

An Investigation of Childhood Inattentive and Hyperactive/Impulsive Behaviour and  
Adolescent Smoking Outcomes in Boys and Girls

by

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## Abstract

Research has shown that there is an association between Attention Deficit/Hyperactivity Disorder (ADHD) and smoking. In the current study the two dimensions of ADHD, inattention and hyperactivity/impulsivity, were examined as predictors of smoking outcomes in a sample from the Canadian National Longitudinal Survey of Children and Youth (NLSCY), taking into account their potential associations with conduct problems. Univariate analyses of inattentive and hyperactive/impulsive behaviour indicated that only childhood inattentive behaviour (measured at age 6/7) among girls significantly predicted adolescent smoking outcomes (measured at age 16/17). Higher levels of inattention were associated with a greater likelihood of regular smoking among girls, even with conduct problems, hyperactivity/impulsivity, and SES in the model.

While the research and analysis are based on data from Statistics Canada, the opinions expressed do not represent the views of Statistics Canada.

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## Introduction

Research has demonstrated that there is a link between Attention-Deficit/Hyperactivity Disorder (ADHD) and smoking: individuals with ADHD are more likely to smoke than controls (Lambert & Hartsough, 1998; Milberger, Biederman, Faraone, Chen, & Jones, 1997; Molina & Pelham, 2003). In addition, those with ADHD are likely to have an earlier onset of smoking (Lambert & Hartsough, 1998; Milberger et al., 1997; Molina & Pelham, 2003), and to smoke more cigarettes than controls (Molina & Pelham, 2003).

Individuals who are diagnosed with ADHD are classified as having one of three sub-types: a predominantly hyperactive/impulsive sub-type, a predominantly inattentive sub-type, or a combined sub-type (American Psychiatric Association, Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision, 2000). Inattentive behaviour includes difficulty staying focused on a task and apparent difficulty attending when addressed, and hyperactive/impulsive behaviour includes difficulty sitting still and difficulty waiting for a turn (*DSM-IV-TR*, 2000; see Appendix A for a detailed list of symptoms).

Research indicates that there is a link between inattention and smoking/tobacco use (Gardner, Dishion, & Posner, 2006; Burke, Loeber, & Lahey, 2001), and that people with ADHD may self-medicate using tobacco (Whalen, Jamner, Henker, Gehricke, & King, 2003). Nicotine, which is the main psychoactive component of tobacco, has been

shown to increase attention (Rezvani & Levin, 2001). Research also suggests that the hyperactive/impulsive dimension of ADHD is important in smoking development (e.g., Fuemmeler, Kollins, & McClernon, 2007). For example, individuals may be more susceptible to trying smoking because of problems with impulse control (McClernon & Kollins, 2008).

Furthermore, some research indicates that individuals with ADHD are at greater risk for developing conduct problems (Lahey, Hartung, Loney, Pelham, Chronis, & Lee, 2007; Mannuzza, Klein, Abikoff, & Moulton, 2004; & Monuteaux, Faraone, Gross, & Biederman, 2007). Biederman, Newcorn, and Sprich (1991) concluded that ADHD and Conduct Disorder (CD) co-occur at a rate of 30 – 50%. CD can involve the following types of behaviour: aggression to people and animals, destruction of property, deceitfulness or theft, and serious violations of rules (*DSM-IV-TR*, 2000).

Conduct problems are a risk factor for substance use (Fergusson & Lynskey, 1998), and some findings support the notion that CD may mediate between ADHD and smoking (Brook, Duan, Zhang, Cohen, & Brook, 2008; Burke, et al., 2001; Barkley, Fischer, Edelbrock, & Smallish, 1990). Molina, Smith, & Pelham (1999) suggested that the two dimensions of ADHD may act differentially (and at different points in time) through other variables to influence substance use; and specifically that hyperactivity/impulsivity might affect problem behaviour. In addition, Burke et al. (2001) indicated that hyperactivity/impulsivity may be linked to conduct problems, and that these may be related to substance use generally; while inattention may be linked to

tobacco use due to its effects on attention. Wolraich, Hannah, Baumgaertel, and Feurer (1998) found that the predominantly hyperactive/impulsive and combined sub-types of ADHD were more likely to be associated with CD, and Côté, Tremblay, Nagin, Zoccolillo, and Vitaro (2002) found that hyperactivity was an important component of risk for CD. Overall, it appears that hyperactive/impulsive behaviour may be associated with increased smoking at least partly through conduct problems.

The current study will explore the associations between childhood ADHD symptoms and adolescent smoking, taking into consideration their potential associations with conduct problems. Inattention and hyperactivity/impulsivity may lead to smoking outcomes via somewhat different mechanisms. Inattention may be associated with smoking outcomes mainly through self-medication with nicotine; while hyperactivity/impulsivity may be associated with smoking outcomes at least partly in association with problem behaviour.

Finally, the manifestation of ADHD appears to differ between boys and girls, and research suggests that girls may be more strongly impacted by ADHD in terms of substance use (Biederman et al., 2002). Furthermore, hyperactivity/inattention may be associated with smoking in girls, but not boys (Galéra, Fombonne, Chastang, & Bouvard, 2005). The potential pathways between the two dimensions of ADHD and smoking will be investigated in boys and girls separately. First, univariate analyses of the associations between inattention and smoking and hyperactivity/impulsivity and smoking will be conducted. These variables will then be considered in the context of

multivariate models including measures of conduct problems (CP), socioeconomic status (SES), and the alternate ADHD dimension. The relationships will be examined using data from the National Longitudinal Survey of Children and Youth (NLSCY), a national survey representative of the Canadian population (Human Resources Development Canada & Statistics Canada, 1996).

### **Associations between Inattention and Hyperactivity/Impulsivity and Smoking**

Some studies have separated inattention and hyperactivity/impulsivity in examining the association between the ADHD dimensions and smoking, with mixed results.

Findings by Fuemmeler et al. (2007), Elkins, McGue, and Iacono (2007), and Molina, et al. (1999) suggest that hyperactivity/impulsivity may have a stronger direct link with smoking than inattention. Fuemmeler et al. (2007) investigated smoking progression between the ages of mean = 15.64 and mean = 22.96 in a nationally representative U.S. sample. ADHD symptoms were reported retrospectively at mean = 22.96 years of age with reference to symptoms between 5 and 12 years of age. Controlling for other variables, including conduct disorder symptoms, they found that hyperactivity/impulsivity symptoms, but not inattention symptoms, predicted progression to regular smoking from non-smoking and experimenting.

Elkins et al. (2007) investigated hyperactivity/impulsivity, inattention, and conduct problems as potential predictors of tobacco initiation (i.e., trying tobacco) and nicotine dependence (as well as other drug use initiation and dependence). They found

that hyperactivity/impulsivity symptoms at (approximately) age 11 predicted both tobacco initiation at (approximately) age 14 and nicotine dependence at (approximately) age 18, even after conduct problems and inattention symptoms were taken into account. Inattention symptoms at age 11, on the other hand, did not predict tobacco initiation at age 14, once conduct problems and hyperactivity/impulsivity were taken into account. Inattention symptoms predicted nicotine dependence when early conduct problems (i.e., age 11) and hyperactivity/impulsivity were controlled for, but this finding was no longer significant once later conduct problems (i.e., age 11 to 14) were controlled for.

Molina et al. (1999) studied males and females in grades 6 to 8 at a school with families with lower than typical socioeconomic status. Using a cross-sectional design, they determined that it was hyperactivity/impulsivity rather than inattention that was linked to smoking.

Findings by Burke, Loeber, White, Stouthamer-Loeber, and Pardini (2007), Tercyak, Lerman, and Audrain (2002), and Burke et al. (2001) suggest that inattention may play a stronger role. Burke et al. (2007) examined the predictive value of inattention and hyperactivity/impulsivity on smoking outcomes during adolescence in a community sample of males in which half the participants were the 30% of students with the most antisocial behaviour. They found significant bivariate relationships between both inattention and hyperactivity/impulsivity and subsequent smoking; however, when antisocial behaviour problems were included in a model, inattention, but not hyperactivity/impulsivity predicted smoking. They also found that inattention during

adolescence predicted smoking during early adulthood (ages 20 and 25 for the two cohorts).

Tercyak et al. (2002) studied a community sample of grade 10 students, and identified individuals with clinically significant levels of inattention and hyperactivity/impulsivity symptoms. In multivariate analyses, they found that significant inattention symptoms were linked with ever having smoked (tried smoking) and with being a current smoker (described as smoking a cigarette in the last 30 days; versus non-current smoker).

Finally, Burke et al. (2001) looked at clinic-referred boys, and found that childhood (ages 7 – 12) hyperactivity/impulsivity and childhood inattention, assessed separately, were not associated with adolescent (ages 13 -15) tobacco use (i.e., dichotomous variable identifying any days of use). On the other hand, *adolescent* inattention and tobacco use were related. The relationship between adolescent inattention and tobacco use remained, even after CD was controlled.

A study by Kollins, McClernon, and Fuemmeler (2005) indicated that both inattention and hyperactivity/impulsivity may play a role in smoking development. Kollins et al. (2005) investigated the association between retrospectively reported symptoms of ADHD and smoking outcomes in a nationally representative U.S. sample. Participants were asked at mean age = 21.94 to report symptoms of inattention and hyperactivity/impulsivity that occurred between the ages of 5 and 12 years old. There was a significant relationship between both inattention and hyperactivity/impulsivity

symptoms and regular smoking, even when controlling for symptoms of conduct disorder and demographic variables. Note, however, that when each dimension was also included as a control for the other, inattention was no longer significant.

Overall, results are mixed, and while inattention may be important in smoking development, as illustrated by the finding that tobacco use may be associated with increased attention (Gardner et al., 2006), it seems that hyperactivity/impulsivity may play an important role as well.

### **Association between Inattention and Hyperactivity/Impulsivity and Conduct Problems**

Some studies have examined inattention and hyperactivity separately in relation to their associations with conduct problems or aggression. Côté, et al. (2002) identified trajectories of hyperactivity, helpfulness, and fearlessness in boys and girls from kindergarten to grade 6 (about 1/3 were selected based on high disruptive behaviour scores). Using combinations of trajectories, they created 8 profiles, and assessed the associations of the various profiles with CD in adolescence. For boys, hyperactivity; hyperactivity and lack of helpfulness; and hyperactivity, lack of helpfulness, and fearlessness were the three profiles associated with CD. For girls, only one profile, hyperactivity and lack of helpfulness, was associated with CD. Inattention was not examined.

Nagin and Tremblay (2001) followed boys from low SES areas from ages 6 to 15 and identified four trajectories in the development of physical aggression. The two higher aggression trajectories were distinguished from the two lower aggression

trajectories most strongly by levels of hyperactivity and opposition in kindergarten. Level of inattention was not significant in the multivariate model. In girls (including sub-groups with and without ADHD), Lee and Hinshaw (2006) found that hyperactivity/impulsivity predicted conduct problems during adolescence (4 to 5 years later), but inattention did not.

On the other hand, Harachi et al. (2006) followed trajectories of aggression in boys and girls separately from grades 2 to 8, and inattention distinguished the bottom and top two aggression trajectories for both boys and girls. Hyperactivity was not examined.

It appears that hyperactivity may play a stronger role in the association between ADHD and CD, especially given the greater prevalence of CD in association with the predominantly hyperactive/impulsive and combined sub-types.

### **Potential Mechanisms relating Inattention and Hyperactivity/Impulsivity and**

#### **Smoking**

The self-medication hypothesis suggests that individuals may engage in substance use to alleviate symptoms of mental health problems (Khantzian, 1997). More specifically, self-medication may be used by those with ADHD to relieve symptoms of inattention (Bekker, Böcker, Van Hunsel, van den Berg, & Kenemans, 2005). Studies indicate that nicotine improves attention (Rezvani & Levin, 2001; Bekker et al., 2005). Levin et al. (1996) found that individuals with ADHD did better on measures of attention when a nicotine patch was used (versus a placebo). Furthermore,

Levin et al. (1998) conducted a study with non-smoking participants without ADHD, and found that individuals did better on measures of attention when a nicotine patch was used (versus a placebo). Levin et al.'s (1998) findings indicate that, even among those without ADHD, nicotine improves attention.

Nicotine has effects on multiple neurotransmitter systems in the brain, and may influence thought processes through a number of pathways (Rezvani & Levin, 2001). Specifically, nicotine leads to increased levels of dopamine, an effect similar to that caused by medications used to treat ADHD (i.e., amphetamine and methylphenidate; Rezvani & Levin, 2001). In fact, research suggests that the use of medications in those with ADHD may reduce smoking behaviour (Whalen et al., 2003). In their review of ADHD and smoking, McClernon and Kollins (2008) suggested that those with ADHD experience problems with the dopamine system in the brain, and as a result, may be more susceptible to the rewarding effects of the increased dopamine levels associated with smoking.

McClernon and Kollins (2008) also point out that, in addition to characteristics which may lead to a greater likelihood of continuing to smoke, those with ADHD may be more susceptible to trying smoking because of characteristics such as novelty seeking, peer difficulties, and impulsivity.

Wilens et al. (2008) found that individuals with ADHD had greater smoking risk, relative to those without ADHD, in association with exposure to smokers (including

smoking parents). Thus, those with ADHD may be more strongly influenced by being around smokers (Wilens et al., 2008).

Finally, inattention and hyperactivity/impulsivity may act as indirect influences on smoking. Those with ADHD face challenges socially and at school (Sullivan & Rudnik-Levin, 2001; *DMS-IV-TR*, 2000). As already discussed, CD and ADHD often co-occur (Biederman et al., 1991), and a number of findings suggest that conduct problems may mediate between ADHD and smoking (Brook et al., 2008; Burke et al., 2001; Barkley et al., 1990). In addition, level of coping skills (Molina, Marshal, Pelham, & Wirth, 2005), level of parental support (Molina et al., 2005), and level of deviant peer affiliations (Marshal, Molina, & Pelham, 2003) have all been found to act as (partial) mediators between ADHD and smoking.

### ***Severity of Inattentive and Hyperactive/Impulsive Behaviour and Smoking***

Some research has focused on the relationship between severity of inattentive and hyperactive/impulsive symptoms and smoking, and as pointed out by Glass and Flory (2010), increasing chances of smoking may be linked with increasing levels of ADHD behaviour. Uphadhyaya and Carpenter (2008) found that, for both inattention and hyperactivity/impulsivity, increases in the number of symptoms were associated with increased smoking in the last month and year. Similarly, Kollins et al. (2005) found that each increase in inattention or hyperactivity/impulsivity was linked with an increased chance of regular smoking. Wilens et al. (2008) found that nicotine dependence was linearly associated with both inattention and hyperactivity/impulsivity

among smokers. McClernon and Kollins (2008) suggest that it is not the diagnostic condition of ADHD that is linked to smoking behaviour, but the problems that form the basis for the condition. These ideas are consistent with findings from research on nicotine and attention, because it has been shown that a nicotine patch improves attention (versus a placebo) even in those without ADHD, suggesting that nicotine has an effect even at sub-clinical levels of inattention (Levin et al., 1998).

### *Gender Differences*

Research indicates that there are differences in the rates of diagnosis of ADHD by gender, with boys more likely to be diagnosed with ADHD than girls (Wolraich et al., 1998). While Wolraich et al. (1998) found that, in a community sample, boys were more likely to have all types of ADHD than girls, but with a smaller gender difference for the predominantly inattentive sub-type; Biederman et al. (2002) found that girls with ADHD were more likely to have the predominantly inattentive sub-type than boys with ADHD in a clinic-referred sample.

Biederman et al. (2002) found that compared to non-ADHD controls, girls with ADHD were at relatively greater risk for substance use diagnoses than boys with ADHD. Furthermore, Galéra et al. (2005) found that hyperactivity/inattention predicted daily smoking among girls, but not among boys (though they did find a separate measure of activity level to be significant among boys). Thus there is some evidence that girls may be more strongly affected by such symptoms than boys in terms of substance use,

including smoking. As such, the variables of interest in the current study will be examined for boys and girls separately.

### **Hypotheses**

1. Boys and girls with higher levels of inattentive and/or hyperactive/impulsive behaviour relative to others of their gender may be more likely to smoke during adolescence (i.e., the relative risk ratio (RRR) values may be significantly greater than 1 among boys and girls).
2. Inattentive and/or hyperactive/impulsive behaviour may be associated with smoking because of a link with conduct problems. The addition of conduct problems to the models for boys and girls may render associations between childhood inattentive and/or hyperactive/impulsive behaviour and adolescent smoking non-significant, suggesting a potential mediating role for conduct problems. This potential result was particularly anticipated for hyperactive/impulsive behaviour because it appears to be more responsible for the link between ADHD and conduct problems.
3. The relative risk of adolescent smoking may be higher among girls than among boys given higher levels of inattentive and/or hyperactive/impulsive behaviour relative to others of their gender (i.e., the relative risk ratio (RRR) may be higher among girls than among boys).

## Method

### **National Longitudinal Study of Children and Youth (NLSCY)**

The National Longitudinal Survey of Children and Youth (NLSCY) is a Canadian project undertaken by Statistics Canada for Human Resources Development Canada (HRDC). The survey was designed to gather information about Canadian children, and contains a broad range of information pertaining to child development and well-being (Human Resources Development Canada & Statistics Canada, 1996).

NLSCY data collection began in 1994/1995, and was focused on children from newborn to age 11. Within a household, the person most knowledgeable about the child (PMK) was asked a series of questions about the child, and about socioeconomic and demographic information (either in person or by telephone in a computer-assisted interview). Older children (ages 10 and 11 in Cycle 1) were asked to fill in Self-Completed Questionnaires. Up to four randomly selected children within a household could be included in the NLSCY. The 13, 439 responding households resulted in a sample of 22, 831 children in Cycle 1 (Human Resources Development Canada & Statistics Canada, 1996). In Cycle 2, the NLSCY surveyed fewer households, and included, at most, 2 children per household. This change occurred for financial reasons, and to lessen the inconvenience for participating families (Statistics Canada, n.d.b).

The sub-set of children of interest in the current study were ages 6 and 7 during Cycle 2. These children were followed up until Cycle 7; and data on these children was available through to ages 16 and 17. The data of interest in the current study included

Cycle 2 data based on PMK reports, and Cycle 7 data based on self-reports. Cycle 2 was selected as the initial cycle for this study in order to utilize data from a different population of children than a previous study in the research group, in which children who were age 6/7 at Cycle 1 were investigated (Hill, Quigley, Johansson, Babchishin, & Maggi, 2008). The measures of interest in the current study included Cycle 2 inattention, hyperactivity/impulsivity, conduct problems, and SES; and Cycle 7 smoking outcomes (N = 672 for girls; N = 619 for boys).

### **Measures**

#### ***Inattentive and Hyperactive/Impulsive Behaviour***

Inattentive and hyperactive/impulsive behaviour was measured at age 6/7 (Cycle 2) partly because of the diagnostic features of ADHD: it is difficult to diagnose ADHD in children younger than 4 or 5 because some types of behaviour seen in young pre-school children may be difficult to distinguish from ADHD behaviour, and because there are fewer demands on attention in younger children; the symptoms of ADHD are usually the most obvious during elementary school. However, individuals who are diagnosed with ADHD must show symptoms before the age of 7 (*DSM-IV-TR*, 2000). Assessment at age 6/7 (Cycle 2) also allowed the measurement of inattentive and hyperactive/impulsive behaviour essentially before smoking onset, making inferences about causality more reasonable.

Analyses to Identify Measures for Inattentive and Hyperactive/Impulsive Behaviour:

*Overview:*

The 10 individual inattentive/hyperactive/impulsive items in the NLSCY (see Appendix B) allowed for 3 possible responses: never/not true, sometimes/somewhat true, or often/very true. These responses were coded as 0, 1, and 2. The items were then added together in various combinations to create potential measures of (1) inattentive behaviour and (2) hyperactive/impulsive behaviour.

Three methods were used to create these potential measures: (1) items were selected based on factor analysis procedures conducted on the 10 inattentive/hyperactive/impulsive behaviour items, (2) the items that most closely corresponded to the *DSM-IV-TR* (2000) ADHD symptoms of inattention and hyperactivity/impulsivity were selected (see Appendixes A and C), and (3) the items were grouped into inattention and hyperactivity based on their identification as such in the planning stages of the NLSCY (Statistics Canada, n.d.a; see Appendix D). (There was one item that was included in both groups of NLSCY items. The hyperactivity items and the inattention items both included “can’t concentrate, can’t pay attention for long”. Reliability analyses were conducted on these potential measures both with and without this item included). Note that when the collected data was analyzed by the NLSCY, a single inattention/hyperactivity score was identified for inclusion in the database (Statistics Canada, n.d.a). However, given the goal of the present study to look at inattention and hyperactivity/impulsivity separately, this scale score from the NLSCY was not used.

The intention was to select the inattention and hyperactivity/impulsivity measures with the highest internal reliability, as a pair, and then use these in the main analysis. Age 6/7 children with data on all ten inattention/hyperactivity/impulsivity items were incorporated into the following analyses, and data were weighted using the Cycle 7 longitudinal weights.

#### Factor Analysis:

The determinant (0.04) indicated that multicollinearity was not a problem. Bartlett's Test of Sphericity was significant (Approx chi square = 5277.1,  $p < 0.001$ ) indicating that the correlations in the matrix were significantly different from 0, and that factor analysis was appropriate. The Kaiser-Meyer Olkin measure of sampling adequacy was 0.88, indicating that the analysis was reliable. Principal axis factors was used in the analysis; the eigenvalues indicated that 2 factors should be identified, while the Scree plot indicated that 1 to 2 factors should be identified. Oblique rotations were used because the factors were expected to be correlated. Direct oblimin and promax rotations produced similar results, and the direct oblimin factor scores were used to select items for the measures (note that the correlation between the factors was 0.55, confirming that oblique rotation was appropriate). The pattern matrix was used for interpretation because it reflects variance unique to the factor (see Appendix E). For each factor, items with factor loadings  $> 0.4$  were selected for inclusion in the measures. One item had a factor loading of  $> 0.4$  on each of the factors (i.e., is distractible, has trouble sticking to

any activity); and this item was therefore omitted from both measures. Interestingly, the 'impulsivity' item (i.e., is impulsive, acts without thinking) appeared to cluster with inattention rather than with hyperactivity in these analyses. This finding seems worthy of further exploration, but for the purposes of the main study, in which inattention and hyperactivity/impulsivity were the constructs of interest based on the literature, the 'impulsivity' item was not included in the factors (the factor loadings for this item were  $< 0.4$ , in any case; see Appendix F for items included in the potential measures based on the factor analysis). Note that the guidelines used for the factor analysis were from Brown (2009).

#### Internal Reliability Analyses:

The items best corresponding to the inattentive and hyperactive/impulsive symptoms for ADHD in the *DSM-IV-TR* (2000) resulted in measures with the highest internal reliability as a pair (see Table 1).

#### Final Measures of Inattentive and Hyperactive/Impulsive Behaviour:

Based on the above findings, the measures based on the *DSM-IV-TR* (2000) were selected for use in the main analysis. The internal reliabilities were determined for the specific male and female samples under study (hyperactivity/impulsivity for males: Chronbach's  $\alpha = 0.72$ ; hyperactivity/impulsivity for females: Chronbach's  $\alpha = 0.72$ ; inattention for males: Chronbach's  $\alpha = 0.84$ ; inattention for females:

Chronbach's alpha = 0.76). Note that when the final inattention and hyperactivity/impulsivity measures were created, all cases were initially retained. Any individuals with data on the 4 items in the given measure were included in that measure.

### ***Conduct Problems***

The conduct problem measure was created by combining two scores from the NLSCY, the physical aggression/conduct disorder score and the property offence score. These scores were created in the NLSCY based on responses (i.e., never/not true, sometimes/somewhat true, often/very true) to specific questions about problem behaviour (see Appendix G). The internal reliabilities for the male and female samples were determined by running an analysis on the 12 individual items making up the two scores (Chronbach's alpha for males = 0.77; Chronbach's alpha for females = 0.71).

### ***Socio-economic Status***

The Socio-economic status (SES) measure was included in the NLSCY database. It was created for the NLSCY using the following 5 measures: PMK's years of education and occupational prestige, spouse of PMK's years of education and occupational prestige, and household income. The variables were standardized based on Cycle 2 households (Statistics Canada, n.d.a). Note that the NLSCY imputed missing or inconsistent data for household income (Statistics Canada, n.d.a).

### ***Smoking***

Smoking outcomes were assessed at age 16/17. According to Health Canada (2002), the prevalence rate for smokers between the ages of 15 and 19 is about 2/3 of the highest prevalence rate, which occurs between 20 and 24 years of age. The alternative approach using the NLSCY data, would have been to assess children's inattentive and hyperactive/impulsive behaviour at age 10/11 (note that this is an older cohort of children than those assessed at age 6/7), and then to assess smoking outcomes at age 22/23. While this strategy would have been likely to capture more individuals who would become smokers, it would have measured inattention and hyperactivity/impulsivity at a time when some children were already starting to smoke. Maggi, Hertzman and Vaillancourt (2007) found that individuals who tried smoking early (i.e., early onset: 10.2% of the sample) had a high probability of trying smoking by age 10. It made sense to assess hyperactive/impulsive and inattentive behaviour early to avoid overlap with smoking onset as much as possible.

In this study, individuals were categorized as non-smokers, occasional smokers, or regular smokers. Findings by Maggi et al. (2007) indicated that there are different developmental trajectories of smoking: they identified trajectories of experimenters who eventually became non-smokers, and trajectories of individuals who became regular smokers (by the final age of the trajectory analysis at 16/17). They suggested that experimental smoking should be treated as a conceptually different category, rather than as a point between non-smoking and regular smoking. In Cycle 7 of the NLSCY, 16 and 17 year old participants were asked about their experience with smoking cigarettes.

Those who said they never smoked, only smoked a few puffs, or didn't smoke anymore were identified as non-smokers; those who smoked a few times a year, once or twice a month, 1 or 2 days a week, or 3 to 5 days a week were identified as occasional smokers; and those who smoked 6 or 7 days a week were identified as regular smokers. All analyses were conducted using multinomial logistic regression (i.e., comparing non-smokers to both occasional smokers and regular smokers). The multinomial logistic regression was run using the z-scores for the standardized behavioural measures (i.e., inattentive behaviour, hyperactive/impulsive behaviour, and conduct problems).

Note that the parallel lines test was conducted using SPSS to assess the suitability of ordinal regression analysis (also using the z-scores for the standardized behavioural measures; and using the Cycle 7 longitudinal sampling weights). The smoking variable was entered with the four independent variables using the negative log-log link function because the probability of the non-smoking outcome was highest, with the cumulative probability levelling off for the occasional and regular smoking outcomes. The parallel lines tests were significant for both genders, indicating that the assumption of parallel lines required for ordinal regression was violated. However, given that the test for girls was identified by SPSS to be of questionable validity, the ordinal regression results were examined, and the results for girls were found to be similar to those obtained using multinomial regression (SES estimate = -0.65,  $p < 0.1$ ; CP estimate = 0.16,  $p < 0.1$ ; inattention estimate = 0.23,  $p < 0.1$ ; hyperactivity/impulsivity estimate = -0.14, ns).

Given the clear violation of the assumption of parallel lines for boys, and the questionable violation of the assumption of parallel lines for girls, multinomial logistic regression was interpreted in these analyses.

### **Procedure**

Children who were age 6/7 during Cycle 2 of the NLSCY were included if they had data on each of the pertinent measures (i.e., Cycle 2 SES, Cycle 2 inattention, Cycle 2 hyperactivity/impulsivity, Cycle 2 conduct problems, and Cycle 7 smoking outcomes). Note that the NLSCY Cycle 7 longitudinal weights and the NLSCY bootstrap weights were used throughout these analyses. Univariate analyses were conducted for inattention and hyperactivity/impulsivity, since these were the key variables of interest. Multivariate analyses were then conducted with SES, conduct problems, inattention, and hyperactivity/impulsivity entered together. All analyses examined non-smoking versus occasional smoking, and non-smoking versus regular smoking. For each gender and smoking status comparison, the RRR values and significance levels were reported with  $p < 0.1$  considered significant.

## Results

### Descriptives

The frequencies of non-smoking, occasional smoking and regular smoking for boys and girls are presented in Table 2. The means, BRR standard errors, confidence intervals, standard deviations, and ranges for inattention, hyperactivity/impulsivity, conduct problems, and SES for boys and girls are presented in Table 3. The correlations among these variables for boys and girls are presented in Table 4. The NLSCY Cycle 7 longitudinal weights were used for all of the above analyses; and additionally, the NLSCY bootstrap weights were used for the means, BRR standard errors, and confidence intervals in Table 3.

### Attrition

Among those who were eligible for inclusion in the study (i.e., data was available on the Cycle 2 variables), 54% of boys and 59% of girls had data for the Cycle 7 smoking outcome. Thus, just over half of potential participants were eligible for analysis in this study. As such, it was critical to conduct an attrition analysis. Among those who had data on the Cycle 2 variables, those who had data on the outcome variable in Cycle 7 were compared to those who did not. The NLSCY Cycle 2 longitudinal weights and bootstrap weights were used in these analyses. Among boys, those who had data on the outcome variable had higher SES than those who did not (OR

= 1.59,  $p < 0.1$ ). Among girls, those who had data on the outcome variable had higher SES (OR = 2.05,  $p < 0.1$ ), higher hyperactivity/impulsivity (OR = 1.20,  $p < 0.1$ ), and lower inattention (OR = 0.88,  $p < 0.1$ ) than those who did not.

### **Univariate Results for Inattention and Hyperactivity/Impulsivity**

#### Non-Smoking versus Occasional Smoking

Neither inattention nor hyperactivity/impulsivity was associated with occasional smoking in boys or girls (boys inattention: RRR = 0.93, ns; girls inattention: RRR = 1.13, ns; boys hyperactivity/impulsivity: RRR = 1.01, ns; girls hyperactivity/impulsivity: RRR = 1.10, ns; see Table 5) in the univariate models.

#### Non-Smoking versus Regular Smoking

Neither inattention nor hyperactivity/impulsivity was associated with regular smoking among boys (boys inattention: RRR = 1.11, ns; boys hyperactivity/impulsivity: RRR = 0.88, ns; see Table 6) in the univariate models. Among girls, inattention, but not hyperactivity/impulsivity, was associated with regular smoking (girls inattention, RRR = 1.52,  $p < 0.1$ ; girls hyperactivity/impulsivity, RRR = 1.20, ns; see Table 6): girls with higher levels of inattention were more likely to smoke regularly than girls with lower levels of inattention.

### **Multivariate Results**

### Non-Smoking versus Occasional Smoking

Among girls, none of the variables (i.e., inattention, hyperactivity/impulsivity, conduct problems, and SES) were associated with occasional smoking. Among boys, only conduct problems were associated with occasional smoking (RRR = 1.65;  $p < 0.1$ ; see Table 7): boys with higher levels of conduct problems were more likely to smoke occasionally than boys with lower levels of conduct problems.

### Non-Smoking versus Regular Smoking

Among girls, conduct problems (RRR = 1.49,  $p < 0.1$ ), SES (RRR = 0.29,  $p < 0.1$ ), and inattention (RRR = 1.43,  $p < 0.1$ ) were associated with regular smoking (see Table 8). Girls with higher levels of conduct problems were more likely to smoke regularly than girls with lower levels of conduct problems; girls with lower SES were more likely to smoke regularly than girls with higher SES; and girls with higher levels of inattention were more likely to smoke regularly than girls with lower levels of inattention.

Among boys, SES (RRR = 0.35,  $p < 0.1$ ) and conduct problems (RRR = 1.52,  $p < 0.1$ ) were associated with regular smoking (see Table 8). Boys with lower SES were more likely to smoke regularly than boys with higher SES; and boys with higher levels of conduct problems were more likely to smoke regularly than boys with lower levels of conduct problems.

## Discussion

The current results suggest that girls with higher levels of childhood (age 6/7) inattentive behaviour are more likely to smoke regularly during adolescence (age 16/17) than girls with lower levels of childhood inattentive behaviour. Although childhood conduct problems significantly predicted regular adolescent smoking among girls, the inclusion of conduct problems in the model did not eliminate the association between childhood inattentive behaviour and adolescent smoking. For boys, on the other hand, there was no association between childhood inattentive behaviour and adolescent smoking. Furthermore, no associations were found between childhood hyperactive/impulsive behaviour and adolescent smoking for either gender.

Few other studies have separated the genders in examining the relationships between inattentive and hyperactive/impulsive behaviour and smoking. The current findings differed from those of Burke et al. (2001) and Burke et al. (2007) who looked at boys only, and found that inattention was associated with smoking outcomes. Note however that Burke et al. (2001) used a clinic-referred sample, and Burke et al. (2007) selected a substantial sub-group of their sample for higher levels of problem behaviour. Because the current sample was drawn from the general population, there were likely fewer participants with high levels of inattention. Perhaps, among boys, smoking behaviour is associated with inattention only at relatively high levels of inattention.

In the context of smoking, girls appear to be more strongly affected by inattention. Other findings also suggest that girls may be more affected by the symptoms associated with ADHD. Biederman et al. (2002) found that girls with ADHD were at relatively greater risk for substance use diagnoses than boys with ADHD, and Galéra et al. (2005) found that daily smoking was associated with hyperactivity/inattention among girls, but not among boys. Studies that have looked at the genders separately have not typically separated inattention and hyperactivity/impulsivity, and in the current study it was specifically inattention at age 6/7 that predicted adolescent smoking outcomes at age 16/17 among girls.

The above findings resulted despite the fact that girls, on average, had lower levels of inattention than boys in the current data (i.e., the mean for inattention was lower for girls and the ranges of the 95% confidence intervals did not overlap; see Table 3). Although this could be related to the attrition analysis results, that girls who had outcome data at Cycle 7 had lower inattention than those who did not (which was not the case for boys), other research is consistent with this finding, indicating that girls do better than boys on measures relating to attention. In a meta-analysis of temperament comparing the genders, Else-Quest, Shibley Hyde, Hill Goldsmith, & Van Hulle (2006) found large differences between boys and girls on effortful control, and smaller but significant differences on some dimensions that they incorporated within this category, including attention, attention shifting, and attention focusing.

Attentional processes are important for effective interaction with parents and peers, and the quality of these interactions has an impact on subsequent development (Wilson & Gottman, 1996). Furthermore, Parke and Buriel (2006) suggest that social interactions between parents and children affect attentional processes, which in turn influence social skills. Thus, attention problems may be associated with problems in socialization processes in a reciprocal manner, with each affecting the other in a negative way.

Because girls generally do better than boys on measures of attention, it is possible that girls who are inattentive, or who are struggling with effortful control, might be more noticeably different than their peers. This situation might create difficulties for them within their peer group, and might also affect the reactions of parents to their children. Parental expectations surrounding attention and effortful control may be higher for girls, and may lead to unrealistic expectations and frustration. It has been found that an understanding of child development may be associated with supportive parenting (Stevens, 1984), and that feeling connected to parents may decrease the risk of smoking behaviour (Scal, Ireland, & Borowsky, 2003). More specifically, level of parental support has been identified as a (partial) mediator between ADHD and smoking (Molina et al., 2005).

It is also possible that girls with higher levels of inattention are especially affected by exposure to smokers. Findings by Scal et al. (2003) suggest that girls may

be more influenced by the smokers around them than boys. Similarly, findings by Wilens et al., (2008) suggest that individuals with ADHD may be more strongly influenced by being around smokers. Perhaps girls with higher levels of inattention are affected by both of these factors, resulting in a compounding of the problem.

The fact that inattention remained significant with conduct problems in the model suggests that self-medication may also play a role in smoking development among girls. As discussed, it has been shown that nicotine improves attention, even in those without clinical diagnoses of ADHD (Levin et al., 1998). Interestingly, Burke et al. (2007), and Burke et al (2001) found an association between inattention and smoking among boys (they did not look at girls); however their participants likely had higher levels of inattention than those in the present study. There are differences between the male and female brains (Halpern, 2000), and it is at least conceivable that there may be differences that make girls susceptible to self-medication at lower levels of inattention.

Finally, given that conduct problems were measured early (at age 6/7), 10 years prior to the measurement of smoking behaviour, it is possible that inattention led to an increase in conduct problems gradually and cumulatively over the intervening years, and that later conduct problems played a mediating role between inattention and smoking. Although conduct problems are more strongly associated with the combined and predominantly hyperactive/impulsive sub-types of ADHD, they can also co-occur with the predominantly inattentive sub-type (Wolraich et al., 1998). There are likely complex

interrelationships among inattention, conduct problems, smoking, and a number of other variables. For example, parental warmth may be associated with all three of these variables: level of parental support has been identified as a (partial) mediator between ADHD and smoking (Molina et al., 2005); and lack of parental warmth has also been identified as a risk factor for conduct disorder/delinquency (Murray, Phil, & Farrington, 2010)

### **Limitations and Future Directions**

Although there were many advantages to using an existing database, including the opportunity to access longitudinal data across an extensive time span, the main disadvantage was that the availability of specific variables and measures was predetermined.

Although they deal with similar concepts, the hyperactivity/impulsivity/inattention items in the NLSCY and in the *DMS-IV-TR* (2000) read quite differently from each other; the *DSM-IV-TR* (2000) items are much more specific and detailed than the NLSCY items (see Appendixes A and B). This situation is to be expected given the purpose and audience for each of these sources, however the differences might result in items and scales that behave somewhat differently from each other.

The sources for the inattention and hyperactivity items for the NSLCY were the Ontario Child Health Study and the Montreal Longitudinal Survey (Statistics Canada, n.d.a). The NLSCY factor analysis identified a single hyperactivity/inattention factor based on Cycle 1 data (Statistics Canada, n.d.a). The current focus on the two separate dimensions of hyperactivity/impulsivity and inattention meant that these items had to be separated into two clusters. This circumstance made it difficult to determine the validity of the measures, and emphasis was therefore placed on the reliability of the potential scales.

As described previously, individuals who are diagnosed with ADHD are classified as having one of three sub-types: a predominantly hyperactive/impulsive sub-type, a predominantly inattentive sub-type, or a combined sub-type (*DSM-IV-TR*, 2000). McBurnett (1994) concluded that research into the clustering of ADHD symptoms supported two dimensions, with hyperactivity and impulsivity as one of the dimensions. However, the distinction between inattention and hyperactivity/impulsivity was not clear cut in the present data.

The NLSCY identified a single hyperactivity/inattention score when factor analysis was conducted on the Cycle 1 data (Statistics Canada, n.d.a). In the current factor analysis of Cycle 2 data, either a one or two factor structure could have been justified. Two factors were retained because of this study's focus on the two dimensions of ADHD based on the literature.

Still, the details of the factor analysis also suggested that the two dimensions might not be clearly separable in the current data. The 'impulsivity' item (i.e., is impulsive, acts without thinking) loaded more highly onto the inattention factor. (Recall that in the present data, the factor loading for impulsivity was  $< 0.4$  for both factors, so this item was omitted from further analysis.) In addition, the item 'can't concentrate, can't pay attention for long' clustered with the hyperactivity items (i.e., can't sit still, is restless or hyperactive; fidgets; and cannot settle to anything for more than a few minutes) rather than the inattention items (i.e., gives up easily; is inattentive; and stares into space) in the factor analysis. Finally, the item 'is distractable, has trouble sticking to any activity' had factor loadings of  $> 0.4$  on both factors, and was therefore omitted. Although measures were not based on the factor analysis, but were rather based on correspondence with *DSM-IV-TR* (2000) items, the factor analysis demonstrates that inattention and hyperactivity/impulsivity may not have been clearly separable.

Interestingly, Rothbart and Bates' (2006; Rothbart, Ahadi, Hershey, & Fisher, 2001) temperament dimensions incorporate attentional focusing and inhibitory control within effortful control, and activity level within surgency/extraversion. The current factor analysis may have corresponded somewhat to these findings, because the 'impulsivity' item loaded more strongly on the inattention factor in this data. This is particularly noteworthy since the current sample was based on the general population, rather than on a clinically based sample. In future, it would be interesting to examine

whether effortful control and/or surgency/extraversion predict smoking outcomes. Findings for inattention and hyperactivity/impulsivity are mixed, and it would be interesting to see whether any informative pattern might emerge if these other predictors were used in a sample based on the general population.

It is also important to note that attrition is a substantial issue in this NLSCY data, as indicated in the description of the attrition analysis. Data was examined when children were aged 6/7 and then again when they were aged 16/17, ten years later. The NLSCY makes every effort to compensate for attrition by using sampling weights, and those with non-response for Cycle 7 are accounted for by this method. Those who are identified as respondents do not necessarily have complete data (Statistics Canada, n.d.b). Individuals who were considered respondents at Cycle 7, but who did not respond to the Cycle 7 smoking question, would not be accounted for in the weighting process. Among those who had data on the Cycle 2 variables, 16% of girls and 22% of boys were considered Cycle 7 respondents, but had no data on the outcome variable (calculated using NLSCY Cycle 7 longitudinal weights).

Recall that the attrition analysis indicated that the Cycle 2 SES scores for both boys and girls were higher for those with smoking data at Cycle 7. In addition, the hyperactivity/impulsivity scores for girls at Cycle 2 were higher for those with smoking data at Cycle 7, and the inattention scores for girls at Cycle 2 were lower for those with smoking data at Cycle 7.

The attrition results for the SES scores were not surprising, since it is not uncommon for those with higher SES to be more easily retained in a study. The attrition results for the hyperactivity/impulsivity scores are perhaps somewhat unexpected, since it might be expected that those with higher levels of 'symptoms' would be more likely to drop out of a study. However, because the sample was based on the general population, high levels of attrition such as those that might occur in a sample with overall higher levels of symptoms might not be expected (e.g., in a clinical population or an at-risk population). In any case, hyperactivity/impulsivity at Cycle 2 did not predict smoking at Cycle 7 for any of the conditions, and given that girls with higher levels of hyperactivity/impulsivity were more likely to be retained, if anything a bias in favour of significant results would have been expected.

With regard to inattention, girls with higher inattention scores were less likely to have Cycle 7 outcome data. While this finding is not surprising, a bias against significant findings would be expected. Nevertheless, the current results indicated that girls with higher levels of inattention were more likely to smoke regularly than girls with lower levels of inattention. If anything, the results may have underestimated the effect. Overall, the fact that there were significant differences between the girls who were retained, and the girls who were not, should be kept in mind in considering the findings.

Future research should focus on clarifying the complex interrelationships among inattention, hyperactivity/impulsivity, conduct problems, smoking, and the many other

associated variables. In addition, research should focus on potential differences between boys and girls in terms of substance use and smoking development. The current results suggest that there are differences between boys and girls in terms of pathways to smoking development in the general population. Additional research should be conducted looking at boys and girls separately to further elucidate the pathways to smoking for each of the genders.

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Table 1

Internal Reliabilities for Potential Measures of Inattention and Hyperactivity

(/Impulsivity)

<u>Basis for Measure</u>	<u>Measure</u>	<u>Chronbach's alpha</u>	<u>No. of Items</u>
DSM-IV-TR	Inattention	0.81	4
	Hyperactivity/Impulsivity	0.72	4
NSLCY	Inattention	0.64	4
	Hyperactivity	0.83	7
	Inattention <sup>a</sup>	0.54	3
	Hyperactivity <sup>a</sup>	0.80	6
Factor Analysis	Inattention	0.54	3
	Hyperactivity	0.81	4

<sup>a</sup> item present in both NLSCY measures removed (i.e., can't concentrate, can't pay attention for long)

Table 2

Frequencies of Non-Smoking, Occasional Smoking, and Regular Smoking for Boys and Girls

	Boys		Girls	
	Frequency	Percent	Frequency	Percent
Non-Smokers	517	83	544	81
Occasional Smokers	53	9	60	9
Regular Smokers	49	8	68	10
Total	619	100	672	100

Table 3

Means of Cycle 2 Variables for Boys and Girls

Predictor	Mean	BRR SE	95 % CI	SD	Range
Boys					
SES	0.06	0.05	-0.04 - 0.15	0.72	-2.67 - 2.2
Inattention	2.23	0.19	1.85 - 2.60	2.15	0 - 8
Hyperactivity/Impulsivity	3.02	0.16	2.70 - 3.33	2.11	0 - 8
Conduct Problems	2.54	0.16	2.24 - 2.85	2.69	0 - 17
Girls					
SES	0.07	0.04	-0.02 - 0.15	0.70	-2.47 - 2.48
Inattention	1.46	0.12	1.23 - 1.70	1.72	0 - 8
Hyperactivity/Impulsivity	2.71	0.15	2.42 - 3.00	2.00	0 - 8
Conduct Problems	1.89	0.14	1.62 - 2.17	2.14	0 - 14

Note. SES was created using 5 measures which were standardized by the NSLCY based on Cycle 2 households. Inattention, Hyperactivity/Impulsivity, and Conduct Problems calculations were based on the unstandardized scores.

Table 4

Pairwise Correlations Among Cycle 2 Variables for Boys and Girls

Predictor	1	2	3	4
Boys				
1. SES	-	-0.06	0.02	-0.11
2. Inattention		-	0.70	0.33
3. Hyperactivity/Impulsivity			-	0.40
4. <u>Conduct Problems</u>				-
Girls				
1. SES	-	-0.24	-0.15	-0.15
2. Inattention		-	0.65	0.37
3. Hyperactivity/Impulsivity			-	0.43
4. <u>Conduct Problems</u>				-

Table 5

Univariate Results for Inattention and Hyperactivity/Impulsivity Distinguishing Non-Smokers from Occasional Smokers for Boys and Girls

Variable	RRR	BRR SE	p-Value	95% Confidence Interval
Boys				
Inattention	0.93	0.24	0.796	0.56 - 1.56
Hyperactivity/ Impulsivity	1.01	0.18	0.962	0.72 - 1.42
Girls				
Inattention	1.13	0.41	0.727	0.56 - 2.30
Hyperactivity/ Impulsivity	1.10	0.22	0.632	0.75 - 1.61

Note. Multinomial regression was run on the z-scores of the standardized Inattention and Hyperactivity/Impulsivity measures.

Table 6

Univariate Results for Inattention and Hyperactivity/Impulsivity Distinguishing Non-Smokers from Regular Smokers for Boys and Girls

Variable	RRR	BRR SE	p-Value	95% Confidence Interval
Boys				
Inattention	1.11	0.25	0.646	0.71 - 1.73
Hyperactivity/ Impulsivity	0.88	0.31	0.718	0.43 - 1.78
Girls				
Inattention	1.52	0.22	0.004*	1.14 - 2.03
Hyperactivity/ Impulsivity	1.20	0.21	0.307	0.85 - 1.69

Note. Multinomial regression was run on the z-scores of the standardized Inattention and Hyperactivity/Impulsivity measures.

Table 7

Multivariate Results Distinguishing Non-Smokers from Occasional Smokers for Boys and Girls

Variable	RRR	BRR SE	p-Value	95% Confidence Interval
Boys				
CP	1.65	0.45	0.065*	0.97-2.81
SES	1.25	0.54	0.599	0.54-2.90
IN	0.84	0.31	0.645	0.41-1.74
H/I	0.91	0.27	0.742	0.50-1.63
Girls				
CP	0.69	0.20	0.191	0.39-1.21
SES	0.81	0.28	0.538	0.41-1.60
IN	1.12	0.62	0.839	0.38-3.31
H/I	1.15	0.41	0.694	0.57-2.31

Note. CP = Conduct Problems; IN = Inattention; H/I = Hyperactivity/Impulsivity.

Multinomial regression was run on the z-scores of the standardized Conduct Problem, Inattention, and Hyperactivity/Impulsivity measures. SES was created using 5 measures which were standardized by the NSLCY based on Cycle 2 households.

Table 8

Multivariate Results Distinguishing Non-Smokers from Regular Smokers for Boys and Girls

Variable	RRR	BRR SE	p-Value	95% Confidence Interval
Boys				
CP	1.52	0.34	0.063*	0.98-2.36
SES	0.35	0.13	0.006*	0.16-0.74
IN	1.30	0.42	0.424	0.68-2.46
H/I	0.61	0.29	0.307	0.24-1.58
Girls				
CP	1.49	0.27	0.027*	1.05-2.12
SES	0.29	0.09	<0.001*	0.15-0.55
IN	1.43	0.27	0.059*	0.99-2.07
H/I	0.71	0.18	0.174	0.44-1.16

Note. CP = Conduct Problems; IN = Inattention; H/I = Hyperactivity/Impulsivity.

Multinomial regression was run on the z-scores of the standardized Conduct Problem, Inattention, and Hyperactivity/Impulsivity measures. SES was created using 5 measures which were standardized by the NSLCY based on Cycle 2 households.

## Appendix A

Inattentive and Hyperactive/Impulsive Symptoms Identified by the *DSM-IV-TR* (2000) for Attention-Deficit/Hyperactivity Disorder (*DSM-IV-TR*, 2000, p. 92)

### Symptoms of Inattention

- (a) Often fails to give close attention to details or makes careless mistakes in schoolwork, work, or other activities
- (b) Often has difficulty sustaining attention in tasks or play activities
- (c) Often does not seem to listen when spoken to directly
- (d) Often does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workplace (not due to oppositional behaviour or failure to understand instructions)
- (e) Often has difficulty organizing tasks and activities
- (f) Often avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort (such as schoolwork or homework)
- (g) Often loses things necessary for tasks or activities (e.g., toys, school assignments, pencils, books, or tools)
- (h) Is often easily distracted by extraneous stimuli
- (i) Is often forgetful in daily activities

### Symptoms of Hyperactivity/Impulsivity

#### Hyperactivity

- (a) Often fidgets with hands or feet or squirms in seat
- (b) Often leaves seat in classroom or in other situations in which remaining seated is expected
- (c) Often runs about or climbs excessively in situations in which it is inappropriate (in adolescents or adults, may be limited to subjective feelings of restlessness)

(d) Often has difficulty playing or engaging in leisure activities quietly

(e) Is often “on the go” or often acts as if “driven by a motor”

(f) Often talks excessively

Impulsivity

(g) Often blurts out answers before questions have been completed

(h) Often has difficulty awaiting turn

(i) Often interrupts or intrudes on others (e.g., butts into conversations or games)

## Appendix B

### Ten Inattentive /Hyperactive/Impulsive Behaviour Items in the NLSCY (Cycle 2)

Can't sit still, is restless or hyperactive

Is distractible, has trouble sticking to any activity

Fidgets

Can't concentrate, can't pay attention for long

Is impulsive, acts without thinking

Has difficulty awaiting turn in games or groups

Gives up easily

Cannot settle to anything for more than a few moments

Stares into space

Is inattentive

## Appendix C

Measures Based on Criteria in *DSM-IV-TR* (2000)

### Hyperactivity/Impulsivity

#### **Can't sit still, is restless or hyperactive**

Hyperactivity (category)

Often fidgets with hands or feet or squirms in seat (Hyperactivity – a)

Is often 'on the go' or often acts as if 'driven by a motor' (Hyperactivity – e)

#### **Fidgets**

Often fidgets with hands or feet or squirms in seat (Hyperactivity – a)

#### **Is impulsive, acts without thinking**

Impulsivity (category)

#### **Has difficulty awaiting turn in games or groups**

Often has difficulty awaiting turn (Impulsivity – h)

### Inattention

#### **Is distractible, has trouble sticking to any activity**

Often has difficulty sustaining attention in tasks or play activities (Inattention – b)

Is often easily distracted by extraneous stimuli (Inattention – h)

#### **Can't concentrate, can't pay attention for long**

Often has difficulty sustaining attention in tasks or play activities (Inattention – b)

#### **Cannot settle to anything for more than a few moments**

Often has difficulty sustaining attention in tasks or play activities (Inattention – b)

#### **Is inattentive**

Inattention (category)

## Appendix D

### Potential Measures based on Categorization in Planning Stages of NLSCY

#### Hyperactivity

Can't sit still, is restless or hyperactive (BBECQ6B)

Is distractible, has trouble sticking to any activity (BBECQ6I)

Fidgets (BBECQ6N)

Can't concentrate, can't pay attention for long (BBECQ6P)\*

Is impulsive, acts without thinking (BBECQ6S)

Has difficulty awaiting turn in games or groups (BBECQ6W)

Cannot settle to anything for more than a few moments (BBECQ6HH)

#### Inattention

Can't concentrate, can't pay attention for long (BBECQ6P)\*

Gives up easily (BBECQ6EE)

Stares into space (BBECQ6KK)

Is inattentive (BBECQ6QQ)

\*internal reliability analyses were run both with and without this item for each potential measure

## Appendix E

### Pattern Matrix for Factor Analysis of Inattentive/Hyperactive/Impulsive Items

Item	Factor 1	Factor 2
Can't sit still, is restless or hyperactive	0.916	-0.173
Fidgets	0.714	0.018
Cannot settle to anything for more than a few moments	0.615	0.099
Can't concentrate, can't pay attention for long	0.479	0.385
Has difficulty awaiting turn in games or groups	0.314	0.194
Gives up easily	-0.087	0.554
Is inattentive	0.213	0.542
Stares into space	-0.010	0.451
Is distractible, has trouble sticking to any activity	0.418	0.437
Is impulsive, acts without thinking	0.225	0.387

## Appendix F

### Potential Measures based on Factor Analysis

#### Hyperactivity

Can't sit still, is restless or hyperactive

Fidgets

Cannot settle to anything for more than a few moments

Can't concentrate, can't pay attention for long

#### Inattention

Gives up easily

Is inattentive

Stares into space

## Appendix G

### Physical Aggression/Conduct Disorder and Property Offences Items from NLSCY (Cycle 2)

#### Physical Aggression/Conduct Disorder

Gets into many fights

When another child accidentally hurts him/her (such as by bumping into him/her), assumes that the other child meant to do it, and reacts with anger and fighting

Physically attacks people

Threatens people

Is cruel, bullies or is mean to others

Kicks, bites, hits other children

#### Property Offences

Destroys his/her own things

Steals at home

Destroys things belonging to his/her family, or other children

Tells lies or cheats

Vandalizes

Steals outside the home