THE RELATIONSHIPS BETWEEN PERSONALITY- AND AFFECT-RELATED TRAITS, GENDER, AND INTENTION TO TRY SMOKING

by

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ABSTRACT

BACKGROUND: Of the many psychosocial factors shown to be associated with an increased risk of becoming a smoker, intentions to try smoking represent one of the strongest predictors of future tobacco use. Although a great deal of research has been done to identify potential determinants of tobacco smoking, very little research has examined the extent to which known risk factors for tobacco smoking are related to tobacco use intentions in adolescents who have yet to try tobacco smoking. The goal of this investigation was to examine the relationships between personality and affect-related risk factors for smoking, as measured by the Substance Use Risk Profile Scale (SURPS), and smoking intentions in a cohort of adolescents who had not yet experimented with tobacco smoking. As part of this investigation, the impact of gender on the measurement of these personality traits and the assessment of their relationships with smoking intentions will be examined.

METHODS: Study Population: Cross-sectional data provided by Grade 8 and 9 students participating in the British Columbia Adolescent Substance Use Survey, captured in the fall of 2010 (N=1352). SURPS: The 23-item version was used to measure 4 dimensions: Anxiety Sensitivity, Hopelessness, Impulsivity and Sensation Seeking. Gender-Based Measurement Invariance: Multi-group structural equation modelling, using M-Plus 6.12, will be used to assess measurement invariance by gender for each of the four SURPS dimensions. Personality and Intention to Smoke: Generalized Estimating Equations was used to examine the relationship between each SURPS dimension and intention to try cigarettes in the future. Effect of Gender: Interactions between gender and each SURPS construct was also examined.

RESULTS: Gender-based Measurement Invariance: Measurement invariance by gender was demonstrated for the SURPS. Associations with intention to try smoking: Hopelessness, Sensation Seeking and Impulsivity were found to be positively associated with intention to try cigarettes in the future among participants who indicated they had never tried smoking a cigarette product (“even a puff or two”). The SURPS dimensions did not significantly interact with gender.

CONCLUSION: These results suggest that characteristics related to impulsivity, sensation seeking and hopelessness are positively associated with the intention to try smoking.
Chapters 2 and 3 are based on secondary analysis using Wave 3 data collected by the BC Adolescent Substance Use Survey (www.basus.ca), a CIHR funded study (MOP-86729). A version of Chapter 2 and 3 will be published, with the proposed authorship order and title detailed in the footnotes for Chapters 2 and 3 respectively. The analysis presented in Chapters 2 and 3 has been approved by the UBC Behavioural Research Ethics Board (H11-02176).

A version of Chapter 2 will be submitted for publication: Memetovic, J., Ratner, P.A., Richardson, C.G. 2013. *Gender-based Scale-Level Measurement Invariance of the Substance Use Risk Profile Scale.*

A version of Chapter 3 will be submitted for publication: Memetovic, J., Ratner, P.A., Gotay, C., Richardson, C.G. 2013. *Moving upstream of tobacco initiation: Using the Substance Use Risk Profile Scale to examine the relationship between personality and affect-related risk and adolescents’ intentions to try smoking.*
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DEDICATION

I would like to dedicate this thesis to my mother; without her tireless encouragement and support, this would all have been a much more difficult ride. I also want to dedicate this thesis to my aunt, Dr. Hildegard Bozilovic, who has always been a mentor for higher education. I love you both.
CHAPTER 1: Introduction and background

Cigarette smoking continues to be the leading preventable cause of morbidity and mortality in the Western Hemisphere, including Canada.\(^1\) In 2002, 16.6% of all reported deaths in Canada were attributable to smoking, which resulted in 515,608 years of life lost prematurely.\(^2\) Physicians for a Smoke-Free Canada reported that coronary heart disease and stroke are two to four times more prevalent in smokers than in non-smokers.\(^3\) Smoking yields the highest burden of chronic diseases, causing chronic obstructive pulmonary disorder and one third of all cancers, with lung cancer having the strongest link to tobacco use.\(^3\) The morbidity and mortality associated with smoking continues to drive the investment in research and policy towards effective tobacco control in Canada.

Over the past three decades, high income countries (HIC’s) have made significant progress in lowering smoking prevalence rates and thus decreasing the number of deaths directly attributable to smoking.\(^4\)–\(^6\) The World Health Organization Reports on the Global Tobacco Epidemic 2003-2011 indicated that the Western Pacific Region of North America is at Stage 4, or the last phase of the smoking epidemic, marked by a significant decrease in smoking prevalence and tobacco-related deaths and a reduction in the gender gap in smoking prevalence.\(^5\)–\(^9\) In particular, reductions in smoking prevalence have been observed among Canadian youth with smoking rates among youth aged 15 to 24 years decreasing from 35% in 1985 to 18% in 2010, according to the Canadian Tobacco Use Monitoring Survey.\(^4\) In British Columbia (BC), a 2008 report based on data from the McCreary Centre Society’s Adolescent Health Survey cited an overall rate of “trying” smoking to be at 26% for youth between the ages of 11 and 17 years, a rate much lower than the overall provincial rate of 56% of youths who tried smoking in 1998.\(^1\)\(^,\)\(^10\)
Additionally, current smoking prevalence (having a cigarette in the past 30 days) among BC youth ages 15-19 has also dropped from 20% in 1999 to 10% in 2011.\textsuperscript{11}

Smoking experimentation, defined as the first time smoking a whole cigarette, and smoking prevalence, in boys and girls, appear to be decreasing in both high income and developing countries.\textsuperscript{4,7,12–14} Up until nearly a decade ago, boys have traditionally had higher rates of smoking, but researchers predict that the gender gap in smoking incidence rates will continue to narrow, in HIC’s, over the next 15 years.\textsuperscript{15} Similar findings were reported by the Youth Smoking Survey (YSS) and a 2011 Vancouver-based study.\textsuperscript{14,16} Although the 2010 YSS results revealed no gender differences in the prevalence rates of current smoking,\textsuperscript{4,14} recent findings reported in Tobacco Use in Canada (2013) suggest that smoking experimentation between grades 6 and 9 still tends to be higher in male students, with 17% of boys reporting having ever tried a cigarette as compared to 14% of girls.\textsuperscript{11}

In addition to a narrowing gender gap in smoking incidence and decreased overall smoking prevalence rates in youth, the age of smoking experimentation and onset has also begun to shift. Findings from the McCreary Centre Society’s Adolescent Health Surveys indicated that, in 2003, the rate of smoking initiation was greatest among pre-adolescents (aged 12 years and younger), which shifted to adolescents aged 15 years and older, in 2008.\textsuperscript{1,10} The 2010 Canadian Tobacco Use Monitoring Survey revealed that the overall smoking prevalence rate of youth aged 15 to 19 years was 11%, and 20% for young adults aged 20 to 24 years.\textsuperscript{4} Although a shift in the age of smoking experimentation and onset has been reported in the past decade, smoking rates have recently been observed to rapidly increase from pre-adolescence (pre-puberty) to adolescence (after the initiation of puberty), and then nearly double after the age of 19 years.\textsuperscript{4}
Secondary school students are therefore an important target population for tobacco control efforts focused on maintaining anti-smoking attitudes and non-smoking behaviour as these youth transition into late adolescence and early adulthood.

In 2006, the Centre for Addictions Research of British Columbia (CARBC) created a Tobacco Strategy for Vancouver Coastal Health emphasizing the need for research to inform tobacco control policy in an effort to reduce the overall smoking prevalence rate to no more than 10%. Although smoking prevalence in youth is close to 10%, approximately 33% of boys and 31% of girls in grades 6-9 reported having some intention of trying smoking in the future and were therefore susceptible to experimentation. Investigating the susceptibility to initiate smoking in a cohort of junior high school students by examining their smoking intentions before they begin to experiment with tobacco, represents a promising opportunity to improve our understanding of the processes linked to smoking initiation in this population. In doing so, the results of this research will contribute to the development of strategies to reduce the incidence of smoking by adolescents.

Research on smoking behaviour has identified many psychosocial risk factors for smoking initiation, often informed by frameworks in social psychology, which stress that the intention to smoke is the most significant predictor of subsequent smoking behaviour. The frameworks commonly applied in these investigations, such as the Theories of Planned Behaviour and Reasoned Action include socio-environmental factors and smoking norms as key determinants in smoking intention and subsequent behaviour. However, factors that have been identified by clinical psychologists to increase the likelihood of smoking, such as personality traits and affective states have not been thoroughly examined in terms of their
relationships with intentions to smoke. The aim of this thesis was to examine the associations between intentions to smoke and personality- and affect-related traits measured by the Substance Use Risk Profile Scale \(^{21,22}\) and determine whether the associations interact with gender. The present chapter will introduce the social psychological theories that are relevant to the understanding of the determinants of smoking intention, and how incorporating concepts from behavioural psychology (e.g., personality and emotion) can improve our understanding of this important outcome. The initial sections of this chapter outline how personality- and affect-related attributes are defined and measured, and describe the significance of considering gender and other sociodemographic factors when studying smoking-related outcomes. The development and validity evidence of the Substance Use Risk Profile Scale are discussed, and recommendations are made for the basis of further validation work in this thesis to ensure that the instrument is not biased on the basis of gender. Lastly, the research objectives of this thesis and the chapters that will address each objective are be presented.

1.1 Personality and affect

Personality is most commonly described with trait theory, originally discussed by Gordon Allport. \(^{23}\) Traits, also known as dispositions or temperaments, are a set of thoughts and emotions that influence behaviour. \(^{23}\) Psychologists have used statistical methods, such as factor analysis \(^{24,25}\), to organize traits into hierarchal clusters or factors. The main “lower level” traits are primarily independent and therefore uncorrelated, each branching from higher order clusters, that correlate with one another. \(^{24,26-29}\) Eysenck, Cloninger, Costa and McRae \(^{26,28-30}\) have
made the largest contributions to the field of personality research by defining and measuring traits with hierarchies, linking them to neurobiology. They also applied their models to describe how various traits increase the risk for maladaptive behaviour, such as substance (mis)use.

Hans Eysenck is one of the most widely recognized personality psychologists, known for proposing that there are three main personality dimensions: Extraversion, Neuroticism and Psychoticism. Extraversion, being social or having a tendency to need social or sensory excitement, has been shown to relate to positive emotion, and includes lower-order (i.e. secondary) traits such as Venturesomeness and Impulsiveness. Neuroticism, a propensity to become excessively emotional, has been found to relate to depression and anxiety. Psychoticism, the third major dimension, is associated with having aggressive and reckless tendencies, and has been shown to be associated with the Impulsiveness subdomain, which is associated with substance use. Eysenck and his colleagues also proposed that all three traits have a neurobiological basis; higher levels of extraversion and neuroticism were proposed to be connected with the dopaminergic pathways in the limbic system. Although seemingly unrelated characteristics, both have been shown to increase a person’s propensity for substance use or misuse. The NEO “Big Five” Inventory, developed and validated by Costa and McCrae, added three “main” or “low order” traits to Neuroticism and Extraversion, including Openness to Experience, Conscientiousness and Agreeableness as three additional independent traits. Although Neuroticism and Extraversion have been found to increase the risk of tobacco use, Conscientiousness has been shown to decrease this risk.

Like Eysenck, Cloninger proposed a biosocial model of personality with three main temperamental clusters (and twelve sub-clusters), originally captured by the Tri-dimensional
Personality Questionnaire: Novelty Seeking, Harm Avoidance and Reward Dependence. Novelty Seeking has been shown to relate to impulsivity (e.g., acting without thoughtful consideration of consequences), and Adventuresomeness. Harm Avoidance was mostly found to relate to pre-emptive worry and shyness. Reward Dependence can be described as the biopsychological dependence on reinforcement, either social or sensory, which can lead to the adaptive maintenance of behaviours, even if harmful, such as smoking and alcohol use. Cloninger’s theory of Reward Dependence has influenced researchers focused on developing the motivation and reward models that drive substance use and gambling. Cloninger has since proposed a seven-factor model that adds Persistence, Self-Directedness, Cooperativeness, and Self-Transcendence to the previously identified factors.

1.1.1 Trait or state?

A personality or affect-related trait would imply that a given set of characteristics and temperaments is relatively stable over time in an individual, while conceptualizing personality and affect as states would imply that these characteristics are more labile. Recent analyses by Hopwood et al. on the stability of personality and affect over a 10-year period, indicate that the trait approach implies that an individual has basic tendencies that are prevalent across many situations, and throughout a life-course. Furthermore, researchers are still establishing whether some personality or affect are more stable than others. For example, positive personality characteristics such as Extraversion may be more stable over time, compared to higher levels of Neuroticism. Hopwood et al. reported findings investigating the 10-year stability of the NEO Personality Inventory, suggesting that affect-related characteristics such as Anxiety and
Depression demonstrated lower stability over time than personality characteristics such as Excitement Seeking and Impulsiveness. A study by Morey and Hopwood also suggests that there is moderate stability of clinical levels of personality disorders over a few years.

1.2 Smoking intention

Smoking is a modifiable risk factor for chronic disease and a behaviour that may be prevented at the pre-initiation or experimentation phases through the deployment of interventions that address adolescents’ intentions to start smoking. Extensive research has demonstrated that there is a robust link between the intention to engage in behaviour and the behaviour itself. Behavioural intention is the individual’s perceived likelihood that he or she will engage in a given behaviour (e.g., “I think” or “I plan”), either in the future or within a specified time-period. Intention can be captured as part of a specific scenario, such as: “If you were presented with a cigarette by a friend, would you try it?” or, more broadly, “Do you think you might try smoking in the future?”

Researches have demonstrated a robust link between behavioural intention and smoking outcomes. For example, Mazanov et al. reported that intention to initiate smoking predicted smoking onset a year later. Results from a longitudinal study investigating smoking initiation by Wilkinson et al. showed that the correlation between the intention to try smoking and subsequent smoking status strong and significant (r=0.64), and yielded the strongest correlation (r=0.37) after adjusting for other predictors of smoking status such as peer and parental use and norms. More recently, Wilkinson, Hoving, and Van de Ven et al. also reported a significant link between intention and smoking onset in adolescence. In light of their findings, Van de Ven et al. suggested that interventions for non-smokers should have their
emphasis placed on maintaining resolute intentions to refrain from trying rather than preventing the actual initiation of the negative health behaviour. Godin et al. used an epidemiological approach to study the relationship between health behaviour and intention, and found a large negative predictive value, using exercise initiation as an example; low intention to engage in a (positive) health behaviour was a very good predictor of not taking action (Negative Predictive Value = 88.1%). Researchers also have shown that non-users with resolute intentions to abstain from using substances such as marijuana or smoking are much more likely to continue to be abstinent at follow-up. Given that data from the 2010 Youth Smoking Survey indicated that approximately one third of adolescents in BC intended to try smoking in the future, studying potential determinants of intention to try smoking is particularly compelling because reporting some intention to experiment is indicative of increased susceptibility to becoming a smoker in the future. Research on the temporal stability of intentions suggests that strongly defined intentions, specifically to abstain from initiating behaviour, are more temporally stable than intentions that are less explicitly defined. Data from the YSS indicate that more than one half of adolescents are expected to have well-defined intentions to abstain from trying smoking. It is therefore expected that those with weaker intentions to abstain (e.g., with some intention to try smoking) will be at higher risk for initiating smoking in the future.

Although it is well understood that behavioural intention is a strong predictor of subsequent behaviour, particularly substance use, much less is known about the determinants of intention, prior to experimentation. For example, little is currently known about how the individual psychosocial traits that are frequently associated with substance use relate to intentions to try smoking. Given the strong association between intention to smoke and future smoking, research on whether individual psychological and affective traits predict greater
likelihood of smoking intention is needed to inform the development and tailoring of psycho-educational tools. Findings could inform tobacco control efforts focused on maintaining strong intentions not to smoke and thus help prevent “never-triers” from initiating tobacco use.

In an effort to contribute to the maintenance of current levels of anti-smoking attitudes and behaviour in youth, this thesis explores the cross-sectional relationships between intentions to try smoking and some personality and affective characteristics of adolescents. The next section of this chapter provides a review of the theoretical frameworks developed by social psychologists that have been applied in health behaviour research to study how psychosocial factors relate to behavioural intentions. Significant contributions have been made in understanding how socially influenced factors, such as peer and family environments, social norms and attitudes, and their interaction with culture influence smoking intention. Research also indicates that these are robust associations between personality traits, such as Neuroticism, Extraversion, Rebelliousness and Risk Taking and current smoking status during adolescence. However, the effects of personality- (e.g., risk-taking or novelty seeking) and affect-related attributes (e.g., hopelessness) on resolute intentions to abstain from smoking have not yet been investigated. Furthermore, researchers have yet to explore how gender influences the associations between these traits with smoking intention. The remainder of Chapter 1 introduces hypotheses regarding the possible links between personality and affect, as measured by the dimensions of the Substance Use Risk Scale, and intention to try smoking in the future. The overarching aim of this research was to determine whether psychological characteristics previously found to relate to current substance use increase the likelihood of having well-defined intentions about smoking in the future, in a community sample of adolescents naive to cigarette smoking.
1.2.1 Theories of behavioural intention: Theory of Planned Behaviour (TPB), Social Cognitive Theory (SCT), and Self-Concept

Ajzen and Fishbein’s Theory of Planned Behaviour (TPB) proposes that the manifestation of a behaviour is directly preceded and predicted by the intention to engage in the behaviour. Intention, as conceptualized by Ajzen and Fishbein, can be further described by two dominant factors: (1) social norms related to that behaviour and (2) outcome expectation and appraisal of likelihood of the behaviour. Subjective norms consist of perceptions of behaviour by social referents and motivation to comply with those referents. Outcome expectation and appraisal of likelihood are captured by Perceived Behaviour Control (PBC) of a particular behaviour. Perceived Behavioural Control (PBC) is theoretically related to self-efficacy, a concept derived from Bandura’s Social Cognitive Theory (SCT). The SCT, as proposed by Bandura, posits that individuals form social schemas -- ideas about situations or people represented and organized subconsciously. Schemas related to substance use have been found to form before any actual experience with drugs, and are activated immediately following a situational prime or social cue. For example, a positive smoking schema could involve feeling social or confident when smoking, while a negative smoking schema could be represented by a person physically addicted to nicotine and who needs to smoke to avoid feelings of withdrawal. Some researchers refer to these types of schemas as “prototype identification” of a typical smoker, the presence of which Rivis and Sheeran suggest is almost equally predictive of behaviour as is intention. For example, although research has shown that the majority of never-smokers intend to remain smoke free a year later, many who initiate
smoking do so in situations containing social “cues” for smoking, such as attending a party where people are consuming alcohol and smoking. 13,95 Although schemas continue to form during early adolescence, impulsivity and risk-taking propensity during this developmental period may contribute to the activation of certain positive schemas that support substance use, or decrease activation of negative schemas, thus increasing the likelihood of substance use. 89,90

The ability to resist acting on social triggers to engage in negative health behaviour is what Bandura referred to as self-efficacy. 99–101 Self-efficacy is a primarily cognitive phenomenon related to personal judgment about one’s ability to follow through with plans, such as abstaining from smoking. 102,103 For example, low refusal self-efficacy, similar to having weak intentions to abstain, was found to increase the risk for smoking intention 104 and initiation, albeit moderated by peers’ and parents’ tobacco use. 107 Smoking schemas and self-efficacy also may be influenced by self-concept, an affective-cognition or self-belief that rapidly evolves in adolescence and influences the choices that are made.

In their review of intersecting social-cognition science and health, Shadel and Cervone called for a better understanding of the psychological mechanisms that influence both smoking initiation and cessation. 108 They, among other researchers, discussed the idea of self-concept, a theory about how the “cognitive-affective beliefs” of the “self” emerge in different life scenarios. 108,109 Self-concept formulates as individuals transition from childhood, rapidly differentiates in adolescence, and becomes more defined in adulthood. 109 Self-concept is expected to evolve in adolescence as young people adapt to changing family, social and academic roles, and manifests in the way that individuals portray themselves as behaving. 103,109 Self-concept is therefore highly dependent on context, and in some instances, can manifest in self-conflict, or the
dissonance between how someone thinks and behaves in different situations. Adolescents who are observed to exhibit self-conflict are more susceptible to external guidance on how to behave. Research on early adolescence (ages 10 to 13 years) has found that greater than average levels of self-conflict are associated with higher approval of pro-smoking advertisements, and stronger intentions to try smoking and to continue smoking. Additionally, if self-image (or self-identity), related to self-concept, and positive stereotypes about smoking (e.g., smoking seen as being sociable or “cool”) significantly overlap, then smoking onset is more likely, as is the intention to smoke. As explored by Rise and Sheeran in a recent meta-analysis of the research related to the Theory of Planned Behaviour and self-identity, self-identity may influence whether an individual embraces the label of being a “smoker” or “ex-smoker” and her or his intention to remain in this social category. Neither self-concept nor self-efficacy were explicitly measured for this thesis research and are not explored further. However, recognizing the theoretical bases of these constructs as they underlie behavioural intention is an important consideration for future investigation of smoking intentions.

Researchers in health behaviour science have relied upon the work of Ajzen, Fishbein and Bandura in their studies of behavioural intention. More recently, Fishbein and Yzer integrated earlier research by Bandura and Ajzen into an Integrative Model of Behaviour Prediction that incorporates personal characteristics, normative and behavioural beliefs, and self-efficacy, which have all been shown to influence behavioural intention. Figure 1 represents the integrative framework of the Theory of Reasoned Action and Social Cognitive Theory outlining proximal and distal predictors of intention ability related to health behaviours. Tobacco control efforts such as in-school education, as well as municipal, provincial, and
federal legislative efforts have all contributed to the successful shift in smoking norms and more pronounced negative health beliefs about smoking in adolescents. This thesis explores how individual traits such as personality and affect-related characteristics or factors (see Figure 1) are associated with the risk of trying smoking. In this thesis, personality- and affect-related factors, previously shown to be associated with current substance use and abuse, are measured using the Substance Use Risk Profile Scale (SURPS).

Figure 1.1: An integrative framework of the Theory of Planned Behaviour and Social Cognitive Theory as predictors of behavioural intention; from Fishbein and Yzer. Published with permission of RightsLink® on behalf of Wiley Online Library.
1.3 The Substance Use Risk Profile Scale (SURPS)

Extensive research in the past two decades has shown a robust relationship between personality traits that predispose individuals to substance use and abuse. In particular, negative emotional states (depression and anxiety), impulsivity, and sensation seeking have been shown to predict smoking. The development of the Substance Use Risk Profile Scale (SURPS), a measure of four personality traits that are known to be associated with alcohol and drug misuse, was based on Cloninger’s theory of the brain’s motivational system. The theory proposes that the effects of certain personality factors influence substance use motives, as with intention and the Theory of Planned Behaviour, and directly influence substance use behaviour.

Based on extensive research on motivation and the personality profiles of alcohol users derived from the Tri-dimensional Personality Questionnaire and the NEO-Five Factor Personality Inventory, Conrod et al. (2000) proposed and validated four personality- and affect-related factors or styles that increase the risk of engaging in maladaptive behaviour related to substance use motives: Anxiety Sensitivity, Hopelessness, Sensation Seeking, and Impulsivity. Substance use motives are said to be tied to the positive and negative reinforcement pathways that evolve with continued use. Positive reinforcement motives are enacted by using substances to enhance positive disposition or mood, and negative reinforcement motives drive use to lessen negative emotion. Both have been linked with chronic drinking, smoking, and marijuana use. The theories of motivation and planned behaviour both attempt to explain the cognitive processes that lead to substance use. This thesis bridges these theories by examining whether personality- and affect-linked risk factors for substance
use, as measured with the SURPS, are directly associated with non-smoking adolescents’ intentions to try smoking in the future.

The most recently validated 23-item version of the SURPS captures four constructs that profile a risk for substance use: Anxiety Sensitivity (5 items), Hopelessness (7 items), Sensation Seeking (6 items), and Impulsivity (5 items). These subscales have been shown to significantly correlate with commonly used personality inventories and have been validated with mainstream and high-risk adolescent populations. The relationships between scores on the SURPS and current and future substance use were examined with data from the Project on Adolescent Trajectories and Health (PATH), a 3-year longitudinal study assessing substance use and psychosocial risk factors in BC secondary students. While Anxiety Sensitivity was not a significant predictor of tobacco use, when controlling for age and gender, Hopelessness, Impulsivity and Sensation Seeking were found to be significant predictors of current and future tobacco use.

1.3.1 Anxiety Sensitivity (AS)

Anxiety Sensitivity (AS) is a cognitive and personality characteristic that increases physical arousal and feelings of anxiety that can lead to negative outcomes, such as loss of physical or mental control. It is similar to Cloninger’s Harm Avoidance trait. Although it is related to trait anxiety, it is distinct from it with the added characteristic of fearing its occurrence. AS has been linked to the development and persistence of panic and anxiety disorders. Higher levels of AS have been linked to substance use that lessens the effects of
anxiety, such as alcohol or prescribed anti-anxiety drugs. An example of an item measuring AS is “It’s frightening to feel dizzy or faint”.

1.3.2 Hopelessness (HP)

Hopelessness is characterized by traits related to negative self-concept and few expectations for achievement, and it has been linked to having high levels of *Introversion*, a factor included in the Big Five Inventory. Individuals with high levels of *Hopelessness* are prone to depression. Similar to the motives for substance use of people with high *Anxiety Sensitivity*, people with higher *Hopelessness* scores are more likely to be sensitive to negative external social cues (e.g. “punishment sensitivity”), and thus engage in negative reinforcement-driven substance use. For example, “I feel that I’m a failure” is one of the items that measures *Hopelessness* in the SURPS.

1.3.3 Impulsivity (IMP)

In the biopsychology literature, impulsivity is a trait characterized by reward-seeking behaviour that immediately relieves negative emotion, and has been shown to correlate with the I.7-Impulsiveness Scale. In research utilizing the Big Five Personality Inventory, impulsiveness has been shown to correlate most highly with aggressiveness and neuroticism. However, the social psychology literature characterizes impulsivity more generally to include behavioural reflexes, such as “acting before stopping to think” or seeking immediate...
over long-term rewards without careful regard for the consequences (e.g., “I feel I have to be manipulative to get what I want”). Impulsivity has been shown to relate to the prefrontal cortex development of executive functioning, or the fine tuning of complex problem solving skills. It also has been shown to correlate with Neuroticism (a Big Five personality dimension) and aggressive behaviour, and has been shown to predict maladaptive behaviour, including substance use, particularly binge drinking. It has been linked to both positive (e.g., to enhance a social experience) and negative motives (e.g., to cope with negative emotion) for smoking. The key component of impulsivity is that some behaviours, such as substance use, may be committed without first processing their benefits and harms: “I often involve myself in situations that I later regret being involved in”.

1.3.4 Sensation Seeking (SS)

Sensation seeking involves novelty seeking and risk-taking tendencies, which are related to Zuckerman’s conceptualization of sensation seeking as a personality trait, and which he included in the Sensation Seeking Scale. Sensation seeking has been linked to Extraversion, as operationalized in the Big Five Inventory. Sensation seekers are more likely to have positive reinforcing motives for alcohol and stimulant use. Sensation seeking has been found to both correlate with current smoking and to predict adolescents’ smoking onset. Unlike the impulsivity characteristic, sensation seeking has not been shown to relate to neuroticism or aggressiveness, or other psychopathic behaviour. Examples of items in this sub-scale/dimension of the SURPS include “I am interested in experience for its own sake, even
if it is illegal” and “I enjoy new and exciting experiences even if they are unusual”. Sensation Seeking also has been shown to relate to maladjustment, including committing crimes and experimenting with substances. However, in contrast with Impulsivity, the literature suggests that the motives of Sensation Seeking are driven more by positive reinforcement (e.g., thrill seeking) rather than because of a lack of ability to discount future consequences or engaging in activities to either increase positive mood or reduce negative mood. Nonetheless, Impulsivity and Sensation Seeking have been shown to have a moderate-sized positive inter-correlation.

1.3.5 Linking substance use intentions to personality-related risk

The roles of individual risk factors in substance use initiation have been demonstrated in neurobiological and behavioural psychology models of addiction, and have been used to guide youth-oriented intervention programs. However, few researchers have investigated whether personality- and affect-related risk factors, shown to be associated with substance use, are related to adolescents’ intention to initiate substance use. Early work by Tucker (1984) demonstrated that there are significant differences in the anxiety and tension traits of adolescents who intend to try cigarettes in the future and of those who do not. Although few researchers have explored the link between individual personality risk factors and intention to smoke, the available research suggests that smoking initiation may be a means of stress reduction. Managing stress is particularly important in persons with neuroticism personality traits, which have been shown to increase sensitivity to perceived stress. For
example, Byrne et al. showed that neuroticism directly predicted the decision to start smoking in late adolescence\(^{38,133}\), independent of school-related and domestic stress. More recently, neuroticism has been shown to strongly and significantly predict adults’ perceived stress.\(^{163}\)

Although Wilkinson et al. did not demonstrate associations between extraversion and self-esteem on intention, extraversion was shown to moderately predict overall perceived control of smoking.\(^{69}\) Extraversion was also shown to interact with the association of the intention to smoke and subsequent smoking behaviour. These studies have predominantly been conducted on cohorts of adolescents because their age is marked by social and environmental changes that interact with developmental, personality, and affective changes that increase the likelihood of experimenting with substances.\(^{164–166}\) The adolescent period may heighten susceptibility to experimenting with substances, especially as a means to manage stress and mood. The next section of this chapter further elaborates how the expectancies related to the effects of substances, such as tobacco, may influence the association between personality-related factors in the pre-experimentation and experimentation phases.

**1.4 Adolescence is a period of vulnerability to the initiation of substance use**

Adolescence is a critical phase of human development with psychological changes coinciding with transition into puberty, which have been studied from both neurodevelopmental and socio-environmental perspectives. Complex decision making and self-regulation do not fully develop until early adulthood.\(^{164,167,168}\) Sensory pruning of the prefrontal region of the brain, such as increased inhibition control, fine-tuning of the risk/reward appraisal system, and improvement in emotive-cognitive regulation have been shown to begin in mid-childhood and
Changes occurring in the ventromedial prefrontal cortex during this period are critical to the intricate development of the risk and reward appraisal systems; these changes are thought to contribute to a heightened risk for impulsive behaviour and risk taking during adolescence.

When puberty begins, typically between 12 and 16 years of age in boys and 10 and 14 years in girls, the emotive-cognitive regulation continues to develop and interact with environmental stimuli. At the socio-environmental level, as adolescents begin secondary school, they are faced with greater academic and extracurricular demands, and with establishing peer relationships. These socio-environmental stressors on adolescent development and well-being have been investigated by sociologists, spearheaded by cultural anthropologists such as Mead and Cote. More recently, Agnew proposed the General Strain Theory (GST), a stress paradigm that provides a framework for understanding the link between stress and adverse psychological outcomes, including depression and delinquency. The contextual challenges occurring at this time, as well as the aforementioned neurobiological changes, create a “perfect storm” than increases vulnerability to adverse emotional outcomes and susceptibility to substance use. Adolescents with internalizing behaviour, which has been measured with Emotional Instability and Extraversion of the Big Five Inventory, for example, have been found to be susceptible to symptoms of depression and anxiety. However, equally important is how adolescents interact with their inevitable environmental stressors, and how they learn to process them, in preparation for adulthood. One such environmental challenge includes remaining abstinent to substance use, which may vary with particular personality characteristics that increase or decrease the likelihood of resisting these behaviours.
Research also suggests that maladaptive behaviour associated with externalizing or internalizing traits becomes more apparent in adolescence. Externalizing traits, related to personality characteristics, such as low Agreeableness, low Conscientiousness and high Extraversion\textsuperscript{33,43,152,156,180} may reinforce novelty seeking and impulsivity. Sensation seeking is greatest during mid-adolescence (ages 10 to 15 years), when pubertal development reaches its peak.\textsuperscript{168,174,179,183} Adolescents have a greater inclination to seek excitement when their self-control is still developing, both of which can increase their susceptibility to experimenting with substances.\textsuperscript{164,168,184}

Adolescence is a period when judgment and decision making are influenced by personality and affective states, and individual responses to changes in the social milieu, particularity when transitioning from elementary to secondary school.\textsuperscript{185} The increasing importance placed on peers, as well as family and school responsibilities, often interact with psychological states, and may influence the susceptibility to experiment with substance use.\textsuperscript{135,168,171,181,186,187} Starting at about age 14, the need to learn how to resist indirect and direct peer pressure to engage in anti-social behaviour begins to increase.\textsuperscript{182} For example, peer smoking has been shown to predict both the onset\textsuperscript{68,88,188,189} and escalation\textsuperscript{189} of smoking in adolescence. Peer-related factors can also interact with individual affective states, such as depression and anxiety\textsuperscript{188} and personality-linked traits such as sensation seeking\textsuperscript{68} to increase the risk of smoking initiation. For example, negative peer and teacher experiences in the school environment have been shown to increase the risk of depression and subsequent drug use.\textsuperscript{190–193} Lower or weak levels of school-related psychosocial outcomes such as academic performance, future academic aspiration, and school cohesion have been shown to predict smoking behaviour.\textsuperscript{42,194–196} In a recent review of research related to adolescents’ cognitive development and
substance use, Steinberg posited that an interaction between pubertal onset, mounting scholastic and extracurricular expectations, and a general decline in parental monitoring due to parents’ occupational demands can place large psychological and social strains on a developing adolescent. These challenges may overwhelm the affective-cognitive system leading to an increased risk of maladaptive psychological outcomes and behaviour (e.g., depression and aggression), as well as substance use initiation.

1.4.1 Adolescence and attitudes towards smoking and health increase susceptibility to smoking

Mid-adolescence poses a particularly vulnerable period for tobacco experimentation because it coincides with a period when anti-smoking beliefs and perceived negative health consequences of tobacco use may be less influential in preventing smoking initiation than during the pre-adolescent period. Chassin et al. observed a weakening of the protective effect associated with negative health and social outcome expectancies related to smoking. Gillmore et al. revealed that adolescents are exposed to more favourable norms towards smoking, despite maintaining beliefs about the long-term negative consequences of smoking. Although negative health beliefs about smoking have been shown to weaken throughout adolescence, particularly among non-smokers, the early adolescent period (ages 11 to 15 years) has been shown to be associated with an increase in the perceived positive psychological consequences of smoking. This trend has been shown to reach a plateau after the age of 21 years. In addition, weaker beliefs in the addictive properties of tobacco have been observed, with young women minimizing the addictive properties of tobacco more so than do young men.
Adolescents have been observed to place little importance on the overall value of health, which could also explain their increased vulnerability for smoking experimentation. Chassin suggested that smokers, compared with non-smokers, have lower than average levels of value placed on health and higher positive values on social, such as peer acceptance. A qualitative study by Stjerma et al. reported that adolescents who smoked believed that their smoking was part of the “teenage experience” and was not indicative of giving up on healthy living in the future, whereas adult smoking was perceived to be an addiction and a problem. This finding is similar to that of Moffat and Johnson, who found that teenagers who smoke often do not identify themselves as smokers. Thus, although researchers have shown that most teenagers are aware of the addictive properties of tobacco, those that smoke may not perceive themselves as being susceptible to addiction during their teenage years, nor perceive smoking to be a long-term health hazard, if it is limited to the first few years of adolescence. This notion reflects the general idea of smoking schemas and self-concept; adolescents who perceive smoking experimentation as being an acceptable or even positive experience may have stronger intentions to try smoking, particularly if they do not believe that they are at risk of becoming addicted. Understanding the individual characteristics that relate to maintaining strong anti-smoking intentions before experimentation occurs has the potential to inform the tailoring of tobacco control strategies to reduce smoking incidence rates during the most impressionable stage of adolescence.
1.5 Sex and gender based analysis in the study of adolescents' smoking behaviour

Many health behaviours such as smoking have been shown to vary by gender. Sex and gender based analysis is therefore often recommended as a core component when considering the social determinants of health in research design, knowledge translation, and health promotion. Gender differences in health outcomes, including smoking and its determinants, are influenced by sociocultural and sex-related factors. This section discusses how, far beyond the dimorphism of sex, gender is a complex sociocultural concept. It can be described in terms of gender identity defined by masculine and feminine characteristics, gender embodiment (e.g., physical appearance and body language adopted by men and women), and relational gender (e.g., how men and women behave with one another and how gender roles may be reinforced). These aspects of gender can all influence psychosocial outcomes, often interacting with ethno-cultural and socioeconomic determinants.

Health Canada has framed sex as the biological and physiological characteristics of a typical man or woman, while gender encapsulates the biologically prescribed sex identity with broader socially molded roles, attitudes and behavioural manifestations. Johnson and Repta described gender in its many forms, including gender identity, institutionalized gender, gender as a “constrained choice”, and as a “performance”. Gender identity can be broadly defined as how people view and present themselves with respect to the social norms of being a man, woman, transgender or other. Institutionalized gender is shaped by media, educational and medical institutions, and broad sociopolitical systems, which can place sociocultural “constraints” on how one’s gender should be displayed, based on the individual’s assigned sex. Gender theorists also have described gender as a performance -- behaviour is reinforced
by societal expectations of how gender is “embodied” and outwardly expressed. Gender is thus defined and expressed through a complex interaction of social, psychological and physiological systems that begin to significantly differentiate during adolescence. It is therefore important to consider the role of gender when investigating social, psychological, and health behaviour outcomes during the highly impressionable developmental stage of adolescence.

1.5.1 Gender development in adolescence

Gender identity begins to develop in early childhood. The changes in the physical and psychological self and the social experiences during adolescence contribute to the growing awareness of one’s gender and sexual identity. Adolescence is a period during which gender identity (self-identifying as being a “man”, “woman” or neither) begins to develop, as social and cultural norms and expectations about what it means to exhibit “maleness” or “femaleness” are defined. This process tapers into “gender transcendence” and “intensification” by which one gauges the gender role behaviour that best fits with one’s own beliefs, attitudes and context. Bem, Eccles, and Bryan, and more recently, Barret and White, for example, argued that an individual often exhibits both masculine and feminine traits, or a balanced combination of both to become more androgynous, a concept that is often measured with the Bem Sex Role Inventory. Parental and peer attitudes also have an important influence on the traits and norms that are reinforced within an individual.

Most women and men proscribe to the sociocultural norms of gender identity, which are in part, determined by their biological sex. Early research posited that being a woman or man is partly related to identifying with traditionally “feminine” characteristics (such as being
expressive or emotional, sympathetic) or “masculine” characteristics (instrumental and less emotive, but more aggressive). However, researchers have since found that these “gendered trait” dichotomies are stereotypical and becoming less appropriate over time, especially as societal attitudes about how these proscribed characteristics influence gender roles are changing and even overlapping. \(^{203,221}\) Furthermore, the idea of masculinity and femininity becomes more integrated in adulthood, whereby the socially prescribed traits of a man or woman become less rigidly defined, especially in the Western world. \(^{201,212}\) Despite the overly simplistic approach to understanding the relationship between masculine and feminine traits and gender, there are few if any measurement tools available that can capture the complexities of gender, particularly in adolescence. \(^{203,212}\) Researchers studying gender in adolescents typically rely on crude definitions to understand how the different facets of gender relate to psychosocial outcomes. \(^{201}\)

Social and developmental psychology research, such as the study conducted by Barret and White, has tracked changes in masculine and feminine characteristics from ages 12 to 25 years, using the Personal Attributes Questionnaire, which assesses gender role orientation and one’s beliefs about the extent to which one’s characteristics are related to traditional definitions of masculinity and femininity. \(^{218}\) Their research has shown that masculine or feminine traits tend to be more pronounced in boys and girls respectively during adolescence and become more equally expressed (i.e., androgynous) in both young men and young women. \(^{218}\) Barrett and White hypothesized that the relative societal value placed on “masculine” over “feminine” traits could influence the continuing development of masculinity in adolescents who already exhibit it. \(^{218}\) Barrett and White also postulated that the preference for masculine traits tends to be higher during adolescence in boys and girls than in late adolescence, and has been tied to lower self-esteem in both girls and boys. \(^{215,218}\) This premise is consistent with the research findings of
Connell and Schippers suggesting that masculine traits may be more socially preferable and that the social influences of “gender relations” were observed to be formed so that masculinities are socially reinforced as superior to feminine traits. \(^{213,222,223}\) Changes in gender identity during adolescence may also increase the extent to which gender influences psychological development and social experiences.

Masculine and feminine characteristics and gender identities are often described as hegemonic or culturally prescribed ideals of what a woman and man should be, and tend to be universal across cultures. \(^{187,219}\) Studies about masculine and feminine hegemonies or dominant socio cultural beliefs about gender have found that gender hegemonies are not equal complements of one another. Positive masculine traits are often associated with more favourable social and health outcomes, such as general well-being. \(^{187,201,213,222}\) In other words, possessing non-hegemonic masculinities is often portrayed as leading to inequitable social and health outcomes in both men and women. \(^{186,223}\) Furthermore, the way that gender hegemonies are currently defined, non-hegemonic masculinities in men, or heightened masculine traits in women, may be less socially desirable. \(^{186,224}\) However, a more masculine/androgynous woman is likely to face less social sanction than is an “effeminate” man. \(^{162,186,222,223}\) In a review of Connell’s work on multiple masculinities, Schippers described how non-hegemonic genders may be more prone to social sanction. \(^{222}\) Women whose behaviour deviates from traditional or socially unquestioned behaviour for women, such as exhibiting stronger sexual agency, may face higher sanction among her peers than if she exhibited these characteristics as a man. \(^{222,225}\) Conversely, a non-hegemonic man may display shyness, emotionality, an apparent lack of physical prowess, or attraction to the same sex, he may face an increased risk of social isolation.
It is in these non-hegemonic groups that researchers postulate an increased risk of maladaptive behaviour, such as substance use, and a higher rate of smoking initiation.  

1.5.1.1 Measuring gender

In this thesis, self-reported biological sex (i.e., male or female) is interpreted in terms of gender (i.e., boy or girl). The interpretations of the gendered effects of personality and affective characteristics on intentions take into account both the biological and psychosocial influences that may influence any differences in boys and girls. From this point forward, sex and gender are termed “gender” to acknowledge the interdependent nature of biological sex and the socio-environmental influences that affect gender. As postulated by Bem in the 1960’s and 1970’s, most men tend to exhibit more “masculine” than “feminine” traits, and most women exhibit more “feminine” traits. Using a dichotomous, self-identifying tool cannot capture the unique subsample of groups who fall outside of the stereotypical norms described above. Characterizing and measuring gender is an ongoing area of research -- its definition and significance continues to evolve and have been found to be especially challenging to address when studying adolescents. For example, the widely used Bem Sex Role Inventory has been deemed an inappropriate tool for adolescents because the indicators refer to “stereotypical” gendered roles and responsibilities often experienced in adulthood, such as rearing children. It also has been suggested that the inventory cannot capture individual gender role perceptions or gender relations, which may influence the way gender interacts with other psychosocial outcomes. Despite the limitations associated with measuring gender and in interpreting possible gender
effects on psychological outcomes, some researchers suggest that gender often influences psychosocial and health behaviour outcomes.

1.5.2 Gender and differences in personality, affect and well-being

Gender differences in personality traits have been studied and reported cross-culturally. Miettunen et al. conducted a meta-analysis of gender differences observed in Cloninger’s Tridimensional Personality profile. Their research found that women scored higher in Harm Avoidance and Reward Dependence, and reported no gender differences in Novelty Seeking. Further support for the importance of considering gender when investigating impulsivity can be found in a recent meta-analysis that indicated that scale items related to avoidance motivation and punishment sensitivity in an impulsivity measure was more commonly endorsed by women. Furthermore, constructs related to sensation seeking (for example, “Venturesomeness” or thrill and adventure seeking) were shown to be stronger in men. A cross-cultural meta-analysis of the Big Five personality traits found that women scored higher in Neuroticism, Extraversion and Consciousness, whereas men were found to be more Assertive. This gender difference was found to be greatest in high income countries; Schmidt and his colleagues posited that in high income countries, there are fewer social and behavioural constraints, which allow larger variability in gender identity formation.

Most social and developmental psychology studies find that positive masculine traits are associated with higher levels of psychological well-being in both men and women. For example, self-identifying with positive masculine traits has been found to be protective
against depressive symptoms in adulthood, in men and women.\textsuperscript{161,187,218,219} Earlier work by Bem also suggested that more depressive symptoms in women compared with men could be mediated by cultural norms that shape acceptable behaviour of emotional display.\textsuperscript{161,213} Data from a longitudinal study, completed by Barret and White in 2002, also found that positive male characteristics were more indicative of well-being than were feminine characteristics. They speculated that this phenomenon could reflect the social advantage that masculinity has historically bestowed, particularly in Western cultures that reward competitiveness and individuality.\textsuperscript{187,218}

Many researchers who have examined how gender influences psychological and affective states in adolescence and adulthood have found similar trends between masculine traits and various externalizing problems (e.g., aggression and impulsive behaviour), and between feminine traits and internalizing behaviours (e.g., anxiety and depression). Johnson et al., for example, found that emotionality in women is associated with social anxiety, loneliness, and social avoidance.\textsuperscript{230} In a recent overview of gender development in adolescence, Clemans concluded that part of the reason why depression is more likely to emerge in girls, compared with boys, is attributable to the importance placed on body-image ideals by girls, which when combined with pubertal development, increases self-image difficulties.\textsuperscript{187,218} Researchers have also attributed depression experienced by adolescent girls to the way they internalize social stress\textsuperscript{231}, which could then lead to smoking behaviour.\textsuperscript{94,95} Pubertal transition during early adolescence has been found to significantly increase girls’ willingness and intention to try alcohol, tobacco and marijuana.\textsuperscript{232} Early-maturing girls have been found to be particularly susceptible to depressive symptoms.\textsuperscript{187,213,218} In both boys and girls, higher levels of stereotypical negative masculine traits, such as challenging authority, and exhibiting delinquent and aggressive temperament, have
been associated with maladaptive behaviour, including substance use. Although boys are more commonly observed to exhibit these traits, a longitudinal study of gender and delinquency, conducted by Barret and White, found that the gender difference in delinquency and aggression is the lowest between the ages of 13 and 16 years.

In addition to differences in the expression of personality and affect, gender has also been shown to moderate or interact with the association between personality, affect, and substance use. For example, Stoltenberg et al. (2008) demonstrated that gender variance in the association between impulsivity and alcohol consumption was only observed with low volume consumers. Specifically, although impulsivity levels were associated with increased risk for drinking in men and women, the effect was stronger in men only in low impulsivity levels. Affect-driven smoking habits also have been demonstrated to be more common in women than in men. Gender therefore appears to play a significant role in the extent to which psychological traits relate to substance use motives, and behaviours including tobacco use.

Adolescence is a period when one starts to become aware of one’s gender identity with respect to social and cultural norms, and behaviour is partly influenced by these gendered norms. Many adolescents start to define gender roles within the context of the physical embodiment of their biological sex which often guides how they are socialized by their parents and peers. Gender therefore influences other socialized behaviours and experiences that may reinforce these sociocultural norms. Throughout history and across many cultures, tobacco use has been an important social and cultural currency that is experienced differently by men and women. The next section describes research that has investigated the impact of sex and gender on
smoking, and the possible psychological and social mechanisms that may explain some
differences in the patterns of tobacco use.

1.6 Gender differences in smoking-related outcomes

Men and women have been shown to differ in their physiological responses to nicotine,
particularly to nicotine metabolism, as well as in their sensitivity to the effects of
psychosocial non-nicotinic stimuli associated with smoking. Girls tend to develop signs
of dependence faster than do boys, most likely due to differences in nicotine response. For
example, girls have been shown to have higher sensitivity to the sedative properties of nicotine
combined with higher subjective sensation ratings (e.g., feeling “high”) after smoking nicotine,
compared with boys. More recently, Richardson et al. used a scale that measures the social,
emotional, sensory, and physical dimensions of tobacco dependence to characterize gender
differences in the smoking patterns of adolescents. Gender differences in physical
dependence related to nicotine withdrawal were not found in youths with equivalent levels of
lifetime cigarette use. However, the emotional need for smoking was significantly greater for
girls than for boys who had smoked a similar number of cigarettes in their lifetimes. Smoking
as a weight-control method has been reported only by female smokers. Among non-
smokers, the association between smoking and weight-loss is likely to be media driven or
influenced by immediate social contexts that perpetuate the belief that thin girls and women are
most attractive.

In an essay about the visual culture of smoking and gender, Tinkler presented the changes
in the dominant discourses of smoking and gender, over time, in the United Kingdom. From the
early 1800’s to the 1950’s, smoking symbolized a visual status symbol, and the behaviour was only acceptable in men. After the 1950’s, smoking was no longer a covert activity of women; it began to symbolize femininity and elegance. Since then, tobacco marketing strategies have often exploited the social aspects of smoking for women by creating cigarette rolls that are likely to emphasize a positive image of a female smoker at a party (for example “Virginia Slims”), and carried in purse-size packages that resemble cosmetics. Visual cues have been employed by public health officials to discourage smoking (e.g., a montage of a pregnant smoker), but may be less compelling than pro-smoking media that exploit adolescent girls’ awareness of and interest in expressing their sexuality.

Researchers in Western contexts have reported relatively consistent trends in the motivations to begin smoking in adolescence and the differences between the motivations of boys and girls. For example, qualitative studies by Amos et al. and Nichter et al. showed that young women are more likely to smoke to cope with social distress. Young women are more likely to smoke in groups to dampen the negative perceptions of female smokers, such as being “out of control” and promiscuous. These findings overlap with research findings related to gender differences in coping with stress. Some researchers have found girls to be more vulnerable to stress, in general, and to seek more peer support, such as using “hangout” coping or to exhibit avoidance coping, whereas boys were noted to have more “instrumental” coping strategies and were less likely to use avoidance coping. Researchers have also speculated that smoking in peer groups may be more endorsed by girls as part of a passive coping mechanism. In boys, becoming involved in activities such as sports, computers, or music has been found to protect them from smoking initiation.


activities may reflect the use of an “instrumental” coping strategy that is less likely to involve tobacco use. \textsuperscript{68,213,249}

Gender differences in the psychological and affect-related risk factors of smoking also emerge during adolescence. Although some affect outcomes (e.g., depression) are more likely to be reported by girls and risk-taking tendencies are more prevalent in boys \textsuperscript{187,213,251}, qualitative research and literature reviews suggest that that female smokers may exhibit more masculine characteristics, such as confidence and rebelliousness, while male adolescent smokers may be more prone to shyness and insecurity. \textsuperscript{160,206,220,250–252} This idea contradicts early and mid-twentieth century portrayals of a “secure masculine” prototype smoker \textsuperscript{255}, but may be congruent with pro-tobacco graphical depictions in advertising with images of socially confident and independent women. \textsuperscript{256} Smoking may be used by some girls as a strategy to project an outward appearance of resilience and self-confidence, while also managing their internal feelings of depression and social anxiety. \textsuperscript{254,257–259} A recent review of the role of gender in tobacco control concluded that in high income countries, girls tended to smoke to regulate their affect and to project confidence while building “social capital” through sharing cigarettes with other female friends. \textsuperscript{226,243,260} Smoking by girls also has been suggested to result from a desire to appear more confident and independent when transitioning from school to the workforce \textsuperscript{253}, which might help explain the recent shift in smoking initiation from early to late adolescence. A qualitative study of Scottish youth indicated that boys may smoke to deal with their anger and to avoid confrontation with their peers. \textsuperscript{243} Although numerous studies have investigated the relationship between smoking and gender, the nature of this relationship, especially in adolescence, has yet to be fully understood. However, a general theme encountered in this literature is that smoking stems from a need to manage a social image that may in part reflect a
gender identity, while also being used to control one’s mood.

Although smoking prevalence is lower in mid adolescence than in young adulthood⁴, most research about smoking during adolescence has focused predominantly on predictors of smoking by youth who have already experimented with tobacco. Relatively little research has been conducted on gender differences in the susceptibility to smoke, particularly in terms of smoking intentions. Kitsantas et al. and Markam et al. independently found that American white girls had less intention of not trying to smoke and had weaker anti-smoking attitudes compared with white males.²⁶¹,²⁶² They posited that this gender difference could be driven by differences in participation in sport, and the link between attitudes towards athletic performance and masculine identity.²⁶¹,²⁶² This supports findings from several qualitative studies that reported that boys often see smoking as impeding their athletic activity, while girls are more concerned about the lingering smell of tobacco smoke.¹⁶²,²⁴³ Gender differences in smoking abstinence or susceptibility thus appear to be influenced by a complex interaction of psychological states and socio-environmental factors that result in different schemas that influence the intention to try smoking.

1.6.1 Incorporating sex and gender based analysis of the relationship between the SURPS and the intention to try smoking

Research organizations that support biological and psychological research initiatives have established recommendations for the incorporation of sex and gender based analysis in operating grant submissions and publications. The Canadian Institutes of Health Research, Institute of
Gender and Health has developed recommendations and guidelines for researchers to outline how sex and gender based analysis will be incorporated into their research questions, analyses, and dissemination activities.\textsuperscript{210–212} The American Psychological Association also recommended ensuring that instruments used to measure psychological or affective states undergo a validation process that includes ensuring that the psychometric properties are equivalent for men and women, boys and girls before researchers interpret putative gender differences in scores.\textsuperscript{263}

1.6.1.2 Gender-based measurement invariance of the SURPS

Researchers investigating smoking behaviour have provided compelling evidence of the gendered processes of psychosocial\textsuperscript{50,234,241,244,264} and personality-related\textsuperscript{120,142} risk factors that drive differences in tobacco dependence. Before considering the presence of the interactive effects of gender and the SURPS dimensions on the intention to try smoking, it is important to confirm that the underlying psychometric properties of the scales used to measure these latent constructs are gender invariant.\textsuperscript{234} Scales with gender-sensitive items could lead to biased total scores for a comparison group, which may subsequently distort or bias the relationships observed between the latent constructs and the outcome of interest.\textsuperscript{234} For example, a study examining gender-sensitive measurement variance of the Centre for Epidemiological Studies Depression Scale demonstrated that women respond differently to items related to affective expression (e.g., crying), which results in bias towards higher depressive symptom scores in women with levels of depression comparable to those of men.\textsuperscript{265} Gender-based measurement invariance across all
dimensions of the SURPS, particularly constructs related to affective regulation and response (e.g., Anxiety Sensitivity), should be established before examining the influence of gender on the relationship between personality and substance use.

1.6.1.3 Intersecting gender with the effects of ethnicity and socio-economic standing on smoking-related outcomes

The effect of gender is often considered within the intersections between multiple individual and environmental characteristics that contribute to the shaping of how gender is broadly defined and personally internalized. More specifically, the influence of both sex and gender should be incorporated with the socioeconomic, ethno-racial, local and broader community loci in which both an outcome of interest and its main antecedents are being studied. Disparities between men’s and women’s health outcomes are often reflective of broader gender inequity in the sociopolitical environment in which these observations are made. For example, tobacco control research has shown that relatively small gaps in men’s and women’s educational attainment and employment opportunities correspond with small differences in their smoking initiation and prevalence rates. The gender gap in the smoking prevalence rate has been narrowing in the past two decades such that the rates of men and women are not substantially different now in the western countries of Europe as well as Canada and the US, while a discernible difference is still present between men’s and women’s smoking rates in highly developed Asian countries, such as China. This narrowing in the gender gap in smoking prevalence is therefore a parallel phenomenon to the narrowing gender-gap in employment and education.
In western countries, being an immigrant of Asian descent, especially first generation, has been shown to be protective against smoking. In a recent review of the research related to the substance use of Asian American youth, Hong et al. found that the prevalence of smoking is lower in Asian Americans than in white Americans, but it is strongly influenced by other sociodemographic factors such as relationships with parents and peer approval, which also influence the susceptibility to substance use. Enculturation to western culture has been shown to weaken this protective effect. However, several studies suggest that enculturation in Asian youth may be more protective against smoking initiation for boys than girls.

Socioeconomic status is a strong predictor of many health outcomes, and has been found to be an influential predictor when studying tobacco-related outcomes. Socioeconomic standing can be assessed with several indicators, including individual and family-level economic resources, usually via gainful employment, educational attainment, and neighbourhood or institutional level social and economic resources. Among adolescents, socioeconomic status has been often determined by measures of parental education, living in a single-parent home, the financial standing of the household, and neighbourhood and school-level median income levels. Some researchers also have investigated the effect of contextual characteristics of social and economic resources, such as neighbourhood cohesion and peer relationships to illuminate how the social practices and beliefs of the neighbourhood influence the decision to start smoking. Lower socioeconomic status has been found to increase the risk for smoking, and some research suggests that the influence of socioeconomic disadvantage on smoking outcomes is especially high for girls.
immigrant status, particularly in western countries, are often found to strongly influence socioeconomic position and its effects on substance use outcomes. 16,202,209,246,269,270,272

In this thesis, parental education was used as an indicator of socioeconomic standing. Maternal education is an important indicator for socio-economic standing for two key reasons: 1) some researchers have concluded that maternal education influences psychosocial (e.g., depression) and other health related factors in adolescence, and 2) in British Columbia (BC) more than 80% of lone parent families are based on female parents as the sole provider. 285 Paternal education is also important because research suggests that it plays an important mediating role between social events and mental health outcomes, including depression. 286,287 A single indicator of socioeconomic position cannot fully represent the complex influence of economic and social resources on health behaviour, or parental education and income on adolescent substance use outcomes. 209,278,281 However, parental education has consistently been shown to be negatively associated with adolescents’ smoking outcomes, with higher levels of parental education being protective against current smoking. 278,279,288–290 Ethnicity has been shown to interact with this relationship. Bachman et al. demonstrated that there is an inverse linear relationship between parental education and the smoking rates of white students in grades 8, 10 and 12, and non-linear trends in African American and Hispanic adolescents. 289 Of the students in the 8th grade with the least educated parents, close to 30% were current smokers compared with less than 10% of the students with parents in the highest education stratum. 289 Although parental education is usually established using the educational levels of both caretakers, a longitudinal study by Singhammer et al., spanning close to 30 years, demonstrated that higher levels of maternal education was protective against daily smoking in adulthood. 278 In a study of parental education and smoking in a sample of female adolescents, Wallace et al.
demonstrated that among white female smokers, lower levels of parental education significantly predicted current smoking (in the past 30 days), but they were not able to demonstrate this trend in other ethnic groups. Interestingly, this study also indicated that the odds of being a current smoker were also higher for adolescents with the highest disposable income (e.g., from an allowance or part-time job). This relationship also interacted with ethnicity, with the odds of being a current smoker being close to eightfold for adolescents who identified themselves as Asian, compared with a threefold odds observed for white adolescents. Given this evidence, sociodemographic factors, specifically parental (maternal) education and ethnicity are important factors to consider when studying smoking in adolescence.

In conclusion, the research objectives, data analysis, and results presented in this thesis provide a gender-based perspective at every step. Chapter 2 presents the rationale and methods of gender-based psychometric validation of the SURPS to ensure that unbiased gender comparisons of the total scores can be made, as shown in the hypothesis testing reported in Chapter 3. Chapter 3 describes, in more detail, the approaches that were taken to incorporate a gender-based analysis in the investigation of the associations between Anxiety Sensitivity, Hopelessness, Impulsivity and Sensation Seeking and intention to try smoking. Chapter 4 provides a summary of the findings and attempts to tie the research findings with current tobacco control efforts, including web-based, targeted health communication and intervention programs.
1.7 Research goals and rationale

In the past decade, BC has made significant progress in reducing both the incidence and prevalence of smoking. The rate of smoking attempts among adolescents has dropped from over 50% in 1998 to 26% a decade later \(^1,3\), with approximately 7% of adolescents identifying themselves as current smokers in 2010. \(^14\) However, these rates are observed to double as teens progress through late adolescence. \(^4\) Additionally, close to 30% of current “never-triers” report having some intention to trying smoking in the future. \(^14\) Understanding the relationship between personality and youths’ intentions to try smoking represents an exciting opportunity to identify risk factors that could be monitored to aid in the reinforcement of strong intentions to refrain from tobacco use during adolescence. However, few researchers have investigated the role of personality and affective factors on smoking intention. As explained in Sheeran’s meta-review of the research about smoking intentions, the total explained variance typically reported in psychological research reports may not explain the individual risk of the intention to try smoking based on personality and affect. \(^72,218\) Furthermore, little work has explored how the effects of personality or affective-related risk on intention to start smoking may vary by sex and gender.

The Substance Use Risk Profile Scale is a validated tool that has been designed for use in epidemiological studies with community samples to predict substance use during adolescence. The SURPS was included in the British Columbia Substance Use Survey (BASUS), a prospective cohort study of BC secondary students designed to track the prevalence and trajectory of alcohol, tobacco and other drug use of students in Grades 8 through 11, as well as the potential determinants of initiation and continuation of substance use. This thesis explores how differences in individual personality and affective traits relate to susceptibility to smoking
by examining the associations between Anxiety Sensitivity (SS), Hopelessness (HP), Impulsivity (IMP) and Sensation Seeking (SS) and the likelihood of having less well-defined intentions to abstain from experimenting with tobacco. Furthermore, because these associations are examined using cross-sectional data, the stability of the SURPS dimensions and its association with intention cannot investigated.

Data collected from the Grades 8 and 9 students who participated in Wave 3 of BASUS (collected between October to December 2010) were analysed to address the following three main objectives:

(1) Ascertain whether the Anxiety Sensitivity, Hopelessness, Impulsivity and Sensation Seeking subscales of the SURPS demonstrate gender-based measurement invariance;

(2) Determine the relationships between intention to smoke and the SURPS constructs, controlling for possible confounders, including gender, SES (as measured by maternal education), and ethnicity (White, Asian, or Aboriginal); and

(3) Examine whether the cross-sectional relationships between Anxiety Sensitivity, Hopelessness, Impulsivity and Sensation Seeking and intention to smoke vary by gender.

Chapter 2 presents the methods, results and discussion of findings for objective 1, while Chapter 3 presents the findings arising from objectives 2 and 3. Chapter 4 will provide recommendations for future research that could further examine any associations identified in the analysis and discussed in Chapter 3, and presents ideas about how the SURPS could be integrated into a multi-component health promotion program that focuses on reducing tobacco use.
CHAPTER 2: Gender-based measurement invariance of the Substance Use Risk Profile Scale

2.1 Background

Researchers in the social and health sciences often incorporate gender-based analyses when studying the effects of psychosocial factors on health behaviour outcomes. Recent recommendations of the Institute of Gender and Health, one of the Canadian Institutes of Health Research 210, indicate that gender should be routinely incorporated in to health and behaviour research to increase our understanding of the biological and psychosocial processes that drive differences in relevant outcomes. Chapter 1 provided an overview of how gender is theoretically framed, analysed and interpreted in the context of psychological functioning and substance use outcomes. Examples in developmental psychology were also given, illuminating how psychosocial traits such as impulsivity 164,168 and sensation seeking 165,291 influence adolescents’ alcohol consumption and cigarette smoking behaviour. Numerous studies discussed in Chapter 1 have provided consistent evidence of a link between depressive and anxiety-related symptoms and a higher propensity to exhibit negative health behaviour in women, including smoking. 239,292,293 Research also suggests that some cognitive, affective and personality traits may be observed in different levels in men and women 151,227,228, and that gender may also influence the relationships between personality and affect-related traits and substance use. 233,234,243,244 Gender is therefore considered to be of fundamental importance in research investigating the relationships between psychological and affective traits and health behaviour. 205,212,294

Substance use and misuse is most likely to be observed during adolescence after the onset of puberty and young adulthood. 168,179,295 The Substance Use Risk Profile Scale (SURPS),
described in Chapter 1, is a four dimensional scale that was designed to measure temperamental and affective traits that may increase the risk of an individual trying tobacco or alcohol.\textsuperscript{139,144,22}

The SURPS consists of 23 items that are indicators of the following four dimensions: Anxiety Sensitivity (5 items), Hopelessness (7 items), Sensation Seeking (5 items), and Impulsivity (5 items).\textsuperscript{139,22} Most research investigating gender differences in psychosocial and behavioural traits involves the use of psychometric instruments. The CIHR Institute of Gender and Health\textsuperscript{210} and the American Psychological Association\textsuperscript{263} recommend that researchers perform validity tests, such as assessments of measurement invariance, of these psychological assessment tools before using them to explore gender differences. An instrument that is found to be structurally equivalent, in terms of its measurement structure, in all groups of interest is said to be measurement invariant.\textsuperscript{265,296–298} Despite the aforementioned guidelines on sex and gender-sensitive analysis, few studies involving the use of psychological measures include assessments of gender-based measurement invariance.

Establishing gender-based measurement invariance is recommended before comparing differences in the total scores of men and women, to ensure that the total scores are not derived from a biased instrument.\textsuperscript{296,298,299} For example, instrument bias could occur because the content of individual items is interpreted differently by men and women. This can result in the observed total scores being systematically biased.\textsuperscript{299–301} An example of this bias was found with the Centre for Epidemiological Studies Depression (CES-D) symptom inventory\textsuperscript{302}, a widely used inventory of depressive symptoms. The CES-D consists of 20 items assessing various depressive symptoms, which when summed provide a total score indicating the extent of depressive symptomatology.\textsuperscript{302} A study by Zumbo and Koh found that, given equivalent levels of depressive symptomatology, women were more likely to endorse the “crying spells” item, and
men were more likely to endorse “talking less than usual”. Given that a woman is more likely to endorse “crying spells” than an equally depressed man, the woman would appear to be more depressed if the response to this item was included in the creation of a total score on the scale. Since the SURPS construct of Hopelessness is very similar to the concept of depression assessed by the CES-D, it too may contain items that are more (or less) likely to be endorsed by one gender over the other.

Recent validation efforts of recognized psychosocial tools have included the establishment of gender-based measurement invariance. For example, Richardson et al. demonstrated that the Adolescents’ Need for Smoking Scale was gender-invariant at the construct, metric, scalar and error variance levels. This tool was used to capture the multi-dimensional nature of tobacco dependence, including social and emotional influences of the need to smoke, which were expected to influence boys’ and girls’ smoking patterns. The Perceived Stress Scale, a commonly used scale of perceived stress, also has been found to exhibit complete measurement invariance across gender, but not across mental health states.

The construct of gender is most commonly captured by using self-reported sex (being male or female) and is often used as a covariate, or part of an interaction term with another covariate of interest, in regression models. Gender/sex may also be used as a grouping variable when testing mean differences in total scores of psychosocial scales. Developmental psychologists investigating psychological traits of adolescents often explicitly recognize potential variation by gender. For example, studies investigating associations between the SURPS dimensional scores and substance use have included gender as a covariate, and one study reported gender-differences in mean scores in Sensation Seeking. However, these
differences could be due to gender differences in the psychometric properties of the instrument. The objective addressed in Chapter 3 is to examine how the relationships between psychological and affective traits (as measured by the SURPS) and intentions to try smoking vary by gender. However, before these gender effects can be reliably investigated, the gender-based measurement invariance of the SURPS needs to be established.

The purpose of this chapter is to present the results of measurement-invariance tests of the SURPS conducted using multi-group confirmatory factor analysis (CFA). An ungrouped CFA is also presented to provide support for a four-factor model of the SURPS, and the results are compared with previous CFA work reported by Woicick 22 and Krank. 142

2.2 Testing for gender-based measurement invariance

2.2.1 Confirmatory factor analysis

Confirmatory factor analysis (CFA) tests the validity of a proposed measurement structure by examining how the data captured by the indicators of an instrument, designed to measure a construct or constructs, fit relative to a hypothesised model. 305,306 CFA typically uses latent variable models, which can be described as having both a measurement and structural model. 306 The measurement model defines the mathematical relationships among the observed item responses (i.e., indicators) and the unobserved latent or common factor, which drives the responses to the scale items. Typically, the relationship is a linear or an approximately linear relationship. The structural model specifies the relationships (i.e., covariances) among the
latent/unobserved variables. 

Although the measurement and structural components are modelled in CFA, in this thesis, only the measurement model, or the relationships between the observed scale response items and the latent variables are interpreted. For indicators that are categorical, a generalized linear model is used to estimate the regression parameters.

For any latent variable model (with continuous or categorical indicators), the latent variable $\eta_j$ relates to the observed indicator variables $y_j$ as

$$
\eta_j = \alpha + B\eta_j + \zeta_j,
$$

where $B$ is a matrix of structural parameters related to the latent variables, $\alpha$ is the intercept vector\(^1\) and $\zeta_j$ is a vector of “disturbances” (i.e., error, or factors not incorporated into the measurement model), assumed to follow a multivariate normal distribution.

With ordinal indicator variables, the measurement model is a *generalized latent variable model*. The measurement model is evaluated by comparing differences between the model-implied covariances associated with the model parameters and the covariances in the observed data. Estimating the covariance matrices of continuous latent variables and observed ordinal variables (i.e., individual items) involves the use of polychoric correlations.\(^3\) Polychoric correlations are calculated based on the latent response distribution, which is an observed ordinal (categorical) distribution estimated from an underlying latent variable continuous distribution.\(^3\)

---

\(^1\) The intercept is not modelled when conducting confirmatory factor analysis with ordinal variables, using WLSMV. This is explained further in section 2.3.
These distributions are used to estimate the value of the score (level) for the observed ordinal variable \( y \) from the unobserved continuous latent response variable \( y^* \) instead of the observed continuous response, as with continuous indicators:

\[
y^*_j = \nu + \Lambda_y \eta_j + \varepsilon_j.
\]  

(2)

The \( \nu \) represents the vector of intercepts, \( \Lambda \) is the factor loading matrix and \( \varepsilon_j \) is the vector of unique factors of each response variable including measurement error.\(^3\) The unique factors are assumed to follow a multivariate normal distribution.

Categorical or ordinal response variables also need a threshold model\(^3\) that, with the multivariate assumption, yields a probit latent variable model. The latent variable distribution is used to estimate the probability of the value of the score (level) for the observed ordinal variable \( y \) from the unobserved continuous latent response variable \( y^* \) as determined by \( \tau \) threshold parameters:

\[
y = c, \text{ if } \tau_c < y^* < \tau_{c+1}.
\]  

(3)

As specified by the threshold model, the probability of the latent response \( y^* \) category depends on whether it is higher or lower than a given threshold value, whereby the total number of thresholds is equal to \( c \) categories less 1.\(^2,4,3\) For example, given that there are four response options for each SURPS item, there are three implied thresholds. The figure below shows the threshold model for a four-level ordinal response\(^3\), assuming normally distributed uncommon factors (i.e., error):
The generalized latent variable measurement model is estimated with a generalized linear model using a conditional response distribution where the uncommon factor follows a distribution with a mean of 0. The latent response $y^*_j$ therefore becomes $g(\mu_j)$ where $g(.)$ represents a vector of linked functions specified by a probability density distribution (e.g., Poisson for ordinal response variables), and $\mu_j$ is the conditional mean of the responses given the latent variable $\eta_j$. Each specified equation (for every indicator) estimates the probability of a response (i.e., 1, 2, or 3) given an intercept and loading coefficient ($\lambda$).
\[
\log (\mu_j) = \ln[\text{Pr}(\mu_j)/(1-\text{Pr}(\mu_j))] = \nu_i + \lambda_i \eta_j. \tag{4}
\]

To solve the generalized latent variable models as specified in equation 4, factor loadings are standardized by fixing one item of each latent construct with a loading of 1 and an intercept of 0, and adjusting the other loadings in the construct relative to the reference item. Standardized loadings can also be squared to yield $R^2$ values, which represent the percentage of variance of the observed variables explained by the latent construct. Below is an example of a path diagram (see Figure 2.2), a schematic representation of the measurement model of Impulsivity.

**Figure 2.2:** Measurement model of Impulsivity
2.2.1.1 Model estimation using least squares estimation

The most commonly used method for estimating the parameters in a measurement model is maximum likelihood (ML). However, maximum likelihood estimation assumes that the observed variables are continuous and follow a multivariate normal distribution. This assumption has been shown to be violated when estimating polychoric covariance structures and thresholds, necessary with ordinal data, especially with items with fewer than five values. Given that all items in the SURPS have four response options, using ML could lead to inflation of the $\chi^2$ statistics and underestimated standard errors. An alternative estimator that can be used instead of ML is the weighted least squares with mean and variance adjustment (WLSMV). This method estimates a weighted matrix of asymptotic covariance matrices of the polychoric correlations in the estimation of the thresholds and loadings. The estimator iteratively uses different weight matrices ($W$) until the differences between the observed polychoric covariance matrix and the model-implied covariance matrix are minimized (i.e., least squares estimation). Unlike weighted least squares (WLS), WLSMV uses the diagonal of the weight matrix to estimate the parameter coefficients, and tends to estimate smaller residuals. In addition, WLSMV is more robust to skewed distributions of the indicators than is WLS, in that the $W$ matrix is more appropriate for small to moderate sample sizes.

2.2.2 Taxonomy for testing measurement invariance

When an instrument is said to be measurement invariant, each construct is measured using the same metrics across groups. As described by Steenkamp and Baumgartner,
instrument bias can be due to differences in construct configuration, loading magnitudes, intercepts or residual variance. Recent work by Marsh referred to a broad hierarchal classification of measurement invariance that was applied in this thesis: \textit{configural, weak, and strong invariance}. When conducting measurement invariance assessment of the unobserved common factor $\eta_j$, using ordinal indicators, factor loading, factor variance and residual (error) variance invariance can be simultaneously tested in two steps to establish \textit{strong invariance}.

2.2.2.1 \textit{Configural invariance}

If the constructs are measured by the same set of items in both groups, they are said to have \textit{configural invariance} and exhibit the same configuration, such that the same items load on the same factors for all groups of interest. This is the least restrictive form of invariance because the magnitude of the item loadings can still vary across the groups. Even if configural invariance is demonstrated, an instrument can still be systematically biased in the loadings, intercepts or thresholds, which would affect the validity of any score comparisons undertaken across groups.

2.2.2.2 \textit{Weak invariance}

A more restrictive form of invariance is \textit{metric invariance}, whereby the magnitude of the loadings of each item belonging to a construct must be the same for all groups of interest. An instrument that demonstrates \textit{metric invariance} is said to display \textit{weak invariance} across the
Weak invariance is sufficient to compare construct correlations between boys and girls, but not their means.

2.2.2.3 Strong invariance

Even if weak invariance is demonstrated, latent means can have systematic or additive bias due to differences in the intercepts with continuous data or thresholds with ordinal data. This bias must be ruled out before observed mean scores can be compared across groups. With ordered categorical observed variables, threshold invariance is tested instead of intercept or latent mean invariance. Invariance in factor loadings, thresholds, as well as factor and error variance is considered strong invariance. If strong invariance of the instrument is shown, both construct correlations and means can be compared between boys and girls.

2.2.3 Partial measurement invariance

If a tool demonstrates less than strong measurement invariance, it is said to exhibit partial measurement invariance. Partial measurement invariance is observed when a scale factor exhibits strong invariance across groups in some items but not others, or some factors but not others. If measurement invariance on gender were found for the SURPS, additional analytical steps would need to be taken to ensure the comparability of the means and the accuracy of the correlations for boys and girls. Muthén and Muthén suggested conducting partial-measurement invariance tests by relaxing equality specifications for indicators across groups.
groups and retesting the model fit.\textsuperscript{315} For example, if differences in the CFI, an index of model fit, between Steps 1 and 2 are larger than 0.01\textsuperscript{317}, Modification Indices can be viewed to determine whether certain parameters should be estimated independently for each group, identifying which item factors and thresholds should be freed to improve fit.\textsuperscript{315} This could be done with one item at a time, until good or excellent model fit is achieved. Alternatively, if raw scores are obtained for each dimension via summation, items with loading variance in groups could have a weight assigned to one group before calculating the group members’ weighted summed scores.\textsuperscript{318} The present analysis focused on demonstrating \textit{strong invariance} to ensure that both means and correlations could be used to examine the relationships between gender and each of the SURPS domains.

\textbf{2.3 Data sample}

\textbf{2.3.1 Data source (BASUS)}

The BC Adolescent Substance Use Survey (BASUS) is a prospective cohort study that was designed to capture changes in psychosocial functioning and substance use trends in adolescents attending publicly-funded English-speaking secondary schools in British Columbia. BASUS is administered through an online platform designed and hosted by the BC Arthritis Research Centre (ARC), allowing for anonymous reporting of responses to the survey content. The survey questions included self-reported use of alcohol, tobacco, marijuana and other drugs, lifestyle and health indicators, as well as assessments of psychological and social functioning.
Superintendents from all of the school districts in British Columbia were approached and asked for permission to contact principals of the middle schools (grades 7 and 8) and secondary schools (grades 8 through 12) in their districts. Once the principals approved, recruitment strategies were introduced, including in-school announcements, posters, and take-home booklets for parents to read. All of the participants received a $25 gift card for each wave of participation. Follow-up reminders included both online (via email and Facebook), text messaging and traditional (postal) letters. The survey has been administered in two waves from October 2009 to December 2012; the first annual wave occurred from October thru December and the second annual wave occurred from April thru June of every year. A total of 65 schools were enrolled. The eligibility criteria in each wave included having obtained direct or parental consent (if required by the school district) or passive online assent and being at least 13 years of age.

In Wave 3, all of the participants were presented with the Substance Use Risk Profile Scale. The scale items were presented in a grid with a list of questions from 1 through 23 (not grouped by dimension), with the response options placed horizontally on the top of the grid. The participants could choose only one response per item but were permitted to change their responses until they completed the survey. Non-responses were permitted. The cross-sectional data analysed here were obtained from a sample of adolescents (n = 1,352) enrolled in Grades 8 or 9 in 62 BC secondary schools (i.e., from Wave 3 in the fall of 2010). Of the 62 schools from which the students were originally recruited, the response rates varied from 0% to 80% (average participation rate = 17%) among the Grade 9 students, and from 0% to 67% (average participation of 5%) among the Grade 8 students.
2.3.2 Sociodemographic variables

Gender was captured by asking participants to identify themselves as either male or female.

Parental education is often included as an indicator of socioeconomic status in studies involving adolescents’ psychosocial risk. The participants were asked to identify the highest education obtained by their mother and (or) father, with 7 levels ranging from “Some Elementary School” to “Post-graduate/professional school (PhD, MD, and Law)”

To reduce the number of response options with low cell counts, the categories were collapsed as follows: Some High School (reference category), Completed High School, Some Post-Secondary School, Completed Undergraduate Degree, and Completed Post-Graduate Degree. This decision was based on the psychosocial literature that suggests that a lack of secondary school completion by parents or caretakers influences parenting practices and monitoring, which increases the risk of their children or towards substance use. 319,320

To capture the ethno-racial profile of this sample, the participants were provided with a check-list of ethnic and racial descriptors that are widely used in psychosocial and health behaviour research in the Canadian context, including the provincial census and the annual McCreary Centre Adolescent Health Survey. 10 The categories were collapsed into 4 non-overlapping categories: Aboriginal, Asian (including Chinese, Japanese, Korean, Filipino, South East Asian, South Asian, and West Asian), White/Caucasian (reference category) and other (Latin American, Black, and Other). The data were collapsed to increase the sample sizes of the ethno-racial minorities. A hierarchy was imposed when more than one category was selected. The term, non-overlapping is used here to mean that if a participant selected Aboriginal along
with other ethnicities, he or she was coded as Aboriginal, and if an Asian ethnicity was selected, the participant was coded as Asian. For example, if both Asian and Aboriginal were selected, the status was coded as Aboriginal and if Asian and White/Caucasian were selected, the status was coded as Asian.

2.3.3 Substance Use Risk Profile Scale (SURPS)

The SURPS contains 23 items that measure four dimensions: Anxiety Sensitivity (5 items), Hopelessness (7 items), Sensation Seeking (6 items), and Impulsivity (5 items). Responses to each item were provided on a 4-point Likert-type scale: 1 (“strongly disagree”) to 4 (“strongly agree”). The development and validity research already conducted for the SURPS is introduced in Chapter 1. The structural (i.e. psychometric), concurrent and predictive validity (i.e., cross-sectional and longitudinal validity to predicting substance use and misuse) have already been examined by Krank et al. 142

2.4 Data analysis

2.4.1 Multi-group and ungrouped confirmatory factor analyses

The analyses presented here were used to examine gender-based measurement invariance of the SURPS using multi-group confirmatory factor analysis according to the methods described Muthén and Muthén, as well as Millsap and Yun-Tein. 308,315 Gender grouping was defined by
self-reported male or female status. The threshold, loading, and error variance invariance, by gender, of the Substance Use Risk Profile Scale was tested to establish whether the scale had *strong measurement invariance* using multi-group CFA, with M-Plus 6.12 software. After measurement invariance was ascertained, an ungrouped confirmatory factor analysis was performed.

### 2.4.1.1 Testing gender-based measurement invariance in two steps

A two-step process was used to examine measurement invariance with ordinal dependent data. The thresholds were modelled (instead of intercepts and means), and the thresholds and loadings were estimated in the same step because the probability of a response to an item is dependent on both. Step 1 involved setting the residual variances for all groups to equal one, and freeing the threshold and loadings for all items in boys and girls. This step tested for factor and error variance invariance. In this step, the common factor means were constrained to be zero for both groups, the residual variance of one of the items within a common factor to 1 in both groups, and the factor loadings and thresholds also were set to be free in both groups (Appendix B). In addition, theta parameterization for model identification, for the two groups, was used, which specified the unique factor variance to identity (i.e., $\Theta_2 = I$). The identity matrix specifies the error correlations to be 1 with identical indicators for both groups, and zero for non-identical indicators. However, the common factor variances of the latent covariance matrix ($\Sigma^\eta$) were allowed to be free. In Step 2, the factor loading parameters and thresholds

---

2 The loading of the first item of each construct is fixed to 1
3 $\Sigma^\eta$ is the matrix for latent variables $\eta$
were constrained to be equal for boys and girls. At the same time, one group was constrained to have common factor means of zero, and only one group was constrained to have a unique factor variance constrained to identity ($\Theta_2 = I$). In Step 2, factor and error variance invariance is tested by freeing the residual variances of the first indicator in each dimension one group, and constraining them to equal 1 in the other (default setting). The latent means ($\kappa$) could not be estimated at the same time as the thresholds, which is why threshold and loadings were free to be estimated when the latent means were fixed to be zero. Step 2 verifies that thresholds and loadings in all factors are invariant in boys and girls. In both steps, to identify the models, the first item of each factor was set to have a loading of 1.

To test for measurement invariance, the nested models of invariance parameters were statistically compared using a $\chi^2$ difference test. However, because $\chi^2$ difference tests are sensitive to large sample sizes, and hence have the power to detect small, statistically significant differences in the $\chi^2$ estimates, Cheung and Rensvold recommended using a cut-off of a change in the Comparative Fit Index (CFI) of $\leq -0.01$ to compare the two models. The CFI is used in latent variable modelling to assess an improvement in fit of a baseline (i.e., independence model) compared with a proposed model. A larger index (up to a maximum of 1) indicates improvement in fit of the specified model compared with a baseline model. The CFI is used preferentially over a difference in $\chi^2$ estimates, because the CFI is adjusted for the number of parameters estimated with a penalty term added. The estimate of the CFI is also used to determine overall fit of the model. While a score of over .95 indicates excellent fit (as per Hu and Bentler), more recent criteria indicate that a CFI > .90 is adequate fit. The Root Mean Square Error of Approximation (RMSEA) is the square root of the mean covariance residuals (i.e., unexplained covariance), with zero indicating a perfect fit. A cut-off of less
than .06 indicates excellent fit \(^{323}\), while a RMSEA < .10 is considered adequate. \(^{142,324}\) Changes of less than .01 on the CFI between steps 1 and 2 demonstrate \textit{strong measurement invariance}.

\textit{2.4.1.2 Missing data}

When creating latent variable models with categorical outcome variables (i.e., indicators) and using WLSMV, the \textit{pairwise present} method is used. \(^{315}\) This means that all available data are considered for each pair of indicators. \(^{326-328}\) The limitation with this method is that sample statistics are established using different sample sizes, because of the variation in the missing value patterns. \(^{315,326,328}\) In addition, given that variables loading on a factor are expected to be correlated, the missingness may not be random, which could lead to bias in the parameter estimates. \(^{328}\)

\textit{2.4.1.3 Adjusting for clustering}

Students clustered within a school are expected to have responses that are not independent, although the schools are considered independent. This correlation in responses must be taken into account with the BASUS data to provide relatively less biased standard errors of the parameter estimates. \(^{329}\) M-plus uses a robust covariance estimator for standard errors with the COMPLEX function, after specifying clustering by school. The robust covariance
estimator uses an empirical covariance matrix, and does not require any distributional assumptions or correct specifications of a covariance structure.  

2.4.1.4 The reliability of each SURPS dimension

In this analysis, two reliability coefficients for each dimension were obtained (as reported in Table 2): Cronbach’s alpha (\( \alpha \)) and construct reliability. Cronbach’s alpha\(^{331} \) is the most commonly reported measure, but it is dependent on the number of items in a scale, assumes that the loadings are equivalent in magnitude in a dimension, and assumes that cross-loadings are absent. \(^{332} \) Although outliers can significantly inflate Cronbach’s alpha\(^{333} \), as explained in Chapter 3, no outliers in any of the dimensions were noted.

Construct reliability is dependent on the standardized loadings (and thus variance) explained by the common construct. \(^{334} \) The formula used to calculate construct reliability is as follows:\(^{334,335} \):

\[
\text{Construct reliability} = \frac{[\Sigma (\text{std. loadings})]^2}{([\Sigma (\text{std. loadings})]^2 + [\Sigma (1-\text{std. loadings})]^2)}
\]

2.5 Results

2.5.1 Sociodemographic descriptors

Of the 1,352 participants in the survey, 76% were in Grade 9 (n = 1,020), 24% were in Grade 8 (n = 239), and less than 1% were in the higher grades. Thirty one percent of the sample were 13 years of age (n = 420), 67% were 14 years of age (n = 906), and 2% were 15 years of
age (n = 24). Two cases were older than 15 years of age and were excluded from further analysis. Out of 1297 who specified their ethnicity/race, more than one half (52%) of the participants identified themselves as White/Caucasian (n = 674), 35% identified as Asian (n = 454), and 11% identified as Aboriginal (n = 140). Nearly 40% of the participants stated that their mothers or fathers had completed at least an undergraduate degree, a significantly larger proportion than the BC statistic of 12% (according to the 2006 Census). Forty-four percent (n=583) reported being male and 56% reported being female (n=748). In comparison, the BC Ministry of Education also reported more males (52%) compared to females (48%) attending public schools in 2009/2010.

2.5.2 Missing value patterns

Ninety-six percent of the participants (n = 1,299) responded to at least one item of the SURPS. Depending on the subscale or dimension, there were participants from 62 schools with these clusters varying from 1 to 85 participants. The item with the most missing responses (18%) was item 15 (“Generally, I am an impulsive person”), followed by item 18 (“I get scared when I experience unusual body sensations”), with 14% missing a response. The test of difference of proportions was conducted to determine which items had differences in the proportion of missing responses stratified by gender. The results are presented in Table 2.1. The difference in the proportions of girls and boys that did not respond to any of the SURPS items was not statistically significant (p = .08). Comparisons also were conducted to determine whether missing vs. non-missing responses for individual items were associated with gender.
The test of proportions revealed that missing responses for items 1-5, 11-14, 16 and 17 were statistically significantly associated with gender; the boys had larger proportions of missing responses for all these items (Table 2.1). This suggests that a lack of response may have been associated with survey completion (the girls completed more questions than did the boys), rather than an issue with item wording.

**Table 2.1** Percentage of missing values for each item of the SURPS, by gender

<table>
<thead>
<tr>
<th>SURPS Subscale</th>
<th>Total Missing</th>
<th>Missing Male (n=583)</th>
<th>Missing Female (n=748)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Anxiety Sensitivity (AS)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(8) It's frightening to feel dizzy or faint</td>
<td>116</td>
<td>52 (9%)</td>
<td>64 (9%)</td>
</tr>
<tr>
<td>(10) It frightens me when I feel my heart beat change</td>
<td>114</td>
<td>50 (9%)</td>
<td>64 (9%)</td>
</tr>
<tr>
<td>(14)* I get scared when I’m too nervous</td>
<td>85</td>
<td>48 (8%)</td>
<td>37 (5%)</td>
</tr>
<tr>
<td>(18) I get scared when I experience unusual body sensations</td>
<td>199</td>
<td>81 (14%)</td>
<td>118 (16%)</td>
</tr>
<tr>
<td>(21) It scares me when I am unable to focus on a task</td>
<td>104</td>
<td>51 (9%)</td>
<td>53 (7%)</td>
</tr>
<tr>
<td><strong>Hopelessness (H)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1)* I am content (R)</td>
<td>207</td>
<td>110 (19%)</td>
<td>97 (13%)</td>
</tr>
<tr>
<td>(4)* I am happy (R)</td>
<td>68</td>
<td>40 (7%)</td>
<td>28 (4%)</td>
</tr>
<tr>
<td>(7) I have faith that my future holds great promise (R)</td>
<td>100</td>
<td>51 (9%)</td>
<td>49 (7%)</td>
</tr>
<tr>
<td>(13)* I feel proud of my accomplishments (R)</td>
<td>67</td>
<td>40 (7%)</td>
<td>27 (4%)</td>
</tr>
<tr>
<td>(17)* I feel that I’m a failure</td>
<td>87</td>
<td>47 (8%)</td>
<td>40 (5%)</td>
</tr>
<tr>
<td>(20) I feel pleasant (R)</td>
<td>95</td>
<td>46 (8%)</td>
<td>49 (7%)</td>
</tr>
<tr>
<td>(23) I am very enthusiastic about my future (R)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Impulsivity (I)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2)* I often don’t think things through before I speak</td>
<td>74</td>
<td>42 (7%)</td>
<td>32 (4%)</td>
</tr>
<tr>
<td>(5)* I often involve myself in situations that I later regret being involved in</td>
<td>99</td>
<td>56 (10%)</td>
<td>43 (6%)</td>
</tr>
<tr>
<td>(11)* I usually act without stopping to think</td>
<td>92</td>
<td>51 (9%)</td>
<td>41 (6%)</td>
</tr>
<tr>
<td>(15) Generally, I am an impulsive</td>
<td>253</td>
<td>114 (20%)</td>
<td>139 (19%)</td>
</tr>
</tbody>
</table>
person
(22) I feel I have to be manipulative to get what I want

Sensation Seeking (SS)
(3)* I would like to skydive
(6) I enjoy new and exciting experiences even if they are unusual
(9) I like doing things that frighten me a little
(12) I would like to learn how to drive a motorcycle
(16)* I am interested in experience for its own sake, even if it is illegal
(19) I would enjoy hiking long distances in wild and uninhabited territory

<table>
<thead>
<tr>
<th>Item</th>
<th>Male</th>
<th>Female</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>168</td>
<td>79 (14%)</td>
<td>89 (12%)</td>
<td></td>
</tr>
<tr>
<td>76</td>
<td>42 (7%)</td>
<td>34 (5%)</td>
<td></td>
</tr>
<tr>
<td>193</td>
<td>82 (6%)</td>
<td>111 (15%)</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>40 (7%)</td>
<td>40 (5%)</td>
<td></td>
</tr>
<tr>
<td>103</td>
<td>55 (9%)</td>
<td>48 (6%)</td>
<td></td>
</tr>
<tr>
<td>125</td>
<td>69 (12%)</td>
<td>56 (8%)</td>
<td></td>
</tr>
<tr>
<td>86</td>
<td>44 (8%)</td>
<td>42 (6%)</td>
<td></td>
</tr>
</tbody>
</table>

* Differences between male vs. female (p<0.001) (z difference of proportions test)
R is reverse coded

2.5.3 Gender-based measurement invariance of the SURPS

The results of the multi-group CFAs are presented in Table 2.2. The CFI of Steps 1 and 2 suggested moderate to good fit given the criterion of Weston et al. of CFI > .90. Although the $\Delta \chi^2_{(61)} = 145.33$, p-value < .001, this test is influenced by sample size, and small statistically significant differences are likely to occur with sample sizes of over 400, which may not be practically or theoretically informative. The $\Delta$CFI revealed a decrease of .003, well below the cut-off recommended by Cheung and Rensvold, and a minimal change in the RMSEA. Although the mean RMSEA changed, the 90% confidence intervals were shown to overlap, and within the recommended estimate of around or below .06. Furthermore, constraining the models to have equivalent thresholds and factor loadings for boys and girls improved both the CFI and RMSEA. This improvement in fit from Step 1 to Step 2 with a more constrained model could be due to a reduction in the number of parameters that needed to be estimated, which
reduced the penalty score and improved the CFI and RMSEA. Given the minimal changes in CFI and RMSEA between the two models, the SURPS was determined to exhibit *strong measurement invariance* for the boys’ and girls’ responses.

**Table 2.2** Fit indices of gender-based measurement invariance of the SURPS

<table>
<thead>
<tr>
<th>Invariance Model</th>
<th>Model Constraints</th>
<th>Model $\chi^2$ (df)&lt;sup&gt;a&lt;/sup&gt;</th>
<th>CFI</th>
<th>RMSEA (90% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1: Threshold and Loading</td>
<td>Equivalent configuration, error variance set to unity&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1497.95 (448)&lt;sup&gt;v&lt;/sup&gt;</td>
<td>.914</td>
<td>.061 (.057-.064)</td>
</tr>
<tr>
<td>Step 2: Factor and Error Variance</td>
<td>Equivalent thresholds and factor loadings</td>
<td>1521.39 (509)&lt;sup&gt;v&lt;/sup&gt;</td>
<td>.917</td>
<td>.056 (.053-.059)</td>
</tr>
<tr>
<td>Differences in Model Fit</td>
<td>-</td>
<td>145.33 (61)&lt;sup&gt;v&lt;/sup&gt;</td>
<td>.003</td>
<td>.005</td>
</tr>
</tbody>
</table>

<sup>a</sup>Weighted least squares estimator with theta parameterization; degrees of freedom estimated by Mplus 6.12 software (Muthén & Muthén, 2010).

<sup>b</sup>Theta parameterization (Muthén & Muthén, 2010).

<sup>v</sup>p-value < .001.

2.5.4 Confirmatory factor analysis of the SURPS

The results of the ungrouped confirmatory factor analysis (see Tables 2.3 and 2.4) provided support for a four-factor model for the 23-item version of the SURPS. The factor loadings are presented in Table 2.3. According to Comrey and Lee, factor loadings greater than .71 are considered excellent because they explain more than 50% of the variance of an indicator; loadings between .55 and .63 are considered good. The standardized factor loadings and construct reliability indices suggest that compared to *Impulsivity, Hopelessness, Sensation Seeking*, and the items in *Anxiety Sensitivity* do not correlate as strongly. One item in particular, “It’s frightening to feel dizzy or faint”, had a comparatively low loading in the AS dimension.
The CFI of .924 and RMSEA of .061 both suggest good fit (see Table 2.4). Like
the CFI, the RMSEA has a complexity penalty, which is the $\chi^2$ to degrees of freedom ratio, but
tends to be positively biased when sample size and degrees of freedom are relatively small. The coefficient of determination ($R^2$) is also presented in Table 2.2. The general definition of the
coefficient determination is that it is the ratio of explained to unexplained variance of the
outcome, which in this case represents the indicators. The closer $R^2$ is to one, the more the
latent factor explains the variance in each indicator or item.

<table>
<thead>
<tr>
<th>SURPS Subscale</th>
<th>Standardized Factor Loadings</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Anxiety Sensitivity (AS)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cronbach’s $\alpha = 0.72$; Construct reliability = 75%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(8) It’s frightening to feel dizzy or faint</td>
<td>0.440</td>
<td>0.194</td>
</tr>
<tr>
<td>(10) It frightens me when I feel my heart beat change</td>
<td>0.640</td>
<td>0.409</td>
</tr>
<tr>
<td>(14) I get scared when I’m too nervous</td>
<td>0.634</td>
<td>0.402</td>
</tr>
<tr>
<td>(18) I get scared when I experience unusual body sensations</td>
<td>0.706</td>
<td>0.499</td>
</tr>
<tr>
<td>(21) It scares me when I am unable to focus on a task</td>
<td>0.643</td>
<td>0.413</td>
</tr>
<tr>
<td><strong>Hopelessness (H)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cronbach’s $\alpha = .88$; Construct reliability = 95%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) I am content (R)</td>
<td>0.684</td>
<td>0.468</td>
</tr>
<tr>
<td>(4) I am happy (R)</td>
<td>0.835</td>
<td>0.697</td>
</tr>
<tr>
<td>(7) I have faith that my future holds great promise (R)</td>
<td>0.820</td>
<td>0.672</td>
</tr>
<tr>
<td>(13) I feel proud of my accomplishments (R)</td>
<td>0.835</td>
<td>0.697</td>
</tr>
<tr>
<td>(17) I feel that I’m a failure</td>
<td>0.748</td>
<td>0.560</td>
</tr>
<tr>
<td>(20) I feel pleasant (R)</td>
<td>0.815</td>
<td>0.664</td>
</tr>
<tr>
<td>(23) I am very enthusiastic about my future (R)</td>
<td>0.805</td>
<td>0.648</td>
</tr>
<tr>
<td><strong>Impulsivity (I)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cronbach’s $\alpha = .78$; Construct reliability = 90%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Sensation Seeking (SS)
Cronbach’s α = .77; Construct reliability = 88%

(2) I often don’t think things through before I speak 0.700 0.490
(5) I often involve myself in situations that I later regret being involved in 0.751 0.563
(11) I usually act without stopping to think 0.840 0.706
(15) Generally, I am an impulsive person 0.632 0.400
(22) I feel I have to be manipulative to get what I want 0.671 0.450

(3) I would like to skydive 0.591 0.349
(6) I enjoy new and exciting experiences even if they are unusual 0.734 0.539
(9) I like doing things that frighten me a little 0.743 0.552
(12) I would like to learn how to drive a motorcycle 0.637 0.406
(16) I am interested in experience for its own sake, even if it is illegal 0.752 0.565
(19) I would enjoy hiking long distances in wild and uninhabited territory 0.498 0.248

All factor loadings are significant at p < .001.

Table 2.4 Fit indices of the four-factor structure of the SURPS

<table>
<thead>
<tr>
<th>Fit Indexes</th>
<th>Four-Factor Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model $\chi^2$ [df] $^a$</td>
<td>1323.38 (224)$^b$</td>
</tr>
<tr>
<td>p-value</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>CFI</td>
<td>.924</td>
</tr>
<tr>
<td>RMSEA</td>
<td>.061</td>
</tr>
<tr>
<td>(90% CI)</td>
<td>(.058-.065)</td>
</tr>
</tbody>
</table>

$^a$ Weighted least squares estimator with theta parameterization; Df estimated by Mplus 6.12 software (Muthén & Muthén, 2007).

$^b$p-value < .001.

2.5.5 Post hoc CFA analyses

The current CFA analysis revealed relatively large modification indices (i.e., changes in $\chi^2$) for cross-loadings with item 16 on Anxiety Sensitivity, Hopelessness and Impulsivity and item 17 (“I feel that I’m a failure”) on Anxiety Sensitivity, Sensation Seeking and Impulsivity. As
recommended by Muthén, modification indices (MI), rather than expected parameter changes, in the ungrouped CFA output were examined for suggested indicator loadings and correlations. Modification indices for the suggested cross-loadings for items 16 and 17 were over 100 (ranging from 120.7 to 251.6). In comparison other cross-loading and error correlation output for model fit improvement yielded modification indices well below 100. This finding suggests that the presence of these items reduces the discriminant validity of the instrument, or the extent to which separate constructs are unrelated. Cross-loading indication would also violate the independent-clusters or simple structure model of the CFA, which requires that each item load on only one factor.

Post hoc analyses, informed by the modification indices, were conducted by deleting items 16 and 17, which led to a substantial loss in model fit, obtaining fit indices of CFI = .841 and RMSEA = .089 and CFI = .744 and RMSEA = .112, respectively. However, post-hoc analysis is exploratory and not confirmatory by nature. Furthermore, the CFA results in this analysis, which included all 23 items of the SURPS in a four-dimensional structure indicated adequate to good fit (CFI > .90; RMSEA < .60). Analyses by Woicick et al. and by Krank et al. included the addition of error covariances to the model. Marsh suggested that correlating errors should be avoided unless there is a mix of positive and negative items, where it may be expected that negative items would have correlated errors as a result of a method effect (i.e., in the same construct). Although item 17 is negatively worded (“I feel that I’m a failure”), none of the modification indices for correlating items was above 100 and thus no correlated errors were added to the CFA model.
2.6 Discussion

Incorporating sex or gender has become essential when investigating the effect of personality and affect on health behaviour outcomes, with gender often included as a covariate in predictive or causal models. Many studies use psychosocial instruments to capture psychological and mood-related traits and then compare total scores across gender groups. However, few conduct appropriate validity analyses to demonstrate that the instruments employed are not gender biased. More recently, researchers have conducted gender-based measurement invariance assessments of instruments before analysing the potential for gendered effects of various traits on health-related outcomes, using multi-group confirmatory factor analysis. However, a gender-based measurement invariance evaluation of the SURPS has not yet been published. To demonstrate that the SURPS is not psychometrically biased according to gender, this chapter presented an evaluation of gender-based measurement invariance. This chapter also presented findings of an ungrouped CFA of a 4-factor structure using WLSMV. A study correlating the SURPS with substance use in undergraduate students by Woicick et al. obtained similar results with a CFI = .90 and RMSEA of .060, with the 23-item version. Another study with a community sample of BC secondary students by Krank et al. also demonstrated adequate to good fit with a CFI = .92 and RMSEA = .047. However, Krank et al. these fit indices were only demonstrated with a 20-item version demonstrated best fit best fit, that did not include item 16 (“I am interested in experience for its own sake, even if it is illegal”), item 22 (“I feel I have to be manipulative to get what I want”) and item 19 (“I would enjoy hiking long distances in long uninhabited territory”).
Some validation research, including confirmatory factor analysis of the SURPS has been conducted with clinical and community-based samples of youth.\textsuperscript{139,144,22} However, there is currently no published work on the gender-based measurement invariance of the SURPS. The results presented in this analysis demonstrate strong gender-based measurement invariance of the SURPS. Although the $\chi^2$ difference tests revealed significant differences in fit between the constrained models, this test is overly sensitive to small but substantively insignificant changes in model fit with moderately sized samples.

A one-group CFA was tested with all 23 items of the SURPS, which resulted in fit indices indicating adequate to good fit.\textsuperscript{323} As presented in results, additional post hoc analyses were conducted to compare the ungrouped CFA results with those obtained by Krank \textit{et al.}, although they based their work on a 20-item version of the SURPS. The findings of the single group CFA support the use of the SURPS as a measure of four psycho-affective dimensions: Impulsivity, Hopelessness, Sensation Seeking and Anxiety Sensitivity.

2.6.1 Limitations and future analyses

This chapter presented the first known gender-based measurement invariance of the SURPS, using the WLSMV algorithm for categorical indicators, with data from a community sample of adolescents. Although model fit was good, the fit may not have been excellent (i.e. CFI above 0.95)\textsuperscript{323} because of potential problem indicators or the presence of latent classes (i.e., unidentified heterogeneous sample). Future analyses should also include an assessment of measurement invariance of gender in older cohorts (e.g. young adults), and of ethnicity.
Compared to the other SURPS dimensions, AS yielded a lower construct reliability score, and the item “It’s frightening to feel dizzy or faint” yielded the lowest loading. This suggests that more scale development research may be useful for the adolescent population. For example, focus groups with adolescents and subsequent qualitative analysis may further inform scale development researchers what this particular item means to them, using the Talk Aloud Protocol (references). This research may further inform whether the phrasing is relevant for adolescents. Exploratory factor analysis (EFA) could reveal whether dropping this item improves construct reliability of this dimension, and improve overall fit of the 4-factor model of SURPS. EFA could also reveal whether more than one latent factor may be present, based on the items that measure Anxiety Sensitivity. Furthermore, as discussed in Chapter 4, the presence of latent classes (or sub-groups of individuals who yield similar factor parameters within a dimension), may also explain why the CFI of the 4-factor model was not higher.

2.7 Conclusion

This chapter has demonstrated that the SURPS measures the same four constructs in boys and girls and that the psychometric properties of the instrument are the same for boys and girls in a sample of BC secondary students. Establishing measurement invariance in this sample allows for further investigation into substantive differences in boys’ and girls’ Anxiety Sensitivity, Sensation Seeking, Hopelessness and Impulsivity scores. In light of previous research indicating that there are gender differences in tobacco abstinence patterns, including intention to experiment with tobacco, the effect of gender on the association of these personality and affective constructs with tobacco use intention are examined in Chapter 3. Establishing
measurement invariance of the SURPS ensures that the total scores are not gender-biased when studying the interaction effects using grand mean centred total scores of each SURPS construct. This work is an important step towards the on-going validation of the SURPS to ensure that future research examining differences in boys’ and girls’ scores on these constructs is not influenced by gender-based instrument bias.
CHAPTER 3: Examining the relationship between personality and affect-related attributes and adolescents’ intentions to try smoking, using the Substance Use Risk Profile Scale

3.1 Background overview

Western countries have experienced a decline in smoking prevalence due in part to a strong commitment and collaboration between public health practitioners and government to implement effective tobacco control policies. However, despite national declines in smoking among youth in the past two decades, 30% of adolescents try smoking at least once by the time they reach 19 years of age. In 2010, approximately 8% of BC students in Grade 7 had tried smoking a tobacco product, a proportion which more than tripled to 24% of students who had started high school in grade 8. Additionally, close to one third of youth who have never tried smoking a cigarette were identified as being susceptible to smoking in 2010, as defined by having low smoking refusal skills when offered a cigarette by a friend and having an intention to try smoking in the future. As discussed in Chapter 1, researchers have observed a shift in the age of smoking experimentation from pre-adolescence to mid-adolescence. Understanding risk factors for adolescents’ intentions to try smoking appears to represent a timely means of informing school-based tobacco control interventions focused on preventing smoking experimentation.

Intention to smoke has been shown to be the strongest predictor of subsequent smoking behaviour. Most research related to smoking intentions has focused on aspects of the Theory of Planned Behaviour related to subjective attitudes and norms, both individual and as influenced by peers and role models, as well as individual self-efficacy. Although personality-
related traits have been found to be associated with substance use and have been shown to predict predisposition to smoke, their associations with smoking intentions have yet to be examined. The research presented in this chapter addresses this gap in the literature by examining the relationship between personality and affect-related traits and intention to try smoking cigarettes in the future in a sample of non-smoking youth.

The Substance Use Risk Profile Scale (SUPRS) has been used as a tool to guide behavioural intervention research with illicit drug users. In a randomized control study conducted in the United Kingdom, Conrod et al. used the SURPS as a screening tool to identify adolescents with a high propensity to engage in risky behaviour and drug use, and subsequently guide an intervention protocol that included targeted interventions (according to SURPS scores) to improve coping skills. The intervention included psycho-educational, cognitive behavioural and motivational components that addressed each of the SURPS domains (Anxiety Sensitivity, Sensation Seeking, Impulsivity and Sensation Seeking) by linking the domain to specific maladaptive behaviours. The motivational component was patient-centred, guiding the patient to identify and reframe cognitive patterns linked to the SURPS domains and reckless behaviour. The intervention was found to be effective in reducing drug use at the 12-month follow-up. In addition to this work, other researchers have found that individuals who are high in Anxiety Sensitivity can be helped by cognitive-behavioural or motivational interventions that reduce panic and anxiety symptomatology. For example, Assayag et al. investigated the role of anxiety sensitivity (measured by the Anxiety Sensitivity Index) on the efficacy of nicotine-replacement and cognitive-behavioural therapy on smoking outcomes in adult female regular smokers. Their results indicated that persistently high levels of anxiety sensitivity reduced the efficacy of the treatment. The research of Conrod et al and Assayag et al. suggest that the
dimensions of the SURPS can both identify youth at risk of engaging in negative health behaviours and guide subsequent intervention strategies to eliminate existing substance use behaviors. Research examining the extent to which the SURPS could also be used to identify youth at risk of initiating substances such as tobacco smoking represents a potentially useful extension of this field of research. The research presented here is the first to examine whether the constructs measured by the SURPS are associated with an indicator of smoking susceptibility, the intention to try smoking, in adolescents with no previous experience with tobacco use.

The preceding chapters introduced gender as an important factor to consider when investigating the biological, social and psychosocial determinants of smoking. Recent recommendations by the CIHR Institute of Gender and Health note that gender is often included as a covariate in research, but is not routinely interpreted using appropriate biological or psychosocial theoretical frameworks. In the context of this thesis, gender differences in the experience or expression of personality and affective traits may influence the psychometric properties of the instrument measuring these traits. The American Psychological Association recommends that researchers conduct validation studies to ensure that the instruments used to measure temperamental or affective traits are psychometrically equivalent across groups of interest, such as boys and girls. Chapter 2 of this thesis described an investigation of the gender-based measurement invariance of the Substance Use Risk Profile Scale that was carried out to ensure that any differences found in the analyses of SURPS total scores of boys and girls are not due to instrument bias. Demonstrating measurement invariance of the SURPS was a necessary prerequisite to studying the influence of gender on the relationships between each of
the SURPS domains and the intention to try smoking, allowing further examination of how psychological and affective traits may manifest differently in boys and girls.

3.2 Research approach and hypotheses

This chapter explores the relationship between the personality and affect-related characteristics measured by the SURPS and their effects on the risk of having less than well-defined intentions to abstain from tobacco use experimentation. The model building approach that was used was the hypothesis or explanatory model. Unlike a predictive model, an explanatory model building approach does not aim to increase accuracy in explaining variance of the outcome. Rather, a hypothesis or explanatory model aims to evaluate the association of a particular variable or effect of interest. In other words, the models considered in this thesis were focused on assessing whether an association exists between each SURPS dimension and the intention to try smoking.

The four dimensional structure of the SURPS has previously been validated and scores on the SURPS have been incorporated into models that assessed the associations between each SURPS dimension and substance use. Four separate models were tested to investigate whether characteristics related to novelty seeking and risk taking, as measured by Impulsivity (IMP) and Sensation Seeking (SS), and states related to negative affect as measured by Hopelessness (HP) and Anxiety Sensitivity (AS), are associated with having non-definite plans to abstain from smoking. Based on previous research on psychological and affective states and substance use, and more recent work on the SURPS with a community sample of adolescents by
Krank et al. and Woicick et al., it was hypothesized that higher than average scores on *Hopelessness* (HP), *Sensation Seeking* (SS) and *Impulsivity* (IMP) would be associated with a greater risk of expressing non-definite plans to abstain from smoking in the future (**Hypothesis 1, Hypothesis 2 and Hypothesis 3**). *Anxiety Sensitivity* captures aversion to physical arousal and anxious states, which could be caused by nicotine use, particularly among first-time experimenters. However, an association between *Anxiety Sensitivity*, as measured by the SURPS and tobacco use in adolescents has not yet been demonstrated, although the construct itself, as measured by other instruments (e.g., the Anxiety Sensitivity Index) has been shown to be associated with smoking relapse in adult women. These results suggest that the desire to smoke may be related to using tobacco to decrease anxiety-related symptoms of arousal.

Alternatively, weak intention to smoke may be related to an adolescent’s knowledge of the physical side effects of nicotine indigestion, such as increased heart beat or shortness of breath, experienced when nicotine is directly ingested – an idea they could have learned through media or people they know who smoke. Although these possible mechanisms suggest that AS could either protect against or increase the risk of trying smoking, it is not expected that *Anxiety Sensitivity* would significantly explain the intention to smoke in the average non-smoking adolescent from a community sample. Thus, it is hypothesized that in this sample of adolescents, *Anxiety Sensitivity* will not be associated with the intention to abstain from smoking in the future (**Hypothesis 4**).

As described in Chapter 1, the research literature indicates that smoking behaviours vary by gender in adolescents and that the effect of psychological and affective states on tobacco use also appear to vary by gender. For example, the literature related to negative affect and tobacco has shown that girls with higher levels of internalizing psychological states, such as depression,
are more likely to endorse experimenting with tobacco and report using it as part of a coping mechanism.\textsuperscript{42,131,249,254,352,353} It is therefore hypothesized that the association between Hopelessness and having non-definite intentions to try smoking is stronger for girls than it is for boys (Hypothesis 1a).

The developmental and health behaviour research reviewed in Chapter 1 also suggests that boys, compared with girls, are more likely to engage in risk-taking behaviour, including experimentation with illicit and other substances.\textsuperscript{54,139,151,354,355} However, as discussed in Chapter 1, although boys may have higher levels of sensation seeking compared with girls, the literature concerning gender and psychosocial factors suggests that girls who smoke may be more likely to exhibit some characteristics of sensation seeking and risk taking.\textsuperscript{151} It was therefore expected that being female would increase the strength of the association between Sensation Seeking and having non-definite intentions to try smoking (Hypothesis 2a). That is, a girl with the same level of Sensation Seeking as a boy, and with comparable sociodemographic characteristics, was expected to have stronger intentions to try smoking. Conversely, a recent meta-analysis of gender and novelty seeking revealed that aspects of Impulsivity that relate to cognitive traits such as executive functioning do not vary significantly by gender, while motivational aspects, such as punishment sensitivity, are more likely to be greater in girls.\textsuperscript{151} Five of the seven items of the Impulsivity dimension were derived from the Impulsiveness and Venturesomeness Scales\textsuperscript{33,147}, and are related to self-identified impulsive tendencies, while only one item of the Impulsiveness subscale appears to specifically relate to punishment sensitivity (e.g. “I often involve myself in situations that I later regret being involved in”). The majority of the items of the Impulsivity dimension of the SURPS appear to capture aspects of “hard-wired” novelty-seeking traits, which the literature suggests do not exhibit robust gender differences.\textsuperscript{151}
It was therefore hypothesized that gender differences in the relationship between Impulsivity and intention to try smoking would not be significant (Hypothesis 3a).

3.3 Methods

3.3.1 Study sample and design

The cross-sectional sample used in this analysis was introduced in Chapter 2. The sample used in this analysis was the same as that described in Chapter 2. It consisted of 1,352 Grade 8 and 9 students attending a BC secondary school, and who were enrolled in the fall 2010 wave of the BASUS survey (September to December 2010). Only participants who indicated they had never tried a cigarette product were included in this analysis. More specifically, the non-smokers were defined as having not selected the response, “Yes” for the question, “Have you ever tried the following, even a puff or two: Cigarettes from a pack, roll-your-own cigarettes?” The participants were clustered within 62 schools, which were treated as independent clusters in the statistical analyses.

3.3.2 Outcome variable

The participants who indicated that they had never tried even a puff of a cigarette (from a pack or a roll-your-own) were subsequently asked, “Do you think you might try smoking in the future?” The response options were on a 4-point Likert-type scale: “Definitely Yes,” “Probably Yes”, “Probably Not” or “Definitely Not.” Because most of the participants answered
“Definitely Not,” and none of the participants answered “Definitely Yes,” the categories were collapsed into “Definitely Not” and “Not Definitely Not” (i.e., Definitely Yes, Probably Yes and Probably Not) to prevent empty cells from arising in the analysis. “Definitely Not” was coded as the reference category.

From herein, those participants that indicated that they would *Definitely Not* try smoking in the future are referred to as having no intention to try smoking, and those that indicated otherwise (*Probably Not, Probably Yes or Definitely Yes*) is referred to as having an intention to try smoking in the future. Further support for this dichotomization is found in research by Byrne *et al.* who theorized that youths who have other than well-defined plans to abstain from tobacco use are at higher risk of future smoking. This hypothesis was supported by Mazanov and Byrne’s work, which indicated that 91% of youth with no previous smoking experience and a definite intention (vs. non-definite intention) to abstain at baseline were smoke-free 12 months later. Moreover, they reported that in both the smoker and non-smoker groups at baseline, non-well defined plans to abstain from smoking were less predictive of subsequent behaviour. This finding complements other research findings that suggest that strongly defined intentions are more temporally stable than those less defined. Other researchers have also presented similar theoretical perspectives in their studies of the intention to try smoking.
3.3.3 Explanatory variables

3.3.3.1 Sociodemographic variables

Gender, parental education and ethnicity were considered for inclusion as covariates in this analysis. The participants were asked to identify the highest education obtained by their mother and (or) father, with 7 levels ranging from “Some Elementary School” to “Post-graduate/professional school (PhD, MD, and Law)”. To avoid empty cell counts in the models, the categories were collapsed as follows: Some High School (reference category), Completed High School, Some Post-Secondary School, Completed Undergraduate Degree, and Completed Post-Graduate Degree. To capture the ethno-racial profile of this sample, the participants were provided with a check-list of ethnic and racial descriptors. Final categories were collapsed into four non-overlapping categories: Aboriginal, Asian (including Chinese, Japanese, Korean, Filipino, South East Asian, South Asian, and West Asian), other (Latin American, Black, and Other) and White/Caucasian (reference). The data was collapsed to increase the sample sizes of the ethno-racial minorities and decrease likelihood of empty cells. For further information about the coding of sociodemographic characteristics, refer to Chapter 2.

3.3.3.2 The Substance Use Risk Profile Scale (SURPS)

The SURPS contains 23 items that measure four dimensions: Anxiety Sensitivity (5 items), Hopelessness (7 items), Sensation Seeking (6 items), and Impulsivity (5 items). Responses to each item were provided on a 4-point Likert-type scale: 1 (“strongly disagree”) to 4
(“strongly agree”). Six of the seven items in the Hopelessness dimension were reverse coded. Because total scores of zero are not theoretically interpretable, each dimension’s score was mean centred. The exponent of the logistic regression coefficient for each SURPS dimension was thus interpreted as the risk of the outcome occurring (having an intention to try smoking in the future) based on having a score one point greater than the gender-specific mean score.

3.3.4 Effect modification (gender with SURPS dimensions)

Initiatives by research funding agencies, such as the CIHR Institute of Gender and Health, have recommended that theoretical and methodological consideration of gendered effects be undertaken when investigating psychosocial and health outcomes. The Gender, Sex and Health Research Guide recommends including gender in one’s analytical methods, and interpreting one’s findings using biological and socio-cultural lenses. The analytical approach to investigating possible gender effects in this study was to test for effect modification by male/female status of the relationship between each of the SURPS dimensions and smoking intention.

3.4 Analysis

3.4.1 Missing values and multiple imputation

Recent trends in social science research include the use of data substitution methods over list-wise or pair-wise deletion to avoid the potential for bias in parameter estimates. List-wise or
pair-wise deletion can significantly reduce the effective sample size, which not only decreases statistical power but also inflates the standard errors. Deleting cases with missing responses can also bias the estimation of effect sizes because participants with high response rates may differ from those who do not respond or selectively respond to survey questions. Multiple Imputation (MI) has become a recommended method for dealing with missing covariate or outcome data. It is a method that creates multiple regression parameters from a set of theoretically feasible covariates to predict a distribution of possible values for the missing outcome variable of interest. With continuous data, MI can be executed using expectation maximization or Monte Carlo multiple chain methods, which can produce negative and non-integer values. Naive rounding of these non-integer values (e.g., rounding an estimated response of 4.4 to 4.0) can bias the results derived from the imputed data. To avoid this potential bias, logistic regression was used to impute ordinal-level missing data; this method yields positive integers only and the imputed solutions do not need to be rounded.

The MI process assumes that the data are derived from a multivariate normal distribution and that the missing data are missing at random (MAR). The MAR assumption is that the probability that an observation is missing is dependent on the distribution of the observed variables from which the imputation is based. According to Graham and Hofer, missing data are best predicted from both observed and non-observed information. Observed information refers to the data collected from the participant, and the unobserved information is that data that have not been collected from the participant. Even if not all of the missing data are modelled using the observed data, accounting for some of the "missingness" in the imputation models usually leads to acceptable results.
It is recommended that at least five imputations be completed to obtain an optimal estimate (or average) of the parameter estimates, within and between parameter variances, and an average of the measurement error that equals zero. Because missing values inflate variance, the greater the number of imputations made, the greater the “variance restoration efficiency” obtained. Further, the more missing data that are present, the greater the number of imputations needed. It has been found that five imputations are sufficient to yield 98% of restorative efficiency. Each imputation involves 10 iterative processes until the model converges.

For this analysis, 10 imputations were chosen in conjunction with a conservative data filtering approach of only keeping cases with a maximum of 15% missing data, which in this case is the maximum of one item missing per SURPS dimension. The imputations were generated using the Missing Values program of IBM PASW® 19.0. A simulation study by Barzi et al. found that imputed data with more than 10% missing yielded less consistent results. Cases also were deleted if they had question-specific completion times of fewer than two seconds per item, even if they had completed all 23 items. The two-second-per-item cut-off was based on the distribution of the completion times of all the participants, as well as recommendations regarding the minimum amount of time required to read and answer questions offered by two naive survey takers.
3.4.2 Comparing the total score means of the SURPS dimensions by gender

Using IBM PASW® 19, total score means (non-centred) of the SURPS dimensions of the five imputed datasets were compared by male/female status with an independent samples t-test. The results were subsequently pooled. When the Levene’s test of equal variance failed (an assumption of the parametric $t$-test), a pooled difference of means with and without the equality of variance assumption was calculated. The gender-specific means and standard deviations were also tabulated.

3.4.3 General estimating equations

The four empirical models of the SURPS were analysed with general estimating equations (GEEs), which belong to a family of generalised linear approximation models. General estimating equations can be used to yield parameter estimates with standard errors that have been adjusted for the effect of clustering or for the non-randomness of responses provided by students attending the same school. To specify the working correlation matrix to increase the likelihood of correct model specification, the structure of the data must be considered. The PA-GEE model assumes that the observations/students within a cluster/school are correlated, and that the clusters are independent from one another.\textsuperscript{330(p59)} This is why a working correlation matrix of observations within each cluster must be specified.\textsuperscript{330(p60)} A robust, sandwich covariance estimator accounts for correlations in observations when estimating the standard errors of the parameters, even when the proposed covariance model of the data is not correctly
specified. The analysis was conducted using PASW 19.0 IBM® (see Appendix C syntax codes).

All of the results are reported as relative risk ratios, which indicate how a 1-point change from average, on each SURPS dimension, increases the likelihood of having an intention to try smoking in the future. To estimate the relative risks, a modified Poisson distribution was specified for all of the GEE models, as proposed by Lee and Chia. A robust error covariance estimator was also used because Poisson regressions tend to overestimate the standard errors in models with binary outcomes. To test for potential confounding by sociodemographic factors (e.g., grade, parental education, and ethnicity), univariate logistic models predicting intention to smoke were specified for each of the potential socio-demographic factors. The final models included those covariates that could potentially confound the effects of the SURPS constructs on the intention to smoke and tested the interaction effects of each SURPS construct and gender.

3.4.3.1 Univariate analysis of intention to try smoking

A confounder is defined as a variable that can bias the measure of association between a main predictor variable of interest and an outcome. To be a confounder, a variable must: (a) be associated with the main predictor, (b) predict the outcome, and (c) not be on the causal pathway associated with the predicted main effect. The sociodemographic covariates considered in the final modelling process were theoretically justified based on their inclusion in psychosocial and health behaviour research of adolescents. The results of the univariate analyses were used to inform the inclusion of the sociodemographic covariates in the final hypothesis-testing models.
A conservative approach of choosing parameter estimates with at least a $p$-value of .25 in the univariate models was used to determine whether the covariate was included in the final model. This was done to increase the precision of the hypothesis-testing models by including covariates that are theoretically important and which would create relatively less biased estimates of the main effects. Gender was retained in all the models because it was used to evaluate the study hypotheses related to effect modification.

3.4.3.2 Hypothesis-testing models

Four separate models were evaluated to test the associations between each SURPS dimension and the intention to try smoking in the future (i.e., one model was used for each dimension of the SURPS). The socio-demographic variables were included in the models if they demonstrated a significant univariate relationship with the intention to try smoking in the future and because of their theoretical importance when studying the effects of psychological and affective traits on smoking-related outcomes. To determine if the relationship between each SURPS construct and having an intention to try smoking in the future varied by gender, an interaction term was initially included in each regression equation – the interaction was removed and the model re-run if the interaction term was not significant at a $p$-value of $\leq .05$. If an interaction between gender and any of the SURPS dimensions was found to be significant, relative risks were calculated with the interaction and main effect terms. Stratified results are presented to compare the effects of each SURPS dimension for both boys and girls. The $p$-values of the covariates in the final models were adjusted using the Bonferroni correction.
for multiple comparisons. Since the four models were run for one outcome, a conservative cut-off for Type 1 error of .01 was applied.

3.5 Results

3.5.1 Sample demographics and univariate analysis results

Sociodemographic descriptive findings were first presented in Chapter 2. A total of 1,231 participants (91.8%) reported never having tried a cigarette from a pack or a roll-your-own. Out of 1192 participants who responded to the question “Do you think you might try smoking in the future”, 71% (n=854) had no intention of trying smoking in the future. Conversely, 29% (n=338) had some intention to smoke (probably yes or probably not). Within the some intention group, 5% responded “Probably Yes’ (n=59), and 23% (n=273) responded “Probably Not”. None of the participants stated that they would definitely try smoking in the future. These findings differ from those of the Youth Smoking Survey, wherein 80% of youth reported having never tried smoking and 72% of those who had never tried smoking indicated having well-defined intentions to abstain from smoking in the future.14

Table 3.1 shows the frequency distribution of the socio-demographic characteristics of the total sample and for those with no intention to try smoking in the future. Unadjusted relative risk ratios for each variable with the intention to smoke are also presented in Table 3.1. Statistically significant relative risk ratios above 1.0 indicate an increased likelihood of having some intention of trying smoking in the future. For example, Asian ethnicity was associated
with being 21% less likely having some intention to try tobacco in the future, compared with White/Caucasian students (unadjusted relative risk (URR) = 0.79; 95% confidence interval (CI): 0.53, 0.97) (see Table 3.1). Ethnicity and gender were not found to interact in any of the four models of covariates.

Table 3.1 Socio-demographic characteristics (by total sample and by intention to try smoking) and unadjusted relative risk ratios

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total Sample (N = 1352)</th>
<th>Intention to Try Smoking (n= 1192)</th>
<th>URR (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Definitely Not (N = 854)</td>
<td>Some² Intention (N = 338)</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>583 (44%)</td>
<td>357 (42%)</td>
<td>181 (54%)</td>
<td>Referent</td>
</tr>
<tr>
<td>Female</td>
<td>748 (56%)</td>
<td>489 (58%)</td>
<td>154 (46%)</td>
<td>0.93 [0.79,1.10]</td>
</tr>
<tr>
<td>Total</td>
<td>1331</td>
<td>846</td>
<td>335</td>
<td></td>
</tr>
<tr>
<td>Grade</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 9</td>
<td>329 (24%)</td>
<td>641 (75%)</td>
<td>253 (75%)</td>
<td>1.10 [0.82,1.54]</td>
</tr>
<tr>
<td>Grade 8</td>
<td>1020 (76%)</td>
<td>213 (25%)</td>
<td>83 (25%)</td>
<td>Referent</td>
</tr>
<tr>
<td>Total</td>
<td>1349</td>
<td>854</td>
<td>336</td>
<td></td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aboriginal</td>
<td>140 (11%)</td>
<td>67 (8%)</td>
<td>38 (12%)</td>
<td>1.23 [0.86,2.05]</td>
</tr>
<tr>
<td>Asian</td>
<td>454 (35%)</td>
<td>324 (39%)</td>
<td>101 (31%)</td>
<td>0.79 [0.53,0.97]*</td>
</tr>
<tr>
<td>Other</td>
<td>43 (3%)</td>
<td>27 (3%)</td>
<td>10 (3%)</td>
<td>1.23 [0.86,2.05]</td>
</tr>
<tr>
<td>White/Caucasian</td>
<td>674 (51%)</td>
<td>417 (50%)</td>
<td>181 (54%)</td>
<td>Referent</td>
</tr>
<tr>
<td>Total</td>
<td>1311</td>
<td>835</td>
<td>330</td>
<td></td>
</tr>
<tr>
<td>Maternal Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undergraduate degree or higher</td>
<td>380 (40%)</td>
<td>250 (41%)</td>
<td>98 (29%)</td>
<td>0.86 [0.46,1.30]</td>
</tr>
<tr>
<td>Some post-secondary</td>
<td>269 (28%)</td>
<td>177 (29%)</td>
<td>59 (18%)</td>
<td>0.77 [0.38,1.14]</td>
</tr>
<tr>
<td>Completed high school</td>
<td>217 (23%)</td>
<td>138 (22%)</td>
<td>57 (17%)</td>
<td>0.90 [0.46,1.42]</td>
</tr>
<tr>
<td>Less than completed high school</td>
<td>94 (10%)</td>
<td>51 (8%)</td>
<td>26 (8%)</td>
<td>Referent</td>
</tr>
<tr>
<td>Total</td>
<td>960</td>
<td>616</td>
<td>240</td>
<td></td>
</tr>
<tr>
<td>Paternal Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undergraduate degree or higher</td>
<td>370 (40%)</td>
<td>259 (31%)</td>
<td>88 (26%)</td>
<td>0.85 [0.47,1.32]</td>
</tr>
<tr>
<td>Some post-secondary</td>
<td>272 (29%)</td>
<td>166 (20%)</td>
<td>77 (23%)</td>
<td>1.03 [0.63,1.83]</td>
</tr>
<tr>
<td>Completed high school</td>
<td>188 (20%)</td>
<td>113 (16%)</td>
<td>45 (13%)</td>
<td>0.92 [0.52,1.64]</td>
</tr>
<tr>
<td>Less than completed</td>
<td>97 (11%)</td>
<td>60 (7%)</td>
<td>26 (8%)</td>
<td>Referent</td>
</tr>
<tr>
<td>Characteristic</td>
<td>Total Sample ¹</td>
<td>Intention to Try Smoking (n= 1192)</td>
<td>URR (95% CI)</td>
<td>p-value</td>
</tr>
<tr>
<td>----------------</td>
<td>----------------</td>
<td>------------------------------------</td>
<td>--------------</td>
<td>---------</td>
</tr>
<tr>
<td>high school</td>
<td>(N = 1352)</td>
<td>Definitely Not (N = 854)</td>
<td>Some²</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Some Intention (N = 338)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>927</td>
<td>598</td>
<td>236</td>
<td></td>
</tr>
</tbody>
</table>

¹ The subtotals do not add to 1352 because there are missing responses for gender, grade, ethnicity, maternal and paternal education
² Respondents who responded “Probably Yes” or “Probably Not” were coded as having some intention of trying smoking.
³ Includes Chinese, Japanese, Korean, Filipino, South East Asian, South Asian, and West Asian youth.
⁴ Includes Latin American, Black, and Other youth; *p < .05.

### 3.5.2 Substance Use Risk Profile Scale

#### 3.5.2.1 Missing value patterns of the SURPS and covariates

Missing values were examined for the items associated with each dimension of the SURPS. Overall, 14% (n = 190) of the cases were deleted before the multiple imputation was conducted because they had more than one item missing in a dimension; this includes 55 cases that did not complete any of the SURPS items. Three cases were removed because of very brief completion times (less than 2 seconds per item). Fifty-two cases had missing information on ethnicity and 57 cases did not provide their gender.

#### 3.5.2.2 Mean scores of SURPS dimensions by gender

The means and standard deviations of Anxiety Sensitivity, Hopelessness, Impulsivity and Sensation Seeking are presented in Table 3.2. An independent samples t-test was conducted to
compare the mean scores of the boys and girls, using a Bonferroni corrected type I error cut-off for p-values of .01. The girls had significantly higher scores on Anxiety Sensitivity, with a mean score that was 1.33 points higher than the boys’ mean. The boys had significantly higher scores on Sensation Seeking, yielding a mean score that was 1.66 points higher than the girls’ mean.

Table 3.2 Means and standard deviations of the SURPS dimensions by gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>Anxiety Sensitivity$^\dagger$</th>
<th>Hopelessness</th>
<th>Impulsivity</th>
<th>Sensation Seeking$^\dagger$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>11.03 (2.76)</td>
<td>11.75 (3.44)</td>
<td>11.28 (2.88)</td>
<td>15.93 (3.64)</td>
</tr>
<tr>
<td>Female</td>
<td>12.37 (2.73)</td>
<td>12.12 (3.63)</td>
<td>10.99 (3.04)</td>
<td>14.26 (3.96)</td>
</tr>
<tr>
<td>Combined</td>
<td>11.76 (2.84)</td>
<td>12.03 (3.57)</td>
<td>11.13 (2.97)</td>
<td>14.97 (3.92)</td>
</tr>
</tbody>
</table>

$^\dagger$ A pooled mean from all imputed datasets is provided by PASW 19.0 and the SD was obtained by averaging all of the datasets (10 imputed and original).

3.5.2.3 Adjusted relative risk of intention to try smoking

The results presented in Table 3.3 indicate that Hopelessness, Impulsivity and Sensation Seeking were found to be associated with the intention to try smoking in the future in this cohort of adolescents after adjusting for ethnicity and gender. Anxiety Sensitivity was not found to be significantly associated with the intention to try smoking, in this sample. Impulsivity, for example, demonstrated a 14% increase in the likelihood of having an intention to try smoking in the future, given a one-point increase from the mean score. Given that the standard deviation of Impulsivity is 2.97 (Table 3.2), having a score one standard deviation above average would result in a 43% increase in risk of having some intention to try smoking. A one point increase in Sensation Seeking yields a 9% increased risk in having intention to try smoking; scoring one standard deviation of 3.92 above the mean would increase risk of having some intention to try smoking by 41%. Scoring 1 point above Hopelessness increases risk of intention by 7%, or by
27%, for a score 1 standard deviation above the mean. No effect of gender was observed. Ethnicity was associated with the intention to try smoking with a protective effect found for participants self-identifying as Asian (observed in two of the four models).

<table>
<thead>
<tr>
<th>SURPS dimension</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anxiety Sensitivity</td>
<td>1.01[0.98,1.04]</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Hopelessness</td>
<td>--</td>
<td>1.07[1.04,1.11] ***</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Impulsivity</td>
<td>--</td>
<td>--</td>
<td>1.13[1.10,1.15] ***</td>
<td>--</td>
</tr>
<tr>
<td>Sensation Seeking</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>1.09[1.06,1.12] ***</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>0.93[0.76,1.13]</td>
<td>0.93[0.77,1.12]</td>
<td>0.98[0.81,1.17]</td>
<td>1.07[0.88,1.30]</td>
</tr>
<tr>
<td>Male</td>
<td>Referent</td>
<td>Referent</td>
<td>Referent</td>
<td>Referent</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>0.87[0.42,1.81]</td>
<td>0.82[0.40,1.64]</td>
<td>0.83[0.42,1.65]</td>
<td>0.86[0.42,1.77]</td>
</tr>
<tr>
<td>Asian</td>
<td>0.81[0.66,1.00]</td>
<td>0.76[0.62,0.93] **</td>
<td>0.81[0.66,0.98] *</td>
<td>0.93[0.77,1.34]</td>
</tr>
<tr>
<td>Aboriginal</td>
<td>1.26[0.87,1.82]</td>
<td>1.15[0.81,1.65]</td>
<td>1.17[0.79,1.72]</td>
<td>1.23[0.84,1.79]</td>
</tr>
<tr>
<td>White</td>
<td>Referent</td>
<td>Referent</td>
<td>Referent</td>
<td>Referent</td>
</tr>
</tbody>
</table>

**p < .001; **p < .01; *p < .05
ARR, adjusted relative risk; CI, confidence interval.

Each model includes only one SURPS dimension, with total scores grand mean centred. The adjusted relative risk (ARR) in each model represents the percent increase in risk increase of intending to try cigarettes, for a one point increase in the score from the mean, adjusted for ethnicity and gender.

3.5.3.3 Post hoc assumption testing

The assumptions of the models were evaluated, including the linear approximations of the four hypothesis-testing models and the adjustment for clustering by schools, using the general estimating equation. The guidelines were based on the recommendations of Field 370, for logistic regression assumption testing and of Hardin and Hilbe 371, for generalised estimating
equations. This section presents both the tests conducted and the findings. Relevant plots are provided in Appendix C for reference. All of the assumption tests were conducted using IBM® PASW® 19.0.

The first assumption addressed (without a statistical test) is that the values of the outcome variable were independent. Homoscedasticity or homogeneity of variance of the residuals across levels of predictors was demonstrated using Levene’s test with both non-transformed and transformed data (natural log) and with Q-Q plots. The Shapiro-Wilk and Kolmogorov-Smirnov tests were conducted to determine whether the samples in each level deviated from normality; however, this test is likely to be significant with a p-value of less than 0.01, given the relatively large sample size, so even small deviations may not be substantively significant. Tests for multi-collinearity among the predictors and independence of errors were conducted using the linear regression module because they cannot be conducted with logistic regression. Multi-collinearity was not demonstrated; although the pooled variance inflation factor (VIF) and tolerance values were not obtained. All of the imputation datasets had VIF and tolerance values that were below 2 (a VIF of less than 10 is considered sufficient). Independence of the errors was successfully demonstrated with the Durbin-Watson test, with coefficients less than 2 considered sufficient. The linearity of the logit was demonstrated by including, in every model, the interaction term of the relevant SURPS dimension with its natural log (e.g., Anxiety Sensitivity * ln(Anxiety Sensitivity)) and determining whether it was statistically significant. None of the models demonstrated significant interaction terms, which confirmed the linearity of the logits.
Once the models were estimated, further testing was completed by examining the Pearson residuals for the predicted values. The standardized (Pearson) residuals were normally distributed, with no cases larger than the 97.5\textsuperscript{th} percentile or smaller than the 2.5\textsuperscript{th} percentile, assuming a Chi-square distribution. Influential cases on the parameter of interest (the SURPS dimension) and on the outcome (the intention to try smoking) were examined with DFBETA’s and Cook’s distance, respectively. The range of DFBETA’s were well below the recommended cut-off of 1.0 \textsuperscript{370(pp217–219),371(p158)}, with no absolute values passing 0.01. None of the models had Cook’s distance exceeding a value of 1.0. \textsuperscript{370(pp217–219)} The predicted values of mean response for each SURPS dimension across the Pearson residuals were also plotted to determine whether there was heterogeneity of variance and linear approximation (see Appendix D). The plots suggested that there was heterogeneity of variance; a “funnelling” effect was observed as the predicted value dropped, in all models, which could have occurred because the reference category actually consisted of three smoking intention levels (i.e., “Probably Not,” “Probably Yes,” and “Definitely Yes”). The risks of these three levels of intention could be different.

The randomness of the residuals across the schools was also tested, using the Wald-Wolfowitz run test for the non-imputed dataset (because the data had to be sorted by school and not imputation). \textsuperscript{371(p149)} The null hypothesis is that the residuals are random across subjects. The test values used were mean and median residuals. The median residuals were not randomly distributed among the schools for Sensation Seeking and Anxiety Sensitivity. This may have occurred because the number of cases per school was unbalanced, yielding different medians (i.e., some schools had only a single participant); however, why this affected the models for Sensation Seeking and Anxiety Sensitivity, specifically, and not the other models, is not known. Randomness of the mean residuals was demonstrated in all four models. School-specific
Pearson residual plots versus mean predicted value plots were visually inspected for evidence of a linear relationship (see Appendix D). Schools with similar cluster sizes were selected; they indicated approximately the same positive and negative Pearson residuals for each SURPS dimension for most schools. 371

3.6 Discussion

In this chapter, four hypothesis models were examined to determine whether there was an association between each SURPS dimension and intention to try smoking in the future, controlling for possible confounders. The interaction of gender with the SURPS dimensions was also tested for significance in each of these models. The findings suggest that there is an association between the personality and affective states measured by the SURPS and intention to try smoking in a community sample of adolescents. Consistent with the hypotheses presented earlier, Impulsivity, Sensation Seeking, and Hopelessness were shown to be associated with a higher risk of intending to try smoking in the future. Although there is very little published literature on smoking intentions and personality to date, a study by Byrne et al., found that the Neuroticism characteristic of the Big Five, most similar to the Impulsivity dimension of the SURPS, positively associated with the intention to commence smoking. 38 Conner et al. found that Extraversion (Big Five) (related to Sensation Seeking) positively interacted with intention to smoke and subsequent smoking. Finally, a more recent study by Nezami et al., found a positive relationship between depressive symptoms (similar to the Hopelessness dimension) and intention to try smoking. 124

Anxiety Sensitivity was not associated with intention to try smoking; a finding that is consistent with the hypothesis that having fear of physical arousal is not likely to influence the
risk of intending to smoke with adolescents naive to the physiological effects of cigarette smoking. Furthermore, as introduced in Chapter 2 and elaborated on in Chapter 4, there may be a latent sub-group or class that would be more associated with smoking related outcomes, as well as intention to smoke. For example, a higher-risk group with a maladaptive form of sensitivity to feelings of anxiety may be more prone to decreasing these feelings through tobacco use, as was demonstrated in a sample of adult women who have already become smokers (citation). It is unclear whether this maladaptive form of Anxiety Sensitivity will affect intention to try smoking in a sample of adolescents who have not had a personal experience with cigarette use. Further investigation into the role of Anxiety Sensitivity on smoking intention may further be examined with a sub-group of adolescents according to positive or negative tobacco expectancies. The role of Anxiety Sensitivity on intention should also be examined longitudinally, as smoking expectancies continue to evolve.

The relationships found between the SURPS and smoking intentions complement a recent analysis of Krank et al, who examined the Substance Use Risk Profile Scale and substance use outcomes in a comparable cohort of adolescents. They demonstrated that all dimensions of the SURPS except for Anxiety Sensitivity contributed to significant increases in the odds of endorsing tobacco use, after adjusting for grade and gender. Other investigators recently administered a Dutch version of the SURPS to adolescents between 11 and 15 years of age in Holland. Using structural equation modelling, they found that Sensation Seeking and Hopelessness were linked to lifetime use of tobacco. The current research adds to the research of Krank et al. on the SURPS by examining how these traits relate to adolescents’ intentions to try smoking, a marker of smoking susceptibility.
Contrary to the hypotheses presented in this chapter, gender did not significantly modify the relationships between the SURPS dimensions and the intention to abstain from trying smoking. One explanation for this finding is that gender was not shown to predict the adolescents’ intentions to try smoking, and did not influence the extent to which the SURPS dimensions were related to intention to try smoking. The lack of a significant relationship between intention to try smoking and gender is consistent with recent reports demonstrating nearly equal rates of smoking experimentation for boys and girls at this stage of adolescence. Another potential explanation concerns the way that gender was measured. In chapter 1, the complexity of gender identity and its influence on psychosocial and developmental outcomes were discussed. Identifying gender identity with a specific sex, a dichotomous descriptor for being male or female cannot capture the nuances and influences of identifying with non-hegemonic masculine and feminine traits, which might influence adolescents’ intentions to try smoking. A more comprehensive measure of masculine and feminine characteristics could be used in future research, using a measure such as the Personal Attributes Questionnaire, which has been validated for use with both adolescents and young adults.

In Chapter 2, a measurement invariance of the SURPS based on male/female status was conducted to determine if the SURPS instrument can yield unbiased total scores. Although not part of the central hypotheses presented in this chapter, comparisons of mean score by gender were also examined. Mean scores in Anxiety Sensitivity and Sensation Seeking were both found to differ by gender. Girls, compared with boys, had significantly higher means in their Anxiety Sensitivity scores, which is consistent with the developmental psychology literature that suggests that some psychosomatic and anxiety-related traits, similar to those captured by the Anxiety Sensitivity, tend to manifest more in girls than in boys. Anxiety Sensitivity was
demonstrated to be measurement invariant across gender in the previous chapter, which implies that an adolescent male and female with the same level of Anxiety Sensitivity will have the same item response patterns and total score for this domain, on average. Differences in the total scores of boys and girls therefore indicate that adolescent boys, on average, are less averse to feeling anxiety-related physical arousal. The boys, compared with the girls, had higher mean scores in Sensation Seeking, which is also consistent with both the sociological and developmental biology literature related to boys’ risk taking.\textsuperscript{151} Being male has been shown to correlate with behavioural risk taking due to both socially-endorsed and context-mediated “masculine” behaviour\textsuperscript{207,223,374}, and a more reactive dopaminergic system that is sensitive to testosterone levels.\textsuperscript{375} Although mean score comparisons were not presented in the study by Krank \textit{et al.}, Woicick \textit{et al.’}s study of young adults showed that only men’s mean score in Impulsivity was greater than women’s.\textsuperscript{22} Impulsivity was not shown to vary by gender in the current sample of adolescents, which is consistent with Cross’s\textsuperscript{151} recent literature review on impulsivity and gender. Further research is warranted to investigate how sensation seeking and impulsivity evolve and whether gender differences in impulsivity emerge in later stages of adolescence.

Associations between sociodemographic factors and intention to try smoking were also examined. Maternal, paternal education and gender were not associated with smoking intention. Students who identified themselves as Asian were less likely to state that they had an intention to try smoking, compared with adolescents that identified themselves as being only “White/Caucasian”. The protective effects of identifying as Asian on substance use were supported by other ethnographic and population-level research undertaken in American and Canadian contexts. The protective effect of being Asian was also reported in studies conducted in BC, including the studies conducted by Sawatzky \textit{et al.}\textsuperscript{376} and more recently by Duff \textit{et al.}\textsuperscript{16}
Parental monitoring, high values on scholastic achievement, and maintaining family honour have been implicated as potential drivers of the relatively lower likelihood of Asian adolescents experimenting with substances. Additionally, being born outside of Canada, speaking a language other than English at home, and religion has been shown to provide protective effects. It may be valuable to explore the mechanisms that drive this protective effect on the intention to try smoking, as well as its interaction with personality and affective traits as measured by the SURPS. Before interaction effects are studied, however, it would be important to establish the measurement invariance of the English version of the SURPS across ethno-racial cultures.

3.6.1 Limitations

As with any cross-sectional study design, causal inferences cannot be made between personality and affective characteristics captured by the Substance Use Risk Profile Scale and the intention to try smoking. Furthermore, research indicates that scores on some domains of the SURPS such as Sensation Seeking and Impulsivity may change during adolescence. Research is needed to examine how developmental changes in psychological functioning relate to changes in adolescents’ intentions to try smoking. Some researchers have suggested that intention is a state that is expected to shift during adolescence. Because of the time-variant nature of these individual traits and intentions, it is important that researchers examine the possibility that the direction and magnitude of their relationships could change over time. The SURPS has been found to be measurement invariant over time in a community sample of adolescents and could be used to examine the longitudinal relationships between SURPS scores and adolescents’ smoking intentions.
Underreporting of the intention to try smoking may have occurred as a result of a social-desirability bias related to the negative social stigma associated with experimenting with tobacco. However, the use of an anonymous online survey may have minimized the effect of social-desirability when the participants answered questions about their substance use. The percentage of non-smokers was found to be higher in this sample compared with those reported by the McCreary Society and the Youth Smoking Survey. However, the proportion of respondents that expressed an intention to try smoking was larger in this sample than that found in the Youth Smoking Survey cohort. This could be related to the way in which the time-span portion of the intention question was phrased; in this thesis, a specific time frame was not given for intention. The Youth Smoking Survey operationalized susceptibility to try smoking as not having a definite intention to try cigarettes in the future, as well as in the next month. Participants who did not respond “definitely not” to the question “If one of your best friends were to offer you a cigarette, would you smoke it?”, were also considered susceptible.

In a recent meta-analysis and review of the behavioural intention research, Sheeran estimated that intention explained 28% of the variance in all behavioural outcomes. However, this review contained a large body of work, which included positive volitional behaviours, such as starting an exercise or diet program, or using a condom. Intentions for initiating positive health behaviours, such as exercise or improving diet may be less stable and have weaker associations with subsequent behaviour compared with intentions to continue abstaining from negative behaviours, such as smoking. In this analysis, the original intention variable consisted of three distinct levels: Probably Yes, Probably Not, and Definitely Not. As a result, the heterogeneity of risk associated with stating Probably Yes and Probably Not, compared to Definitely Not could not be analyzed. However, as demonstrated by previous
research\textsuperscript{72,87}, the advantage to comparing \textit{Definitely Not} and \textit{Other} as comparison groups would demonstrate the notion that well-defined intentions to abstain from smoking have been suggested to increase overall susceptibility of tobacco initiation.\textsuperscript{13,14}

Although a cross-sectional analysis cannot investigate the temporal stability of intention, intentions that are more stable have been shown to be more strongly associated with behaviour.\textsuperscript{66,379} Given that well-defined intentions are likely to be stable over time\textsuperscript{72,87}, this thesis aimed to understand how personality and affect may increase risk for not having well-defined intentions to smoke. In this analysis, intention was measured with a single question with an unspecified duration (i.e., in the future). Intention questions that include an expectation component with a specific time frame may more strongly predict behaviour at follow-up.\textsuperscript{379} However, Sheeran suggested that research findings have been mixed as to whether expectation (i.e., to engage or refrain from a behaviour within a certain time period) is more robust than intention in general.\textsuperscript{379}

The ethnicity variable used in this analysis was categorised by creating non-overlapping categories: \textit{Aboriginal}, \textit{Asian}, \textit{White/Caucasian} and \textit{Other}. The disadvantage with using this crude categorization is that (1) it reflects racial identity and cannot represent the complex social and cultural influences that describe ethnicity and (2) it cannot capture the effects of identifying with more than one ethnic identity on the intention to smoke. Furthermore, the \textit{Asian} ethnic category consisted of many ethno-racial identities (e.g. Chinese, South Asian, South East Asian), and hence cannot be used to compare the risk of intention among these sub-groups. Future analyses of these Asian sub-categories could be undertaken to further investigate the impact of ethno-racial identities on intention. In addition, self-reported ethnicity could be combined with
measures such as the multi-group ethnic identity measure (MEIM), to further understand how ties with ethno-cultural norms protect against smoking.  

The purpose of this thesis, as addressed in this chapter, was to estimate four separate hypothesis testing models of the relationship between each dimension of the SURPS and the intention to smoke, before the initiation of smoking, controlling for putative confounders. However, these models cannot be used to understand how scores on the SURPS dimensions might interact with each other when predicting intention. For example, research has shown that adolescents with high levels of sensation seeking and impulsivity are at particularly high risk of substance use. In order to do this, all four SURPS dimensions would have to be included in one model that included interactions between the dimension scores. This could be done by using block regression models, after excluding the possibility of multi-collinearity of the dimensions (e.g. by examining the Variance Inflation Factors).

3.7 Conclusion

This chapter examined the associations between _Anxiety Sensitivity_, _Hopelessness_, _Impulsivity_ and _Sensation Seeking_ and the intention to try smoking, in the future, in a cross-sectional sample of BC adolescents who had never tried smoking. The findings suggest that higher scores of _Hopelessness_, _Impulsivity_ and _Sensation Seeking_ are associated with greater likelihood of intending to try smoking in the future. Although the mean scores in _Anxiety Sensitivity_ and _Sensation Seeking_ differed in the boys and girls in this sample, gender was not found to modify the relationship between any of the SURPS scores and the intention to try
smoking. Investigations of the longitudinal trends of SURPS scores and smoking intention could further elucidate the relationships between personality and changes in intention, and its impact on the subsequent initiation of smoking.
CHAPTER 4: Summary and discussion

4.1 Summary of research objectives and findings

Smoking remains one of the key preventable risk factors for chronic disease. Tobacco control initiatives have successfully decreased smoking prevalence in Canadian youth to historical lows of 10% in BC and 15-20% in the Prairie and Maritime provinces. To maintain and continue to decrease these prevalence rates, current tobacco control strategies should focus on preventing initiation. Adolescents’ intention to smoke is recognized as the strongest predictor of future smoking initiation. Although a substantial body of research exists about the role of personality and affective traits on adolescents’ risk of experimentation with tobacco, there is little published work about their relationship with the intention to try smoking.

The British Columbia Adolescent Substance Use Survey collected psychosocial data related to substance use from a community-based cohort of adolescents, using several validated personality-related scales, including the Substance Use Risk Profile Scale (SURPS). The SURPS is a multi-dimensional tool that is used to assess a set of personality-related characteristics (Anxiety Sensitivity, Impulsivity, Sensation Seeking and Hopelessness) that are believed to be associated with an increased susceptibility to use alcohol, tobacco, marijuana, and other drugs (e.g., cocaine and methamphetamine). The SURPS has been used to identify youths and adults that are at risk of substance use, and SURPS scores have been used to guide cognitive-behavioural therapy to successfully reduce high-risk youths’ hard drug use. Although a strong relationship between behavioural intention and the subsequent initiation of substance use, such as smoking, has been well established, researchers have yet to examine the relationships

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between the characteristics assessed by the SURPS and the intention to smoke of adolescents who have yet to try smoking. Additionally, given the mounting evidence indicating that gender is an important determinant of smoking outcomes, the research presented in this thesis utilized methodological strategies for sex and gender based analysis that were derived from guidelines and recommendations produced by CIHR and APA. The application of these gender-based analyses will contribute to the research on gender and health behaviour by studying the impact of gender on the psychometrics of the SURPS dimensions and its interactive effect with the SURPS dimension-specific total scores in models examining adolescents’ intention to smoke.

This thesis aimed to address two key research objectives: (1) to assess gender-based measurement invariance of the SURPS and (2) to examine the association of each SURPS dimension with the intention to try smoking in a sample of adolescents who had never tried smoking cigarettes. The effect of gender on smoking initiation and its interaction with personality-related vulnerability has been identified by researchers in predictive models of substance use, and was also examined in the analysis of the association of each SURPS dimension with the intention to try smoking. The gender-based measurement invariance, or psychometric equivalence, of the Substance Use Risk Profile Scale was evaluated using a two-group confirmatory factor analysis (boy vs. girl) of a 4-dimensional model of the SURPS (see Chapter 2). Establishing the gender-based measurement invariance of the SURPS was a necessary prerequisite to the examination of the effect of gender on the relationship between the SURPS scores and the intention to smoke. Chapter 3 presented the results of cross-sectional analyses of the associations between personality and affect-related risk, using the Anxiety Sensitivity, Hopelessness, Impulsivity and Sensation Seeking dimensions of the SURPS, and intention to smoke in the future in a sample of BC secondary school students who had never tried
tobacco smoking. This was done by using general estimating equation models (one for each SURPS dimension) to obtain the relative risk of the intention to try smoking in the future, as predicted by scores on each dimension of the SURPS.

The results of the test of measurement invariance reported in Chapter 2 indicate that the Substance Use Risk Profile Scale is psychometrically invariant on gender. The gender-based measurement invariance of the SURPS had not been evaluated previously; and thus, these results add to the validation literature related to the scale by demonstrating its psychometric equivalence in male and female adolescents. In Chapter 3, the cross-sectional analyses provided evidence that there is an increased risk of having some intention to try cigarettes in the future with higher levels of Impulsivity [RR 1.13 (95% C.I.: 1.10,1.15)], Sensation Seeking [1.09, (95% C.I. 1.06,1.12)], and Hopelessness [1.07, (95% C.I. 1.04,1.10)]. These findings add to the growing body of literature related to the validity of using the SURPS to capture substance use risk in community samples of adolescents. Effect modification of gender on the relationship between the SURPS and intention was also investigated, and was not observed in these models.

4.2 Implications of findings and methodological recommendations for further research

This thesis is the first investigation to consider whether an association exists between personality related characteristics and the likelihood of having strong intentions to abstain from trying smoking. As a preliminary investigation of this relationship, this study focused on a sample of never-smokers during a particularly vulnerable period of high psychosocial and developmental vulnerability to initiating smoking. Personality and affect-related traits were
captured using the SURPS, an instrument that has recently been shown to be an effective tool to guide cognitive behavioural interventions focused on reducing substance use in youth. This section will explore how SURPS scores could be combined with information on tobacco use intentions to guide customized tobacco use prevention initiatives for adolescents.

4.2.1 Latent modelling of the SURPS dimensions

Although most researchers use total scores of the SURPS dimensions in their analyses, this may not be the optimum approach when studying the association of the SURPS constructs and substance use. For example, Anxiety Sensitivity was not shown to be associated with tobacco use in this sample. This may in part be related to the way Anxiety Sensitivity is modelled. The Confirmatory Factor Analysis of the SURPS dimensions revealed good fit and suggests that using total scores for each dimension would be appropriate for analyzing substance use outcomes in a community sample of adolescents. An alternative to using the total scores of the SURPS (and Anxiety Sensitivity in particular) for data analysis would be to use structural equation modelling to model relationships between latent factors (with measurement error partitioned out of the SURPS scores) and intention to smoke. This could be done by including a measurement model with SURPS indicators and intention as dependent variables, the SURPS dimensions as independent variables. Structural equation modeling could also be used to explore the potential presence of latent classes of Anxiety Sensitivity. Research by Assayag et al. identified two latent classes of the Anxiety Sensitivity Index, which measures an individual’s discomfort with feelings of physical arousal or anxiousness that were associated with smoking relapse at follow-up. Latent classes are sub-groups with specific parameters of latent variables (i.e., item loadings,
thresholds, item and factor variances) suggesting that the heterogeneity in the latent structure of a factor is more appropriately modelled with multiple latent groups to improve overall model fit. The presence of latent classes in the AS may explain why the CFA fit was good but not excellent, in this sample. Assayag et al. discuss several studies on the Anxiety Sensitivity Index that suggest that there may be two discrete classes of Anxiety Sensitivity: a maladaptive group (less than 20% of a sample), and a group with a low risk form of AS (more than 80% of a sample). These findings suggest that a taxonic-dimensional model for the construct consisting of two dichotomous latent classes may better detect the relationships between clinically significant changes in Anxiety Sensitivity and smoking-related behaviour, such as intention to smoke.

Structural equation models could also be used to examine distinct sets of “latent profiles” based on “manifest” total scores of the SURPS, which could subsequently be examined as predictors of smoking intention and tobacco use. Unlike latent class analysis, latent profile analysis does not use the latent variables and unordered categorical indicators; it uses the total scores of each dimension. The premise behind latent profiles is that individuals share a common profile or set of psychological and behavioural traits. This approach could be used to identify groups or “profiles” of individuals who have the highest probability of tobacco initiation. Preliminary work on latent profiles of the SURPS in a cohort of adolescents aged 11-14 by Malmberg et al. revealed that while individual SURPS dimensions predicted substance use, the three latent profiles classified as “Resilients”, “Internalisers” and “Externalisers”) did not. BASUS data could be used to determine if the latent profile approach would be useful in predicting higher risk for intention to smoke and smoking behaviours in adolescence.
Although this thesis demonstrated that scores on the SURPS are associated with the intention to smoke, cross-sectional analysis cannot determine whether having higher than average levels of Impulsivity, Sensation Seeking and Hopelessness lead to increased intention to experiment. A methodological approach to study the effect of the SURPS longitudinally would be to use latent class analysis, which can identify sub-groups of adolescents with unique patterns of change over time. For example, longitudinal latent class analysis would add a mixture model component with two levels: within-class changes and between-class changes, and would estimate threshold probabilities on both class and time. Unlike latent class growth analysis, longitudinal latent class analysis does not make assumptions about the distributions of the observed variables, allows for individual variance within classes, and uses discrete variable categories, rather than intercepts and slopes derived from functions specified for time (e.g. linear, quadratic, or piecewise).

This approach could be useful when modelling latent sub-groups or individual changes over time across all four SURPS dimensions which may deviate from expected global trends. The measurement invariance of the SURPS dimensions across time has been demonstrated by Krank and his colleagues, which supports future investigations of how SURPS profiles may change over time. This approach would complement recent research on sensation seeking and impulsivity that has shown that while sensation seeking tends to peak in mid-adolescence and declines thereafter, impulsivity declines linearly throughout adolescence and plateaus in young adulthood. Furthermore, longitudinal latent class analysis using the BASUS sample may identify sub-groups within Anxiety Sensitivity that increase risk for having intention to smoke, or smoking initiation. Similar work by Assayag et al. found that while one latent class of individuals, characterized by low-level and decreasing levels of Anxiety Sensitivity, was less
likely to relapse, a second latent class, capturing individuals with stable but high-levels of Anxiety Sensitivity were at higher risk of smoking relapse. Examining individual differences in changes over time in SURPS scores and both intention to try smoking and the initiation of tobacco use, in a longitudinal cohort would build on the findings presented in this thesis and may further elucidate determinants of the observed trends towards later-aged (ages 18-25 years) smoking initiation in Canadian youth.

4.2.2 Building support for the “Integrated Model of Behaviour Prediction”

Chapter 1 of this thesis introduced a theoretical framework by Fishbein et al. that identified variables that were directly and indirectly associated variables that influence behavioural intentions and ultimately the behaviour of interest. This framework integrated the Theories of Planned Behaviour and Reasoned Action with Social Cognitive Theory and included personality and emotional variables as distal determinants of behavioural intentions. The research presented in this thesis indicated that personality and emotional factors are associated with increased risk of intending to smoke. Scoring a single point above average in Hopelessness, Impulsivity or Sensation Seeking increased risk of having some intention to try smoking by approximately 10% for each model. To better understand the extent to which these dimensions predict smoking intention, as compared to all known risk factors identified in Chapter 1, predictive models including all putative predictors could be tested to quantify the unique explanatory power associated with psychological and affect-related characteristics.
To further evaluate the specific processes that connect individual personality and affect with tobacco specific efficacy beliefs outlined in Fishbein’s Integrated Model of Behaviour Prediction, the findings reported in this thesis could be further explored by using mediation models. For example, SURPS scores could be incorporated into causal mediation models examining the relationships between personality and affect and smoking intentions. One way to accomplish this would be to use structural equation modelling to study the indirect and direct effects of the SURPS on smoking intention. These causal mediation models could include tobacco outcome valuations/expectancies, and efficacy beliefs about smoking abstinence, as mediating variables between the SURPS dimensions and intention to smoke. Results would further elucidate the possible mechanism that demonstrates how personality and affect increases risk for intention, through other social and cognitive factors that influence the decision to smoke.

4.3 Implications related to preventing tobacco use

The prevalence of smoking in Canadians aged 15 years and older has stabilized at around 15% in the past decade. Despite the relatively low prevalence of smoking, especially in youth, tobacco remains one of the leading causes of chronic disease, and prevention efforts need to be maintained to reduce the smoking prevalence rate even further. The current levelling-off of previously declining rates suggests that novel prevention systems need to be developed to lower the incidence of smoking in youth and to ultimately reduce the rates of smoking in the general population. Given that intention to smoke as a precursor to smoking initiation is well documented, tobacco prevention initiatives would benefit from developing strategies to maintain well-defined intentions to abstain from tobacco in adolescence.
Tobacco control policies that mandate a tobacco free environment have contributed to an overall reduction in smoking at schools since the 1980’s. Schools also have attempted to supplement tobacco control initiatives with intervention programs that incorporate the influence of the school social environment on smoking behaviour. Some programs are based on the “social influence resistance model,” which is focused on building resistance to external cues that could trigger initiation, while others use the “affective education model,” which is based more broadly on increasing self-esteem and coping. The social influence resistance model focuses on developing skills to maintain abstinence by building resilience to social pressure, while the affective education model focuses on stress-management and decision-making skills. When applied individually, these model-based programs have not been shown to significantly reduce substance use. However, when used in tandem they may enable adolescents to develop a more comprehensive set of protective behaviours that address a broad spectrum of individual risk-related characteristics (e.g., being impulsive) and exposure to specific high risk scenarios (e.g., being at a party where other youth are smoking). School-based smoking bans have been implemented, but they do not appear to deter smoking by Canadian adolescents, mainly because they are not specific enough. Poulin and Lovato et al. suggested that socio-demographic factors, community factors (e.g., the high price of tobacco), and perceived smoking norms all influence smoking uptake in Canadian youth. Their findings suggest that tobacco prevention efforts would be more effective if they increased in specificity by taking into account socio-demographic and psychosocial factors that may increase the risk of smoking initiation. The results of the research presented in this thesis support the integration of the SURPS into a comprehensive tobacco prevention initiative based on an affective education approach. This approach could also incorporate information on smoking intention and the social
environment into the social influence resistance components of existing tobacco control strategies. However, before affective educational and social influence intervention models can be implemented in schools, more research would be needed to determine the effect of school-related variables (such as current tobacco control policies) on smoking intention prevalence levels.

4.3.1 Using the SURPS to tailor interventions

This thesis demonstrated an association between the intention to smoke and Impulsivity, Hopelessness and Sensation Seeking. Future research using longitudinal analysis would determine whether causation could be inferred between these dimensions and smoking intention, and ultimately smoking initiation. Provided a causal association could be demonstrated, scores on the SURPS could be used to inform the development and delivery of tailored psycho-educational modules that reinforce strong commitments to abstinence, as demonstrated with alcohol misuse and smoking cessation. This approach would likely involve using receiver operating characteristic (ROC) sensitivity curves to determine cut-off points for each of the SURPS domain scores that indicate susceptibility to shifting away from having definite intentions to not smoke. Castellanos-Ryan et al. recently determined ROC cut-offs scores for each SURPS dimension as well as the predictive validity for future smoking status and other substance use after 18 months in a community sample of adolescents. The cut-off scores for smoking status, with maximized area under the curve (minimum false-positive rate with maximum true-positive rate) of more than 50% were reported to be 13.0 for Hopelessness and 13.8 for Impulsivity. Individuals with SURPS scores higher than cut-off of 13.0 for
Hopelessness were at least 59% likely to be current smokers, and higher than 13.8 for Impulsivity were at least 65% likely to be current smokers. ROC curves could be created using data from the British Columbia Substance Use Survey to predict increased probability of having some intentions to smoke or changing intentions towards plans to experiment in the future. Scores on all four dimensions could also be combined to create “profiles” associated with increased risk of intention to try smoking and applied to developing individual tailored interventions that mitigate this risk.

In addition to informing the development of broadly targeted interventions, scores on the SURPS and reports of tobacco use intentions could be combined with other socio-demographic information to provide customized or tailored feedback \(^{395}\) that addresses individually relevant risk factors for tobacco experimentation. The tailored feedback algorithms for these interventions could also incorporate social environment characteristics represented in the Integrative Model of Behavioural Prediction (Chapter 1) as possible risk factors for stronger intentions to smoke, such as peers’ use of tobacco and smoking norms. \(^{68,78}\) For example, scores on the SURPS dimensions have recently been used to develop tailored cognitive behavioural therapy modules that teach clients about the links between their thoughts and behaviours as a means of reducing substance use. \(^{346}\) Research also suggests that interventions are more effective if they are based on established health behaviour theories, such as the Theory of Planned Behaviour and Social Cognitive Theory. \(^{378,396}\) Additionally, a recent review and meta-analysis by Webb and Sheeran found that interventions that target a moderate or large change in intention can create a small to moderate change in behaviour. \(^{397}\) Incorporating information about smoking intentions, including potential determinants of intention, such as personality-related traits measured by the SURPS, thus appears to be a potentially useful means of
developing tailored social resistance training interventions. These interventions typically focus on strategies for maintaining smoking abstinence, especially in situations where strong abstinence intentions are being challenged.

In this thesis, the primary outcome was based on a single question: “Do you think you may try smoking in the future”. However, as research on behavioural intention suggests, intention measures would need to include specific time and refusal expectancy indicators to more accurately predict subsequent behaviour. Furthermore, having more comprehensive measures of intentions could augment interventions focused on implementation intentions. Implementation intentions, similar to the concept of self-efficacy introduced in Chapter 1, are a series of “if-then” behavioural scenarios identified by an individual to achieve particular goal. Implementation interventions were shown to be effective in quitting smoking, but emerging evidence suggests that they may also prevent initiation. Incorporating time and refusal expectancy measures of intention will aid the development of strategies for implementation intentions, for example to refuse cigarettes when offered them as well as how they would respond to other external (environmental) or emotive-cognitive cues.

4.3.2 Web-based applications for delivering interventions for tobacco use and beyond

Schools are an ideal location for prevention, but targeted individual intervention strategies are resource intensive and as a result, are usually administered in the form of short-term interventions. Additionally, participation in interventions such as support groups run by teachers and counsellors may increase the risk of youths being stigmatized by their peers or other
teachers for their substance use. A potential means of addressing these challenges involves using the internet as a tool for health promotion. The technological capacity of the internet coupled with adolescents’ existing familiarity with it, especially as a communication tool, has led many researchers to consider it an ideal, cost-effective tool for the delivery of ongoing, tailored health promotion activities. This same delivery mode could be applied using the SURPS and smoking intention patterns to identify youth at risk of experimenting with cigarettes, and subsequently delivering and evaluating the impact of online modules that aim to maintain anti-smoking intentions.

The BC Adolescent Substance Use Survey (BASUS) uses a web-based system to collect data about psychosocial risk and substance use in adolescents. Given the high prevalence of internet use by youth, web-based prevention and intervention delivery methods represent a promising opportunity for both investigating the aetiology of alcohol and drug use and delivering interventions. The web-based platform already in place for the BASUS study has been applied to an embedded randomized controlled trial, Supporting Tailored Approaches to Reducing Tobacco (START), to determine the efficacy of ethnic- and gender-targeted messaging on knowledge seeking and risk perception regarding breast cancer and exposure to second hand smoke. This same approach could be used to evaluate the impact of SURPS tailored interventions focused on maintaining strong intentions to abstain from smoking. Furthermore, preliminary research has already demonstrated evidence on the SURPS as a valid tool for identifying youth at risk for trying alcohol, marijuana and other drugs. The data collected in BASUS on other substance use can be used to develop and test interactive web-based tools to identify participants with higher personality and affect-associated risk, and develop interventions to prevent substance misuse.
Research indicates that the effectiveness of many substance use prevention sessions is short-lived. Using a web-based system, researchers could continuously revise the web-based modules to ensure that the customized feedback is relevant to the changing behavioural patterns of adolescents, as they mature. This approach would also support the delivery of brief “booster sessions” throughout high school; such an approach represents a potentially long-term intervention that could contribute to the establishment of more permanent, healthful lifestyles.

4.4 Concluding statement

Having less than strong intentions to abstain from smoking has been shown to increase the risk of smoking initiation. Although personality traits and emotional dispositions have been widely studied as potential determinants of current smoking, little research has examined their potential role in shifting smoking intentions away from strong intentions to abstain prior to initial experimentation. The identification of the psychological factors associated with intentions to experiment or abstain from experimenting with tobacco could be used to inform the development of prevention oriented interventions that will aid in reinforcing and increasing the recent gains in tobacco prevention. The Substance Use Risk Profile Scale (SURPS) was used in this thesis to capture personality and affect. This research demonstrated that the SURPS domains of Impulsivity, Hopelessness, and Sensation Seeking are associated with an increased risk of having intentions to smoke, before experimentation has occurred. Furthermore, this thesis incorporated a sex and gender based analysis to contribute to research demonstrating the impact of gender psychosocial outcomes and smoking behaviour. By testing for gender-based measurement invariance, the SURPS was demonstrated to not be gender biased, allowing for further
exploration of whether gender modifies the relationship between the SURPS dimensions and smoking intention. Findings presented in this thesis suggest that existing smoking prevention strategies could be improved by identifying adolescents at risk of experimenting by evaluating smoking intentions and providing them with interventions designed to maintain strong intentions to abstain from smoking. Specifically, the associations between Impulsivity, Hopelessness, and Sensation Seeking and smoking intentions indicate that tobacco control researchers should consider incorporating the SURPS in tobacco control initiatives focussed on maintaining strong intentions to abstain from smoking.


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APPENDICES

Appendix A: M-Plus 6.12® syntax and partial output

Measurement Invariance

Multi-group CFA (Step 1):

TITLE: step 1 of MI of SURPS (CLUSTERED, CATEGORICAL)

DATA:
   FILE IS SURPS_1352.dat;
   VARIABLE:
      NAMES ARE id school sex SURPS1 SURPS2 SURPS3 SURPS4 SURPS5 SURPS6 SURPS7
      SURPS8 SURPS9 SURPS10 SURPS11 SURPS12 SURPS13 SURPS14 SURPS15 SURPS16
      SURPS17 SURPS18 SURPS19 SURPS20 SURPS21 SURPS22 SURPS23;

      USEVARIABLES SURPS1 SURPS2 SURPS3 SURPS4 SURPS5 SURPS6 SURPS7
      SURPS8 SURPS9 SURPS10 SURPS11 SURPS12 SURPS13 SURPS14 SURPS15 SURPS16
      SURPS17 SURPS18 SURPS19 SURPS20 SURPS21 SURPS22 SURPS23;

      CATEGORICAL ARE all;

      MISSING ARE ALL (980);

      GROUPING IS sex (1=male 2=female);
      CLUSTER IS school;

!This is step one of MI: where thresholds and loadings are free,
!but means of loadings across groups are constrained to be zero;

ANALYSIS:
   TYPE IS COMPLEX;
   ESTIMATOR IS WLSMV;
   parameterization = theta;

MODEL:
anxiety BY SURPS8@1
    SURPS10
    SURPS14
    SURPS18
    SURPS21;

hopeless BY SURPS1@1
    SURPS4
    SURPS7
    SURPS13
    SURPS17
    SURPS20
    SURPS23;

sensat BY SURPS3@1
    SURPS6
    SURPS9
    SURPS12
    SURPS16
    SURPS19;

impuls BY SURPS2@1
    SURPS5
    SURPS11
    SURPS15
    SURPS22;

!this fixes loading of the first item in each dimension to 1 in both groups.
SURPS1-SURPS23@1;

! following commands fix latent means to zero for both groups
    [anxiety@0] (1);
    [hopeless@0] (2);
    [sensat@0] (3);
    [impuls@0] (4);

! free thresholds for both groups (for 4 levels)
Model male:
!next set of commands frees up loadings for males
  anxiety BY SURPS8@1
    SURPS10
    SURPS14
    SURPS18
    SURPS21;

  hopeless BY SURPS1@1
    SURPS4
    SURPS7
    SURPS13
    SURPS17
    SURPS20
    SURPS23;

  sensat BY SURPS3@1
    SURPS6
    SURPS9
    SURPS12
    SURPS16
    SURPS19;

  impuls BY SURPS2@1
    SURPS5
    SURPS11
    SURPS15
    SURPS22;

[SURPS1$1-SURPS23$3];
SAVEDATA: DIFFTEST = deriv.dat;
OUTPUT: SAMPSTAT STAND MODINDICES tech1 tech9;

step 1 of MI of SURPS (CLUSTERED, CATEGORICAL)

SUMMARY OF ANALYSIS

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<table>
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<th></th>
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<tr>
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<td>2</td>
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<tr>
<td>Number of observations</td>
<td>555</td>
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<tr>
<td>Group MALE</td>
<td>555</td>
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Group FEMALE

Number of dependent variables 23
Number of independent variables 0
Number of continuous latent variables 4

Observed dependent variables

Binary and ordered categorical (ordinal)
SURPS1  SURPS2  SURPS3  SURPS4  SURPS5  SURPS6
SURPS7  SURPS8  SURPS9  SURPS10  SURPS11  SURPS12
SURPS13  SURPS14  SURPS15  SURPS16  SURPS17  SURPS18
SURPS19  SURPS20  SURPS21  SURPS22  SURPS23

Continuous latent variables
ANXIETY  HOPELESS  SENSAT  IMPULS

Variables with special functions

Grouping variable SEX
Cluster variable SCHOOL

Estimator WLSMV
Maximum number of iterations 1000
Convergence criterion 0.500D-04
Maximum number of steepest descent iterations 20
Maximum number of iterations for H1 2000
Convergence criterion for H1 0.100D-03
Parameterization THETA

Input data file(s)
SURPS_1352.dat

Input data format FREE

SUMMARY OF DATA

Group MALE
Number of missing data patterns 136
Number of clusters 55

Group FEMALE
Number of missing data patterns 185
Number of clusters 59
THE MODEL ESTIMATION TERMINATED NORMALLY

MODEL FIT INFORMATION

Number of Free Parameters 196

Chi-Square Test of Model Fit

Value 1497.950*
Degrees of Freedom 448
P-Value 0.0000

Chi-Square Contributions From Each Group

MALE 752.234
FEMALE 745.716

* The chi-square value for MLM, MLMV, MLR, ULSMV, WLSM and WLSMV cannot be used for chi-square difference testing in the regular way. MLM, MLR and WLSM chi-square difference testing is described on the Mplus website. MLMV, WLSMV, and ULSMV difference testing is done using the DIFFTEST option.

RMSEA (Root Mean Square Error Of Approximation)

Estimate 0.061
90 Percent C.I. 0.057 0.064
Probability RMSEA <= .05 0.000

CFI/TLI

CFI 0.914
TLI 0.903

Chi-Square Test of Model Fit for the Baseline Model

Value 12763.762
Degrees of Freedom 506
P-Value 0.0000

WRMR (Weighted Root Mean Square Residual)
Multi-group CFA (Step 2):

DATA:
   FILE IS SURPS_1352.dat;
VARIABLE:
   NAMES ARE id school sex SURPS1 SURPS2 SURPS3 SURPS4 SURPS5 SURPS6 SURPS7
   SURPS8 SURPS9 SURPS10 SURPS11 SURPS12 SURPS13 SURPS14 SURPS15 SURPS16
   SURPS17 SURPS18 SURPS19 SURPS20 SURPS21 SURPS22 SURPS23;
   USEVARIABLES SURPS1 SURPS2 SURPS3 SURPS4 SURPS5 SURPS6 SURPS7
   SURPS8 SURPS9 SURPS10 SURPS11 SURPS12 SURPS13 SURPS14 SURPS15 SURPS16
   SURPS17 SURPS18 SURPS19 SURPS20 SURPS21 SURPS22 SURPS23;
   CATEGORICAL ARE all;
   MISSING ARE ALL (980);
   GROUPING IS sex (1=male 2=female);
   CLUSTER IS school;

!This is step two of MI: the factor loading parameters and thresholds were constrained to be equal for boys and girls; in addition, the residual variances of the first indicator in each dimension one group were freed in one group, and constrained to equal 1 in the other !;

ANALYSIS:
   TYPE IS COMPLEX;
   ESTIMATOR IS WLSMV;
   parameterization = theta;
   DIFFTEST is deriv.dat;

MODEL:

   anxiety BY SURPS8@1
       SURPS10
       SURPS14
       SURPS18
       SURPS21;

   hopeless BY SURPS1@1
       SURPS4
       SURPS7
       SURPS13
SURPS17
SURPS20
SURPS23;

sensat BY SURPS3@1
  SURPS6
  SURPS9
  SURPS12
  SURPS16
  SURPS19;

impuls BY SURPS2@1
  SURPS5
  SURPS11
  SURPS15
  SURPS22;

OUTPUT: SAMPSTAT STAND MODINDICES tech1;

step 2 of MI of SURPS (CLUSTERED, CATEGORICAL)

SUMMARY OF ANALYSIS

Number of groups                                             2
Number of observations                                       
  Group MALE                                                 550
  Group FEMALE                                               712

Number of dependent variables                                23
Number of independent variables                              0
Number of continuous latent variables                        4

Observed dependent variables

  Binary and ordered categorical (ordinal)
  SURPS1  SURPS2  SURPS3  SURPS4  SURPS5  SURPS6
  SURPS7  SURPS8  SURPS9  SURPS10  SURPS11  SURPS12
  SURPS13  SURPS14  SURPS15  SURPS16  SURPS17  SURPS18
  SURPS19  SURPS20  SURPS21  SURPS22  SURPS23

  Continuous latent variables
  ANXIETY  HOPELESS  SENSAT  IMPULS

Variables with special functions
Grouping variable     SEX
Cluster variable     SCHOOL

Estimator                                                    WLSMV
Maximum number of iterations                                  1000
Convergence criterion                                    0.500D-04
Maximum number of steepest descent iterations                   20
Maximum number of iterations for H1                             2000
Convergence criterion for H1                            0.100D-03
Parameterization                                             THETA

Confirmatory Factor Analysis

TITLE:  CFA of surps (CLUSTERED, CATEGORICAL)

DATA:
   FILE IS SURPS_1352.dat;

   VARIABLE:
      NAMES ARE id school sex SURPS1 SURPS2 SURPS3 SURPS4 SURPS5 SURPS6 SURPS7 SURPS8 SURPS9 SURPS10 SURPS11 SURPS12 SURPS13 SURPS14 SURPS15 SURPS16 SURPS17 SURPS18 SURPS19 SURPS20 SURPS21 SURPS22 SURPS23;
      USEVARIABLES SURPS1 SURPS2 SURPS3 SURPS4 SURPS5 SURPS6 SURPS7 SURPS8 SURPS9 SURPS10 SURPS11 SURPS12 SURPS13 SURPS14 SURPS15 SURPS16 SURPS17 SURPS18 SURPS19 SURPS20 SURPS21 SURPS22 SURPS23;
      CATEGORICAL ARE all;
      MISSING ARE ALL (980);

   !GROUPING IS sex (1=male 2=female);
   CLUSTER IS school;

   !This is step one of MI: where thresholds and loadings are free,
   !but means of loadings across groups are constrained to be zero;
ANALYSIS:
TYPE IS COMPLEX;
ESTIMATOR IS WLSMV;
parameterization = theta;
!DIFFTEST is deriv.dat;

MODEL:

   anxiety BY SURPS8@1
       SURPS10
       SURPS14
       SURPS18
       SURPS21;

   hopeless BY SURPS1@1
       SURPS4
       SURPS7
       SURPS13
       SURPS17
       SURPS20
       SURPS23;

   sensat BY SURPS3@1
       SURPS6
       SURPS9
       SURPS12
       SURPS16
       SURPS19;

   impuls BY SURPS2@1
       SURPS5
       SURPS11
       SURPS15
       SURPS22;

OUTPUT:  SAMPSTAT STAND MODINDICES tech1;

CFA of surps(CLUSTERED, CATEGORICAL)

SUMMARY OF ANALYSIS
Number of groups 1
Number of observations 1299

Number of dependent variables 23
Number of independent variables 0
Number of continuous latent variables 4

Observed dependent variables

Binary and ordered categorical (ordinal)
SURPS1 SURPS2 SURPS3 SURPS4 SURPS5 SURPS6
SURPS7 SURPS8 SURPS9 SURPS10 SURPS11 SURPS12
SURPS13 SURPS14 SURPS15 SURPS16 SURPS17 SURPS18
SURPS19 SURPS20 SURPS21 SURPS22 SURPS23

Continuous latent variables
ANXIETY HOPELESS SENSAT IMPULS

Variables with special functions

Cluster variable SCHOOL

Estimator WLSMV
Maximum number of iterations 1000
Convergence criterion 0.500D-04
Maximum number of steepest descent iterations 20
Maximum number of iterations for H1 2000
Convergence criterion for H1 0.100D-03
Parameterization THETA

THE MODEL ESTIMATION TERMINATED NORMALLY

MODEL FIT INFORMATION

Number of Free Parameters 98

Chi-Square Test of Model Fit

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<td>P-Value</td>
<td>0.0000</td>
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* The chi-square value for MLM, MLMV, MLR, ULSMV, WLSM and WLSMV cannot be used for chi-square difference testing in the regular way. MLM, MLR and WLSM chi-square difference testing is described on the Mplus website. MLMV, WLSMV, and ULSMV difference testing is done using the DIFFTEST option.

RMSEA (Root Mean Square Error Of Approximation)

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<th>Estimate</th>
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CFI/TLI

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Chi-Square Test of Model Fit for the Baseline Model

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<td>P-Value</td>
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WRMR (Weighted Root Mean Square Residual)

| Value | 2.791 |
Appendix B: Post-hoc model fit output for chapter 2

Without item 16

MODEL FIT INFORMATION
Number of Free Parameters 97

Chi-Square Test of Model Fit

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* The chi-square value for MLM, MLMV, MLR, ULSMV, WLSM and WLSMV cannot be used for chi-square difference testing in the regular way. MLM, MLR and WLSM chi-square difference testing is described on the Mplus website. MLMV, WLSMV, and ULSMV difference testing is done using the DIFFTEST option.

RMSEA (Root Mean Square Error Of Approximation)

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CFI/TLI

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Chi-Square Test of Model Fit for the Baseline Model

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<tbody>
<tr>
<td>Degrees of Freedom</td>
<td>253</td>
</tr>
<tr>
<td>P-Value</td>
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</tbody>
</table>

WRMR (Weighted Root Mean Square Residual)

| Value  | 4.110 |

Without item 17
MODEL FIT INFORMATION

Number of Free Parameters                       97

Chi-Square Test of Model Fit

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* The chi-square value for MLM, MLMV, MLR, ULSMV, WLSM and WLSMV cannot be used for chi-square difference testing in the regular way. MLM, MLR and WLSM chi-square difference testing is described on the Mplus website. MLMV, WLSMV, and ULSMV difference testing is done using the DIFFTEST option.

RMSEA (Root Mean Square Error Of Approximation)

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</table>

CFI/TLI

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<th>0.744</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLI</td>
<td>0.712</td>
</tr>
</tbody>
</table>

Chi-Square Test of Model Fit for the Baseline Model

<table>
<thead>
<tr>
<th>Value</th>
<th>14672.803</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degrees of Freedom</td>
<td>253</td>
</tr>
<tr>
<td>P-Value</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

WRMR (Weighted Root Mean Square Residual)

<table>
<thead>
<tr>
<th>Value</th>
<th>5.191</th>
</tr>
</thead>
</table>
Without 16 and 17

MODEL FIT INFORMATION

Number of Free Parameters 96

Chi-Square Test of Model Fit

Value 4866.978*
Degrees of Freedom 226
P-Value 0.0000

* The chi-square value for MLM, MLMV, MLR, ULSMV, WLSM and WLSMV cannot be used for chi-square difference testing in the regular way. MLM, MLR and WLSM chi-square difference testing is described on the Mplus website. MLMV, WLSMV, and ULSMV difference testing is done using the DIFFTEST option.

RMSEA (Root Mean Square Error Of Approximation)

Estimate 0.126
90 Percent C.I. 0.123 0.129
Probability RMSEA <= .05 0.000

CFI/TLI

CFI 0.678
TLI 0.640

Chi-Square Test of Model Fit for the Baseline Model

Value 14672.803
Degrees of Freedom 253
P-Value 0.0000

WRMR (Weighted Root Mean Square Residual)

Value 5.992
Appendix C: IBM PASW 19.0® syntax code for chapter 3

Imputations (Done for all 4 SURPS dimensions)
MULTIPLE IMPUTATION PSY_SURPS1_Content_W3_R
PSY_SURPS2_NotThinkB4Speak_W3
  PSY_SURPS3_Want2Skydive_W3 PSY_SURPS4_AmHappy_W3_R
PSY_SURPS5_SituationsRegretLater_W3
  PSY_SURPS6_EnjoyUnconventional_W3 PSY_SURPS7_FutureHoldsGreatPromise_W3_R
  PSY_SURPS8_Scary2FeelDizzy_W3 PSY_SURPS9_Like2GetScared_W3
  PSY_SURPS10_Scary2HearChangingHeartbeat_W3 PSY_SURPS11_NotThinkB4Act_W3
  PSY_SURPS12_Want2Motorbike_W3 PSY_SURPS13_ProudofAccomplishments_W3_R
  PSY_SURPS14_GetScaredWhenNervous_W3 PSY_SURPS15_GenerallyImpulsive_W3
PSY_SURPS16_ScaryIllegalOK_W3
  PSY_SURPS17_IamFailure_W3 PSY_SURPS18_ScaredUnusalBodySens_W3
PSY_SURPS19_EnjoyHikingOutofBounds_W3
  PSY_SURPS20_FeelPleasant_W3_R PSY_SURPS21_NotFocusingScary_W3
PSY_SURPS22_Need2Manipulate_W3
  PSY_SURPS23_EnthusiasticAboutFuture_W3_R
/IMPUTE METHOD=AUTO NIMPUTATIONS=10 MAXPCTMISSING=NONE
MAXMODELPARAM =500
/MISSINGSUMMARIES NONE
/IMPUTATIONSUMMARY MODELS
/OUTFILE IMPUTATIONS=

'C:\Users\JasminaBASUS_MAIN\SURPS\SURPS_Paper_READY_Dec20_Anxiety_IMPUTE D.sav'.

Substance Use Risk Profile Scale (totalling and mean centering)
*SURPS Wave 3

IF ((PSY_SURPS8_Scary2FeelDizzy_W3~<>980) AND
  (PSY_SURPS10_Scary2HearChangingHeartbeat_W3~<>980) AND
  (PSY_SURPS14_GetScaredWhenNervous_W3~<>980) AND
  (PSY_SURPS18_ScaredUnusalBodySens_W3~<>980) AND
  (PSY_SURPS21_NotFocusingScary_W3~<>980))

  PSY_SURPS_Anxiety_W3_3=SUM(PSY_SURPS8_Scary2FeelDizzy_W3,PSY_SURPS10_Scary2HearChangingHeartbeat_W3,PSY_SURPS14_GetScaredWhenNervous_W3,PSY_SURPS18_ScaredUnusalBodySens_W3,PSY_SURPS21_NotFocusingScary_W3).

IF ((PSY_SURPS1_Content_W3_R~<>980) AND (PSY_SURPS4_AmHappy_W3_R~<>980) AND (PSY_SURPS7_FutureHoldsGreatPromise_W3_R~<>980) AND
  (PSY_SURPS13_ProudofAccomplishments_W3_R~<>980)
AND (PSY_SURPS17_IamFailure_W3~980) AND
(PSY_SURPS20_FeelPleasant_W3_R~980) AND
(PSY_SURPS23_EnthusiasticAboutFuture_W3_R~980))

PSY_SURPS_Hopelessness_W3_3=SUM(PSY_SURPS1_Content_W3_R,PSY_SURPS4_AmHappy_W3_R,PSY_SURPS7_FutureHoldsGreatPromise_W3_R,PSY_SURPS13_ProudofAccomplishments_W3_R,
PSY_SURPS17_IamFailure_W3,PSY_SURPS20_FeelPleasant_W3_R,PSY_SURPS23_EnthusiasticAboutFuture_W3_R).

IF ((PSY_SURPS3_Want2Skydive_W3~980) AND
(PSY_SURPS6_EnjoyUnconventional_W3~980) AND
(PSY_SURPS9_Like2GetScared_W3~980) AND
(PSY_SURPS12_Want2Motorbike_W3~980) AND
(PSY_SURPS16_ScaryIllegalOK_W3~980) AND
(PSY_SURPS19_EnjoyHikingOutofBounds_W3~980))

PSY_SURPS_Sensation_W3_3=SUM(PSY_SURPS3_Want2Skydive_W3,PSY_SURPS6_EnjoyUnconventional_W3,PSY_SURPS9_Like2GetScared_W3,PSY_SURPS12_Want2Motorbike_W3,PSY_SURPS16_ScaryIllegalOK_W3,PSY_SURPS19_EnjoyHikingOutofBounds_W3).

IF ((PSY_SURPS2_NotThinkB4Speak_W3~980) AND
(PSY_SURPS5_SituationsRegretLater_W3~980) AND
(PSY_SURPS11_NotThinkB4Act_W3~980) AND
(PSY_SURPS15_GenerallyImpulsive_W3~980) AND
(PSY_SURPS22_Need2Manipulate_W3~980))

PSY_SURPS_Impulsivity_W3_3=SUM(PSY_SURPS2_NotThinkB4Speak_W3,PSY_SURPS5_SituationsRegretLater_W3,PSY_SURPS11_NotThinkB4Act_W3,PSY_SURPS15_GenerallyImpulsive_W3,PSY_SURPS22_Need2Manipulate_W3).

*Mean Centering based on imputation

define group_cvars( group = !charend('/'),
                    /vlist = !charend('/'),
                    /suffix = !cmdend )

do !vname !in (!vlist)
    !let !nname = !concat(!vname, !suffix)
    AGGREGATE /outfile=* mode=addvariables overwrite = yes
/*!
  | !group =
  | /y_temp = mean(!vname).
  | compute !nname = !vname - y_temp.
  | exe.
  | !doend
  | delete variables y_temp.
  | !enddate.
  | group_cvars group = Imputation_
  |   /vlist = PSY_SURPS_Anxiety_W3_3
  |   /suffix = Imputation_

General Estimating Equations for final models (Anxiety Sensitivity)
*Note that the same models were applied for Hopelessness, Sensation Seeking and Impulsivity

DATASET DECLARE Anxiety Sensitivity.
OMS
  /SELECT TABLES
  /IF COMMANDS=['Generalized Linear Models'] SUBTYPES=['Parameter Estimates']
  /DESTINATION FORMAT=SAV NUMBERED=TableNumber_
    OUTFILE=' Anxiety Sensitivity '.
GENLIN Intent_BIN_R (REFERENCE=FIRST) BY Ethnicity
  (ORDER=DESCENDING) WITH PSY_SURPS_Anxiety_W3_3ImputationGender_
  /MODEL Ethnicity PSY_SURPS_Anxiety_W3_3ImputationGender_
    INTERCEPT=YES
  DISTRIBUTION=poisson LINK=LOG
  /CRITERIA METHOD=FISHER(1) SCALE=1 MAXITERATIONS=100
  MAXSTEPHALVING=5 PCONVERGE=1E-006(Absolute)
    SINGULAR=1E-012 ANALYSISI TYPE=3(WALD) CILEVEL=95 LIKELIHOOD=FULL
  /REPEATED SUBJECT=School WITHINSUBJECT=ID SORT=YES
  CORRTYPE=EXCHANGEABLE ADJUSTCORR=YES
    COVB=robust MAXITERATIONS=100 PCONVERGE=1e-006(Absolute)
  UPDATECORR=1
  /MISSING CLASSMISSING=EXCLUDE
  /PRINT CPS DESCRIPTIVES MODELINFO FIT SUMMARY SOLUTION
    (EXPONENTIATED)
  /SAVE MEANPRED CIMEANPREDL CIMEANPREDU XBRED XBSTERROR RESID
  PEARSONRESID.
OMSEND.
DATASET ACTIVATE Anxiety Sensitivity.
SELECT IF Var1='Pooled'.
4 COMPUTE Lower=B-IDF.NORMAL(.975,0,1)*Std.Error.
    COMPUTE Upper=B+IDF.NORMAL(.975,0,1)*Std.Error.
    EXECUTE.

4 The following must be specified when obtaining estimates with imputed data so as to obtain accurate confidence intervals (email correspondence with D. Nichols, IBM Statistician on January 24th, 2012)
Appendix D: Plots for assumption checking

Pearson residuals (school specific)

Randomness of residuals across subjects (schools) based on Wald-Wolfowitz Run Test

<table>
<thead>
<tr>
<th>Runs Test</th>
<th>Anxiety Sensitivity</th>
<th>Hopelessness</th>
<th>Sensation Seeking</th>
<th>Impulsivity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Imp 0</td>
<td>Imp 10</td>
<td>Imp 0</td>
<td>Imp 10</td>
</tr>
<tr>
<td>Test Value (Mean)</td>
<td>.00395</td>
<td>.00525</td>
<td>.00307</td>
<td>.00541</td>
</tr>
<tr>
<td>Cases &lt; Test Value</td>
<td>582</td>
<td>665</td>
<td>588</td>
<td>674</td>
</tr>
<tr>
<td>Cases &gt;= Test Value</td>
<td>238</td>
<td>267</td>
<td>234</td>
<td>257</td>
</tr>
<tr>
<td>Total Cases</td>
<td>820</td>
<td>932</td>
<td>822</td>
<td>931</td>
</tr>
<tr>
<td>Number of Runs</td>
<td>323</td>
<td>369</td>
<td>327</td>
<td>365</td>
</tr>
<tr>
<td>---------------</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>Z</td>
<td>-1.344</td>
<td>-1.044</td>
<td>-0.752</td>
<td>-0.666</td>
</tr>
<tr>
<td>Asymp. Sig. (2-tailed)</td>
<td>.179</td>
<td>.297</td>
<td>.452</td>
<td>.506</td>
</tr>
<tr>
<td>Monte Carlo Sig. (2-tailed)</td>
<td>.189</td>
<td>.293</td>
<td>.469</td>
<td>.513</td>
</tr>
</tbody>
</table>

Based on 10000 sampled tables, but different starting seeds for each test

No Variance Among imputations was noted in models from which Pearson residuals are estimated

Standardized residuals (SURPS dimension specific)