%	
Wave 5 intention to try cannabis in the next 3 years among never-users	No Intention	Count	821	58	879	$\chi2$ = 0.245, p = 0.681
		% within groups	74.8%	77.3%	74.9%	
	Some intention	Count	277	17	294	
		% within groups	25.2%	22.7%	25.1%	
Wave 5 frequency of cannabis use in the past 30 days among ever-users	Never	Count	68	5	73	$\chi2$ = 4.821, p = 0. 306
		% within groups	29.8%	31.3%	29.9%	
	Less than 1 day a week	Count	72	4	76	
		% within groups	31.6%	25.0%	31.1%	
	1-2 days a week	Count	36	5	41	
		% within groups	15.8%	31.3%	16.8%	

			EXCLUSION		Total (N: 1537)	Result of Association
			Retained (N: 1401)	Excluded (N: 137)		
Wave 5 frequency of cannabis use in the past 30 days among ever-users	3-6 days a week, but not every day	Count	32	0	32	
		% within groups	14.0%	0.0%	13.1%	
	Every day	Count	20	2	22	
		% within groups	8.8%	12.5%	9.0%	
Perceived SES	Below average	Count	280	11	291	$\chi2 = 5.717$, $p = 0.057$
		% within groups	21.8%	13.3%	21.3%	
	Average	Count	451	26	477	
		% within groups	35.1%	31.3%	34.9%	
	Above Average	Count	553	46	599	
		% within groups	43.1%	55.4%	43.8%	
Ethnicity	White	Count	683	48	731	$\chi2 = 14.048$, $p = 0.003$*
		% within groups	49.8%	38.1%	48.8%	
	Aboriginal	Count	168	19	187	
		% within groups	12.3%	15.1%	12.5%	
	Asian	Count	482	49	531	
		% within groups	35.2%	38.9%	35.5%	
	Other	Count	38	10	48	
		% within groups	2.8%	7.9%	3.2%	
Gender	Male	Count	565	69	634	$\chi2 = 5.188$, $p = 0.029$*
		% within groups	40.3%	50.4%	41.2%	
	Female	Count	836	68	904	
		% within groups	59.7%	49.6%	58.8%	

			EXCLUSION		Total (N: 1537)	Result of Association
			Retained (N: 1401)	Excluded (N: 137)		
Wave 6 reported cannabis use	No	Count	932	73	1005	$\chi 2$ =0.377, p = 0.520
		% within groups	78.7%	76.0%	78.5%	
	Yes	Count	252	23	275	
		% within groups	21.3%	24.0%	21.5%	
Age of participants in wave 5	Mean		14.8137	14.7226	1401	t = 0.166, p=0.099
	Standard Deviation		0.59063	0.61513	137	

a: Distribution of cannabis use modalities (life-time cannabis use, intention to try cannabis, frequency of cannabis use), perceived SES, gender, and ethnicity between retained and excluded groups were compared using Pearson Chi-square test.
b: Average values of Age during Wave 5 was compared between sex groups using Student's t-test.
*: values are statistically different between retained and excluded groups.

A.2 SPSS output of the missing patterns characteristic of MEEQ-B subscales

Univariate Statistics of MEEQ-Bpositive

	N	Mean	Std. Deviation	Missing		No. of Extremes[a]	
				Count	Percent	Low	High
Item2	1398	3.6102	1.19428	3	.2	137	0
Item 3	1396	3.0831	1.17938	5	.4	0	0
Item 4	1396	3.3940	1.23605	5	.4	162	0

a. Number of cases outside the range (Q1 - 1.5*IQR, Q3 + 1.5*IQR).

EM Means[a] for MEEQ-Bpositive

Item 2	Item 3	Item 4
3.6107	3.0836	3.3935

a. Little's MCAR test: Chi-Square = 4.553, DF = 6, Sig. = .602

Univariate Statistics of MEEQ-Bnegative

	N	Mean	Std. Deviation	Missing		No. of Extremes[a]	
				Count	Percent	Low	High
Item 1	1398	4.0515	1.15210	3	.2	0	0
Item 5	1396	3.7042	1.27249	5	.4	0	0
Item 6	1392	4.1645	1.05674	9	.6	81	0

a. Number of cases outside the range (Q1 - 1.5*IQR, Q3 + 1.5*IQR).

EM Means[a] for MEEQ-B negative

Item 1	Item 5	Item 6
4.0514	3.7043	4.1640

a. Little's MCAR test: Chi-Square = 2.042, DF = 6, Sig. = .916

A.3 Modification indices of MEEQ-B items constrained to 2-factor structure

	MI	E.P.C.	Std. E.P.C.	StdYX E.P.C.
BY Statements				
Positive expectancies by Item 1	16.34	-0.14	-0.13	-0.12
Positive expectancies by Item 5	78.09	-0.34	-0.32	-0.25
Positive expectancies by Item 6*	206.40	0.46	0.42	0.40
WITH Statements				
Item 5 with Item 1*	206.44	2.25	2.25	2.91
Item 5 with Item 2	32.33	-0.14	-0.14	-0.206
Item 5 with Item 4	14.845	-0.10	-0.10	-0.15
Item 6 with Item 1	78.12	-0.92	-0.92	-1.31
Item 6 with Item 2	47.21	0.15	0.15	0.26
Item 6 with Item 4	41.80	0.14	0.14	0.023
Item 6 with Item 5	16.39	-0.45	-0.45	-0.58

Minimum Model Index (MI) value for printing the modification index was set to 10.00.
*indicates relevant model fit indices that ground the model modifications of cross-loading item 6 to positive expectancies factor and correlating item 5 with item 1.

A.4 Satorra-Bentler calculation

$$cd = \frac{(8 * 1.3464) - (7 * 1.2481)}{(8 - 7)} = 2.0345$$

$$TRd = \frac{(282.123 * 1.3464) - (53.394 * 1.2481)}{(2.0345)} = 153.9491$$

Difference in degree of freedom: 8-7 = 1

A.5 Mplus output for model 2 in Table 5

Warning message:

"*WARNING: THE RESIDUAL COVARIANCE MATRIX (THETA) IS NOT POSITIVE DEFINITE. THIS COULD INDICATE A NEGATIVE VARIANCE/RESIDUAL VARIANCE FOR AN OBSERVED VARIABLE, A CORRELATION GREATER OR EQUAL TO ONE BETWEEN TWO OBSERVED VARIABLES, OR A LINEAR DEPENDENCY AMONG MORE THAN TWO OBSERVED VARIABLES. CHECK THE RESULTS SECTION FOR MORE INFORMATION. PROBLEM INVOLVING VARIABLE MEEQ_6."*

	Estimate	**S.E.**	**Est./S.E.**	**Two-Tailed p-value**
POSITIVE BY				
MEEQ_2	0.785	0.02	38.936	0
MEEQ_3	0.732	0.021	35.258	0
MEEQ_4	0.815	0.019	43.589	0
NEGATIVE BY				
MEEQ_1	0.14	0.114	1.228	0.219
MEEQ_5	0.153	0.121	1.271	0.204
MEEQ_6	2.673	2.01	1.33	0.183
NEGATIVE WITH POSITIVE	0.152	0.122	1.246	0.213

	Estimate	S.E.	Est./S.E.	Two-Tailed p-value
MEEQ_1 WITH MEEQ_5	0.486	0.029	16.921	0
Intercepts				
MEEQ_1	3.516	0.099	35.683	0
MEEQ_2	3.026	0.074	40.891	0
MEEQ_3	2.617	0.054	48.595	0
MEEQ_4	2.748	0.059	46.278	0
MEEQ_5	2.913	0.067	43.71	0
MEEQ_6	3.943	0.116	33.855	0
Variances				
POSITIVE	1	0	999	999
NEGATIVE	1	0	999	999
Residual Variances				
MEEQ_1	0.98	0.032	30.559	0
MEEQ_2	0.384	0.032	12.141	0
MEEQ_3	0.465	0.03	15.311	0
MEEQ_4	0.335	0.031	10.98	0
MEEQ_5	0.977	0.037	26.441	0
MEEQ_6	**-6.147**	999	999	999
R-SQUARE				
Observed Variable	**Estimate**	**S.E.**	**Est./S.E.**	**Two-Tailed p-value**
MEEQ_1	0.02	0.032	0.614	0.539
MEEQ_2	0.616	0.032	19.468	**0**
MEEQ_3	0.535	0.03	17.629	0
MEEQ_4	0.665	0.031	21.795	0

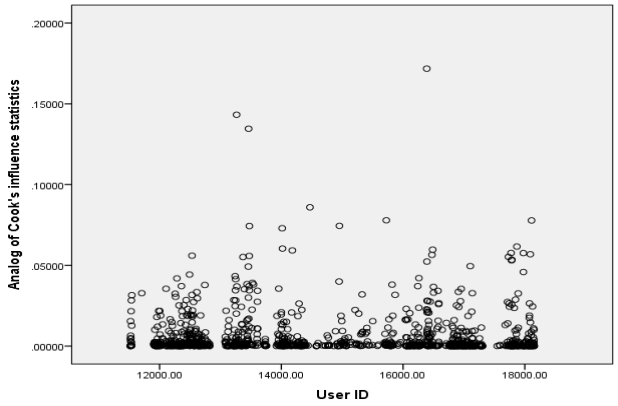
	Estimate	S.E.	Est./S.E.	Two-Tailed p-value
MEEQ_5	0.023	0.037	0.635	0.525
MEEQ_6	**Undefined**	0.71466	E+01	

Appendix B Appendices from Chapter 3

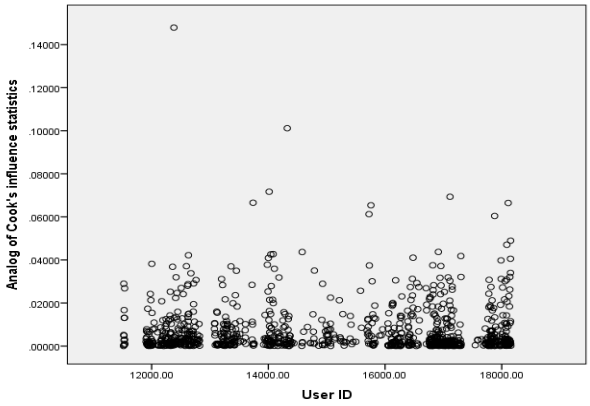
Appendix B contains appendices from Chapter 3.

B.1 Cook's distance for all models

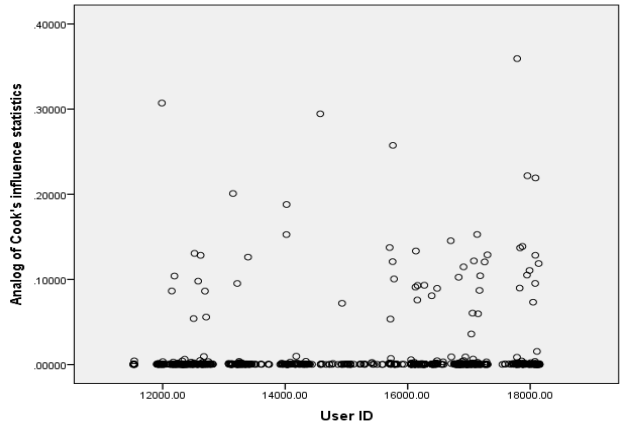
Model 1



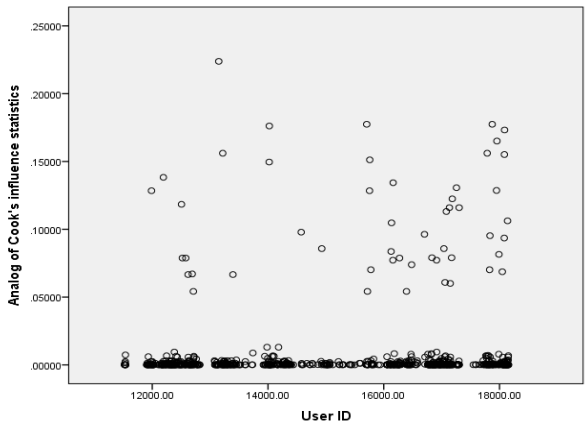
Model 2



Model 3

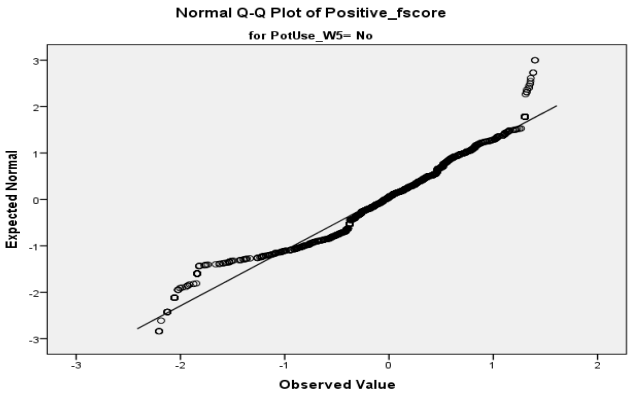


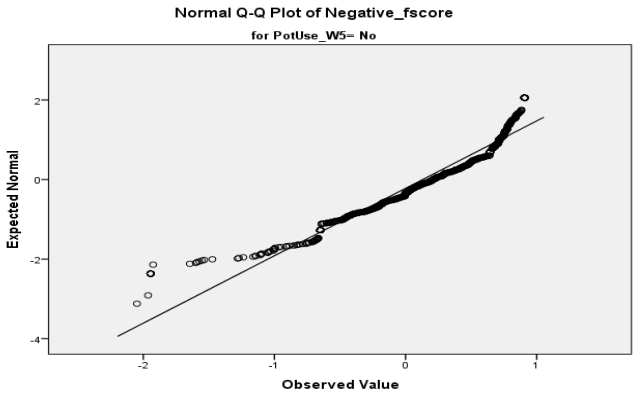
Model 4:

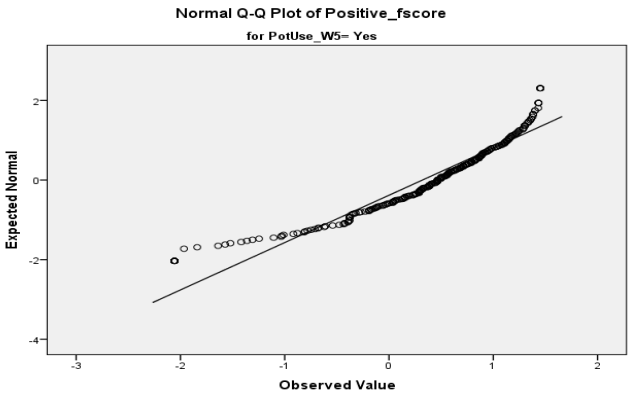


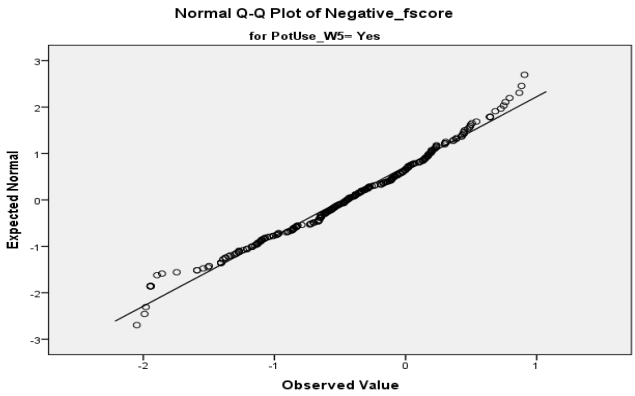
B.2 QQ plots of expectancies residuals of all models

Model 1

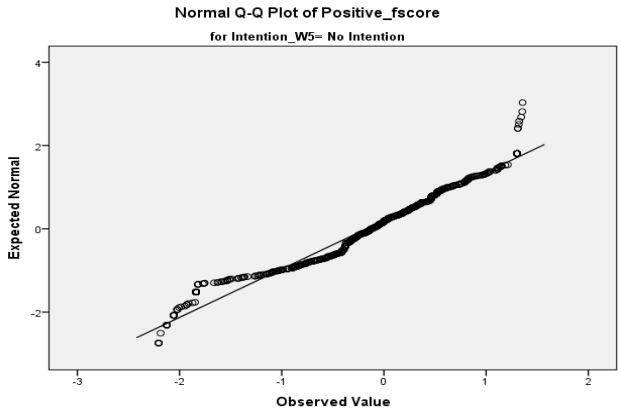


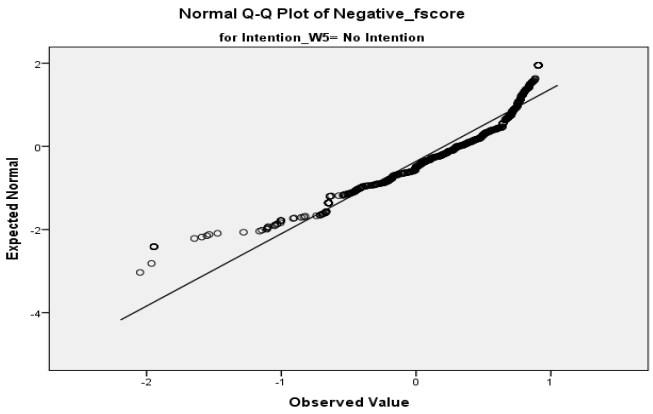


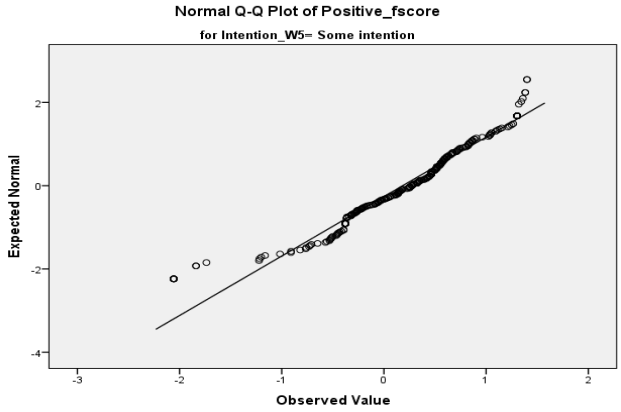


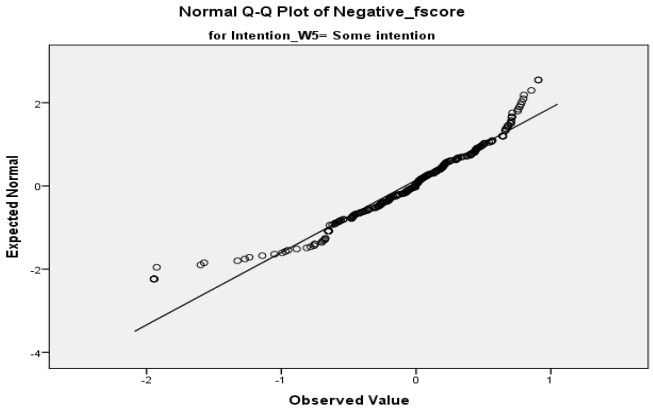


Model 2

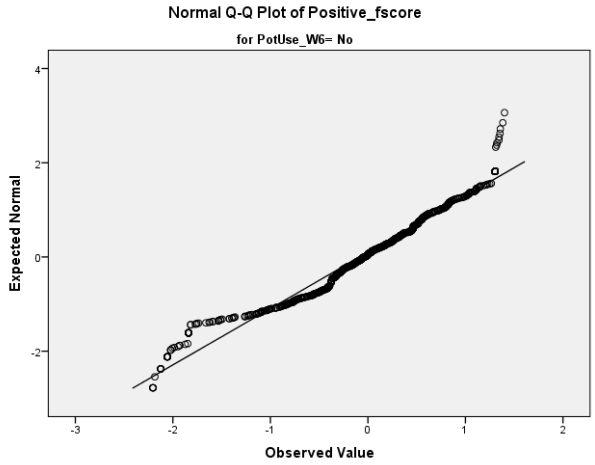

Normal Q-Q Plot of Positive_fscore
for Intention_W5= No Intention
Expected Normal
Observed Value

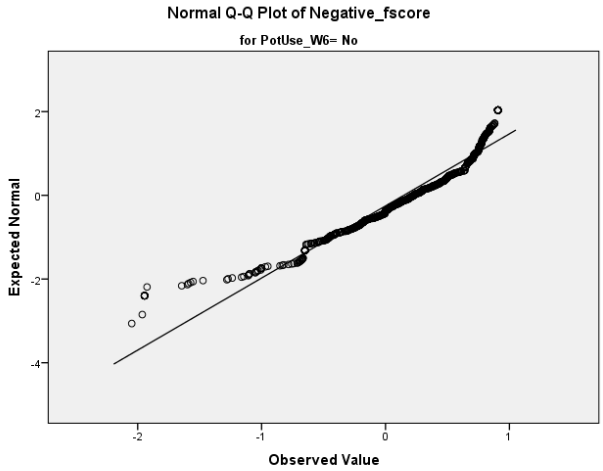

Normal Q-Q Plot of Negative_fscore
for Intention_W5= No Intention
Expected Normal
Observed Value

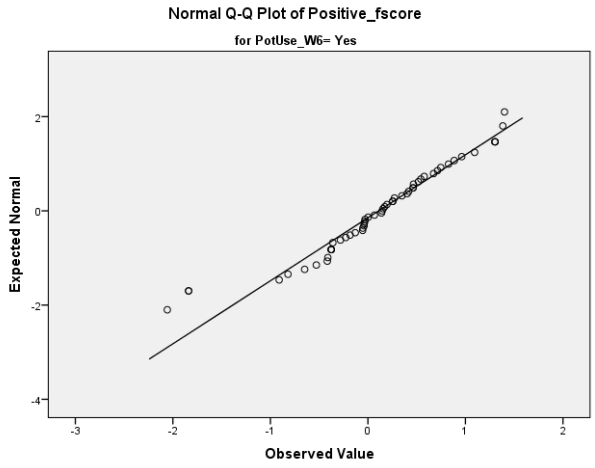

Normal Q-Q Plot of Positive_fscore
for Intention_W5= Some intention
Expected Normal
Observed Value

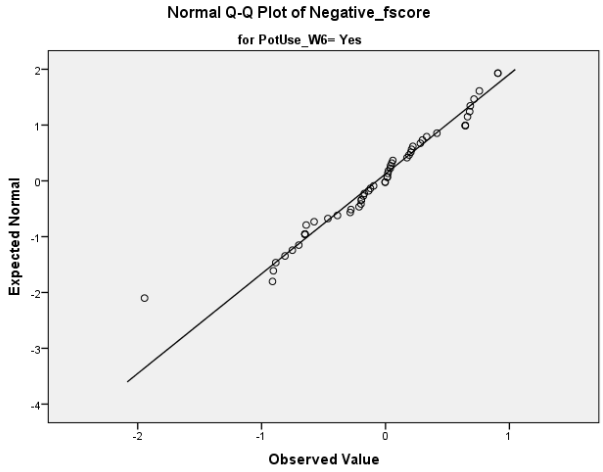

Normal Q-Q Plot of Negative_fscore
for Intention_W5= Some intention
Expected Normal
Observed Value

Model 3


Normal Q-Q Plot of Positive_fscore
for PotUse_W6= No
Expected Normal
Observed Value


Normal Q-Q Plot of Negative_fscore
for PotUse_W6= No
Expected Normal
Observed Value


Normal Q-Q Plot of Positive_fscore
for PotUse_W6= Yes
Expected Normal
Observed Value


Normal Q-Q Plot of Negative_fscore
for PotUse_W6= Yes
Expected Normal
Observed Value