Explanations for antisocial behaviour in adolescents : the role of pubertal development on cognitive processes

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Research suggests that the temporary rise in adolescent antisocial behaviour (ASB) is attributable to a very large number of young people each engaging in a relatively small number of ASB's while progressing through adolescence. One possible explanation for the temporary increase in ASB during adolescence is that during puberty, the cognitive processes responsible for monitoring and controlling behaviour are disrupted. In support of this, recent research has found that adolescents' participation in ASB is positively correlated with the stage of pubertal development rather than age. Additionally, there is evidence that a temporary 'dip' in executive functioning (planning, organizing, decision-making) occurs at an age range (i.e. 11 – 14 years) typically associated with the onset of puberty. This thesis reports a first test of a model which proposes a causal relationship between puberty, decreased executive function and increased antisocial behaviour. Self-report data on pubertal development, antisocial attitudes and ASB participation was collected from 323 boys and girls (ages 9 – 17 years) attending New South Wales public schools. Executive function, (i.e. updating, response inhibition, set-shifting) was measured in a 30-minute individual interview. Data were analysed to determine if participants reported greater participation in ASB during puberty onset and whether this period was also characterized by a decline in executive function. In addition, it was investigated whether adolescents who attain puberty earlier than their peers participate in ASB earlier, longer, and at higher rates than their 'on-time' or 'late-maturing' peers, and whether there was an association between 'early' puberty and a persistent reduction in executive function.

Results revealed that ASB participation was significantly associated with puberty onset timing, and some significant associations were found between antisocial attitudes and pubertal timing. There was some indication of decreased executive function at puberty onset and a link between early pubertal timing and a persistent reduction in executive function. Thus, there is some partial evidence to support the proposed model of adolescent ASB. However, complications in performing mediation analysis prevent concluding that executive function mediates the relationship between pubertal development and ASB. The implications of these findings are discussed with reference to future research in this field.

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EXPLANATIONS FOR ANTISOCIAL BEHAVIOUR IN ADOLESCENTS: THE ROLE OF PUBERTAL DEVELOPMENT ON COGNITIVE PROCESSES

Suzanne Czech

A thesis submitted in fulfillment

of the requirements for the degree of

Doctor of Philosophy

School of Psychology **University of New South Wales**

2008

Dedication

This thesis is dedicated to my three children, Ryan, Deryk, and Krysta. Their typical adolescent behaviour during my candidature assured me that I was pursuing a plausible explanation for a developmental transformation 'from angels to hellions' associated temporarily with adolescence. Despite experiencing this adolescent rite of passage, Ryan, Deryk, and Krysta, were entirely supportive of my work; I could not have accomplished this without their patience and understanding as we journeyed together toward a better understanding of adolescent behaviour.

Abstract

Research suggests that the temporary rise in adolescent antisocial behaviour (ASB) is attributable to a very large number of young people each engaging in a relatively small number of ASB's while progressing through adolescence. One possible explanation for the temporary increase in ASB during adolescence is that during puberty, the cognitive processes responsible for monitoring and controlling behaviour are disrupted. In support of this, recent research has found that adolescents' participation in ASB is positively correlated with the stage of pubertal development rather than age. Additionally, there is evidence that a temporary 'dip' in executive functioning (planning, organizing, decision-making) occurs at an age range (i.e. 11 – 14 years) typically associated with the onset of puberty. This thesis reports a first test of a model which proposes a causal relationship between puberty, decreased executive function and increased antisocial behaviour. Self-report data on pubertal development, antisocial attitudes and ASB participation were collected from 323 boys and girls (ages 9 – 17 years) attending New South Wales public schools. Executive function, (i.e. updating, response inhibition, set-shifting) was measured in a 30-minute individual interview. Data were analysed to determine if participants reported greater participation in ASB during puberty onset and whether this period was also characterized by a decline in executive function. In addition, it was investigated whether adolescents who attain puberty earlier than their peers participate in ASB earlier, longer, and at higher rates than their 'on-time' or 'late-maturing' peers, and whether there was an association between 'early' puberty and a persistent reduction in executive function.

Results revealed that ASB participation was significantly associated with puberty onset timing, and some significant associations were found between antisocial attitudes and pubertal timing. There was some indication of decreased executive function at puberty onset and a link between early pubertal timing and a persistent reduction in executive function. Thus, there is some partial evidence to support the proposed model of adolescent ASB. However, complications in performing mediation analysis prevent concluding that executive function mediates the relationship between pubertal development and ASB. The implications of these findings are discussed with reference to future research in this field.

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Travel from Canada to Australia to complete this degree was made possible by the award of a Queen Elizabeth II British Columbia Centennial Scholarship to take-up international study in a British Commonwealth country, and the award of a four-year tuition and research stipend scholarship (Endeavour International Postgraduate Research Scholarship) provided by The University of New South Wales. I would also like to thank the head of the School of Psychology at UNSW, Professor Peter Lovibond, for ensuring that I had the time, resources, and support necessary to complete my degree.

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Overview of Thesis

The research reported in this thesis was designed to investigate a possible explanation for the temporary increase in antisocial behaviour and attitudes typically observed during the period of adolescence. The first aim of this research was to investigate whether a relationship exists between pubertal development and antisocial behaviour and antisocial attitudes. Previous research has found some evidence for an effect of both pubertal onset stage and pubertal timing on antisocial behaviour. For example, Caspi and Moffitt (1991) found that, among girls, the prevalence of offending behaviour increased during and after puberty onset, and girls who matured earlier than their peers were rated by parents as having more behaviour problems than their on-time and late-maturing peers. More recently, research examining the adolescent brain has discovered that some brain functions may be impaired during the adolescent phase of development (Spear, 2000a, 2000b). In particular, changes in the adolescent brain seem to affect executive functioning which controls our social behaviour, and this may account for the temporary increase in ASB observed during this developmental phase (see Blakemore & Choudhury, 2006). Based on the suggestion by some researchers that this temporary disruption in brain function and behaviour coincides with the pubertal development phase (e.g. Walker, 2002), the research presented in this thesis examines whether a relationship exists between pubertal development and executive function, and whether a temporary disruption in executive function at the time of puberty mediates the relationship between pubertal development and antisocial behaviour (ASB). Thus, this thesis presents the first test of a possible model of ASB in adolescents, namely that the temporary increase in ASB during adolescence is explained by temporary impairment to executive functioning resulting from the physiological changes that occur during pubertal development.

This thesis is divided into five sections. The first section provides background information and evidence from previous research investigating the relationships between pubertal development, executive function, and antisocial behaviour. The second section describes the method used to conduct the study, and includes sections on instrument design and participant selection. The third section provides detailed descriptions of each of the three constructs under investigation, including assessment of the validity and reliability of measurement. The fourth section reports the results of the analyses investigating the research aims and testing the proposed model, and the fifth and final section discusses the results in the context of methodological limitations, possible theoretical explanations for the findings, threats to the validity of the conclusions, and the implications of the results.

Section 1: Literature Review

The first sections aims to set the context of the present research by presenting previous empirical findings and examining how the findings from independent fields of research can be combined to provide a possible explanation for adolescent antisocial behaviour. Although reference is made to research which examines changes that occur in the structure of the adolescent brain, and the role of hormones on the brain areas thought to be associated with the executive functions, detailed discussion of the physiological basis of this process is beyond the scope of the present research. The literature review is presented in two chapters to 1) describe the nature of adolescent antisocial behaviour and possible explanations for this phenomenon from the pubertal development literature, and 2) describe how recent research uncovering disruption in executive functioning during adolescence may account for a developmentally-driven disturbance in behaviour.

Section 2: Method

A detailed description of the measures used in this research is provided in Section 3. Section 2 introduces and describes the materials with a focus on design and procedure of the research. The first chapter describes the process of establishing validity and reliability of the measurement of pubertal development, executive function, and antisocial behaviour and attitudes in a pilot study with young-adult participants. The second chapter in this section describes the method used to investigate the research questions including the research design and procedure employed in the primary study.

Section 3: Data Treatment

The aim of Section 3 was to establish the validity and reliability of measurement of pubertal development, executive function, and antisocial behaviour and attitudes. The first chapter in this section provides a detailed account of how pubertal development measurement (Chapter 5) was defined, including the definition of variables such as pubertal stage, pubertal timing, and pubertal onset age. Next, Chapter 6 explains how the ASB data were transformed to provide a measure of first age of antisocial behaviour participation, and type and severity level of participation. Chapter 6 also describes how an experimenter-designed antisocial attitudes scale was validated and included in the current analyses. Finally, Chapter 7 describes the rationale for the selection of executive function tasks included in the present research and the steps taken to ensure the validity and reliability of the executive function measures.

Section 4: Results

Section 4 presents the analyses and the findings from tests designed to measure the relationship between pubertal development and antisocial behaviour (Chapter 8), pubertal development and executive function (Chapter 9), executive function and antisocial behaviour (Chapter 10), and finally, whether a temporary reduction in executive function mediates the relationship between pubertal development and antisocial behaviour (Chapter 11).

Section 5: Discussion

Chapter 12 summarizes the significant findings from the research presented in this thesis, and discusses the implications of the results. In addition to methodological limitations encountered in the present research, complications presented by limitations in statistical methods employed are described. The evidence for an executive function 'dip' (EFD) model of the association between pubertal development and antisocial behaviour is discussed. Finally the implications of the research are discussed with reference to the need for future research investigating the EFD model as an explanation for adolescent antisocial behaviour.

Operational Definitions

As with most research, the constructs examined in this thesis are broad terminologies containing a breadth of possible definitions. Therefore, the three central constructs examined in this thesis, pubertal development, executive function, and antisocial behaviour/attitudes, are briefly operationalized as follows.

Pubertal Development

Rather than an event, pubertal development represents a transition from childhood to adulthood, and is best measured as a set of biological and physical changes in sexual maturation. This thesis includes four measures of pubertal development: 1) pubertal status (pre, mid, and late), 2) pubertal stage (Stages 1 (pre) through 5 (post)), 3) pubertal timing (early, on-time, or late), and 4) pubertal onset age (age at which significant pubertal changes occurred).

Executive Functioning

Executive functioning may be broadly defined as the higher order functions of the brain, which are responsible for planning, attending to, and organizing behaviour. Miyake et al. (2000) suggest that three executive functions (shifting between mental-sets, updating information in working memory, and response inhibition) are the fundamental executive processes of the brain, and that a combined three-factor model produces a significantly better fit than the individual constructs alone. Consistent with Miyake and colleagues recommendations, a composite executive function variable was computed from the administration of multiple executive tasks measuring these three executive functions.

Antisocial Behaviour & Attitudes

Although antisocial attitudes often accompany antisocial behaviour, the term antisocial attitudes in this thesis refers to a unique set of interpersonal traits that may be used to identify an individual as possessing a particularly antisocial approach to life. The antisocial attitudes self-report measure used in this thesis was designed to correspond with items from a clinical instrument used to assess a psychopathic personality.

In contrast, antisocial behaviour can be defined as any *act* that disturbs the peace or otherwise noticeably disrupts the social order; this can range from relatively minor to very serious acts that are usually against the law (e.g. littering, cheating, stealing, vandalism, violence). For the purposes of this thesis, antisocial behaviour was defined as the full range of these acts (including acts that are illegal because the individual is of minority age, e.g. smoking, drinking) and measured by participants' self-report on four dimensions including prevalence, frequency, career length, and seriousness of the offences committed.

SECTION 1: LITERATURE REVIEW

Antisocial behaviour (ASB) is any behaviour that is contrary to the standards of the society we live in. This includes criminal behaviour, but is also any behaviour that is socially unacceptable or ignores the rights of others (Jacob Arriola, 2002). Definitions of antisocial behaviour include a range of behaviour from relatively minor acts of nuisance behaviour to serious criminal acts, (e.g. property offences, physical assault, theft, graffiti, and harassing or intimidating behaviour (see Elliott & Menard, 1996). Although a small percentage of individuals display this type of behaviour throughout their lifetime, for the majority of individuals any participation in ASB is limited to the period of adolescence (see for example, Moffitt, 1993). Research investigating adolescent ASB patterns has established that among those adolescents who come into contact with the law, only 10% will continue this pattern of criminal behaviour as an adult (see Moffitt, Caspi, Harrington, & Milne, 2002). This means that approximately 90% of adolescents outgrow their antisocial behaviour, even if the behaviour was serious enough to attract the attention of the legal system (see for example, Chen, Matruglio, Weatherburn, & Hua, 2005; Hua, Baker, & Poynton, 2006).

The high prevalence rates of criminal offending among adolescents compared to adult rates has long been a concern for legislating authorities who are under pressure by society to reduce these rates (Grisso, 1996). Thus, criminologists, sociologists, and psychologists have sought to account for the temporary increases in criminal offending during the adolescent period (see Winterdyk, 2000). The findings that the temporary rise in ASB during adolescence is not attributable to a *few adolescents* who are each engaging in a great deal of problem behaviour, but rather that *a very large number of adolescents* are each engaging in a small number of these behaviours (Wolfgang, Figlio, & Sellin, 1972), suggests that developmental theories of ASB participation may best explain this phenomena. The current study investigates the possibility that a developmental process experienced by all adolescents may help to account for the high prevalence of adolescent ASB. In support of this theory are the recent findings that a relationship exists between antisocial behaviour participation and pubertal development in both boys and girls (Caspi, Lynam, Moffitt, & Silva, 1993; Caspi & Moffitt, 1991; Felson & Haynie, 2002; Piquero & Brezina, 2001; Williams & Dunlop, 1999).

It has been proposed by some researchers that this relationship between pubertal development and antisocial behaviour is explained by the mediating effects of a temporary disruption in frontal lobe functioning due to the fluctuations in hormonal and neurotransmitter levels in the adolescent brain (Casey, Giedd, & Thomas, 2000; Walker, 2002). Specifically, it has been suggested that the release of pubertal hormones during this developmental phase may cause a temporary reduction in certain higher-order cognitive functions, specifically executive function abilities, and consequently behavioural control, and that this may result in a decrease in behavioural control and an increase in ASB. Results from neuropsychological research has found that during the years typically associated with pubertal onset (i.e. ages 11 – 14), a temporary reduction in executive functioning occurs, which shows signs of recovery in later years (Giedd et al., 1999).

Executive functioning is commonly referred to as our 'higher order brain functions', and is the term used to describe the complex cognitive processes responsible for planning, organizing, and ordering behaviour, and for deciding which behaviours are appropriate in a given situation (see Miyake et al., 2000 for a review). This includes our ability to control our impulses, take risks, think through to the consequences of our behaviour, and to make appropriate decisions. It has been found that the ability to control behaviour, and make appropriate (e.g. pro-social) decisions is significantly impaired in individuals who have suffered frontal lobe damage, including physical brain trauma (e.g. Stuss & Gow, 1992), and degenerative diseases such as Alzheimer's and Parkinson's disease (e.g. Troyer & Moscovitch, 1996).

This link between frontal lobe damage and executive functioning impairment has been extended to research investigating correlates with extreme forms of ASB, including violent criminal-offending behaviour. Raine (2002) provides a comprehensive review of the relationship between ASB and executive function with 39 examples of biosocial interaction effects found in research with children and adults. Specifically relevant to the current research, is the finding that a subsequent phase of development in the prefrontal cortex during the adolescent period (previously thought to be complete in infancy) increases executive dysfunction and externalizing behaviour during this stage (Raine, unpublished, as cited in Raine, 2002).

The first section of this thesis presents empirical findings as well as theoretical arguments relevant to the proposed relationships between pubertal development, executive function, and antisocial behaviour. Chapter 1 reviews the evidence for a proposed relationship between antisocial behaviour and pubertal development by examining studies focussing on the relationship between both the onset of pubertal development and the relative timing (i.e. early, on-time, or late) of pubertal onset in relation to peers (Caspi et al., 1993; Caspi & Moffitt, 1991). Findings of the effects of pubertal development onset on other psychological processes (e.g. sensation-seeking, substance use, and depression) provide further evidence that the onset of pubertal development is associated with changes in behaviour during adolescence (Ge, Brody, Conger, Simons, & Murry, 2002; Ge et al., 2003; Graber, Lewinsohn, Seeley, & BrooksGunn, 1997). Based on this evidence, and evidence of the presence of traits linked to psychopathy in adolescents, a relationship between pubertal development and antisocial attitudes is proposed (e.g. Lynam, 1996; Lynam, 1997, 1998, 2002; Lynam, Caspi, Moffitt, Loeber, & Stouthamer-Loeber, 2007). It is argued here, that research investigating the 'juvenile psychopath', characterized by, for example, a narcissistic, callous, sensation-seeking attitude, (e.g. Pardini, Lochman, & Frick, 2003), should consider the possible role of the effects of pubertal development on adolescent antisocial attitudes on such behaviour.

In Chapter 2, recent evidence from neuropsychological studies is presented, which suggests that executive function declines temporarily during mid-adolescence (e.g. McGivern, Andersen, Byrd, Mutter, & Reilly, 2002). Supporting literature from brain imaging studies (e.g. Rubia et al., 2000) are also briefly reviewed to demonstrate the existence of a possible mechanism to explain the effect of puberty on executive function. These recent empirical findings combined with the previous findings of a temporary 'dip' in emotional processing during adolescence (e.g. Carey, Diamond, &

Woods, 1980), and the suggestion that these temporary impairments are associated with the onset of puberty (e.g. Giedd et al., 1999) represents the theoretical foundation for the current program of research. The current research study represents a first attempt to test an 'executive function dip' (EFD) model which proposes a causal relationship between puberty, decreased executive function and increased antisocial behaviour.

Chapter 1: Antisocial Behaviour, Antisocial Attitudes and Pubertal Development

Adolescent ASB is of a major concern to legislative authorities, parents and teachers, and the community at large. Although there may be a growing concern among the general public that ASB participation is on the rise, the higher rates of participation in ASB by adolescents in comparison to adults has been evident for over 100 years (see Hirschi & Gottfredson, 1983; Winterdyk, 2000). In the state of New South Wales (NSW), statistics report that youth between the ages of 10 to 19 are responsible for 42% of recorded crime; this figure jumps to 62% when youth to the age of 24 are included ("New South Wales Bureau of Crime Statistics and Research ", 2000). When age groups are divided into 15 – 19 years and 20 – 24 years, each of these groups is responsible for approximately three to four times the rate of offending of the remainder of the population. Although there are many contributing factors within the psychological literature and other disciplines including sociology and criminology, many theorists propose that adolescent ASB can be explained as a developmental process, and that our research focus should be on identifying the contributing developmental factors if we wish to increase our understanding of this important social phenomenon (Lahey & Loeber, 1997; Leblanc, Cote, & Loeber, 1991; Leblanc & Frechette, 1989; Loeber & Farrington, 1997, 2000; Loeber, Keenan, Lahey, Green, & Thomas, 1993; Rutter, 1997).

Research investigating the causes and correlates of adolescent antisocial behaviour has been conducted for decades (see Winterdyk, 2000). Some researchers have proposed a bio-social aetiology, which proposes that participation in ASB is associated with developmental processes of adjusting to the transition from childhood to adulthood (e.g. Caspi & Moffitt, 1991). In this thesis, however, I will examine evidence which suggests a different cause; that adolescent ASB may be related directly to physiological changes associated with pubertal development. Several studies have found that both externalizing (e.g. behavioural problems), and internalizing (e.g. anxiety, depression), behaviours manifested during adolescence are associated with the onset of puberty, rather than a particular age (e.g. Kaltiala-Heino, Marttunen, Rantanen, & Rimpela, 2003). These findings suggest that the increase in antisocial behaviour and antisocial attitudes during adolescence may also be associated with pubertal development onset.

Adolescent Antisocial Behaviour

Any study of ASB participation is complicated by the fact that several aspects of ASB must be considered in its measurement. The seminal work of Blumstein, Cohen, Roth, and Visher (1986), which reviewed the research in this area, recommended that ASB participation be measured on four dimensions including prevalence, frequency, career length, and seriousness of the offences committed. Data on each of these dimensions are necessary to arrive at a comprehensive measure of ASB participation. The prevalence of ASB is assessed as the proportion of the population who offend, whereas, the frequency of offending is the average rate at which these active offenders commit crimes. The career length of an offender is the average duration over which they continue to commit crime, and the 'seriousness' is the severity level of the crimes they commit.

Across adolescent and adult offenders, there is evidence that males participate in ASB at a rate of approximately five times that of females (see for example Blumstein et al., 1986; Hua et al., 2006; Prime, White, Liriano, & Patel, 2001). Males and females also differ in the type of crimes they commit; males more frequently engaging in serious and violent offences such as drug offences, sexual assault, burglary and robbery, and females typically committing minor offences such as shoplifting (see for example Skrzypiec & Wundersitz, 2005). These studies have also found that for the majority of offenders, career length is comparatively short, whereas for a small number of offenders, involvement in ASB and criminal activity is enduring and at a comparatively very high frequency (Blumstein et al., 1986; Prime et al., 2001; Skrzypiec & Wundersitz, 2005; Tarling, 1993). This means that a very small percentage of individuals, typically referred to as chronic offenders, are responsible for a disproportionately large amount of crime.

Although early identification of the chronic offender has received considerable research interest in the past few decades, an emerging area of focus investigates explanations for the relatively higher rates of offending amongst this population in comparison to adults (Blumstein & Cohen, 1987; Blumstein, Cohen, & Farrington, 1988). Research examining ASB participation has established that the majority of criminal offenders are adolescents (aged 19 and younger), with rates decreasing by over 50 per cent by the early 20's and with only 15 per cent of adolescent offenders continuing to offend by age 28 (Blumstein, Farrington, & Moitra, 1985; Farrington, 1986). Until approximately 20 years ago, information on trends and patterns in ASB participation was limited to official crime statistics. However, with the identification of early conduct problems present in youth (Loeber & Farrington, 2000; Lynam, 1996; Smart, Vassallo, Sanson, & Dussuyer, 2004; Speltz, DeKlyen, Calderon, Greenberg, & Fisher, 1999) and the advent of self-report (Lewinsohn, Rohde, & Farrington, 2000), and parent and teacher report methodologies (Youngstrom, Loeber, & Stouthamer-Loeber, 2000), two distinct developmental trajectories of ASB have emerged (see for example Moffitt, 1993)

Moffitt (1993) cites official (1980) statistics from the Federal Bureau of Investigation (reprinted here as Figure 1.1), which indicates that arrest rates rise steeply in the adolescent years followed by a steep decline by age 20 (Blumstein et al., 1988), and findings from developmental research investigating externalizing behaviours in youth which indicates that the participation in antisocial behaviour is also represented by a steep increase between the ages of 7 to 16, with a rapid decline at age 17 (Wolfgang et al., 1972; Moffitt 1993, reprinted here as Figure 1.2).

Figure 1.1. Pattern of arrest rates by age (reproduced from Moffitt, 1993). Original legend reads "Age-specific arrest rates for United States Federal Bureau of Investigation's (FBI) index offenses in 1980. (Index offenses include homicide, forcible rape, robbery, aggravated assault, burglary, larceny, and auto theft. From "Criminal Career Research: Its Value for Criminology" by A. Blumstein, J. Cohen, and D.P. Farrington, 1988, *Criminology, 26*, p. 11. Copyright 1988 by the American Society of Criminology. Adapted by permission.)"

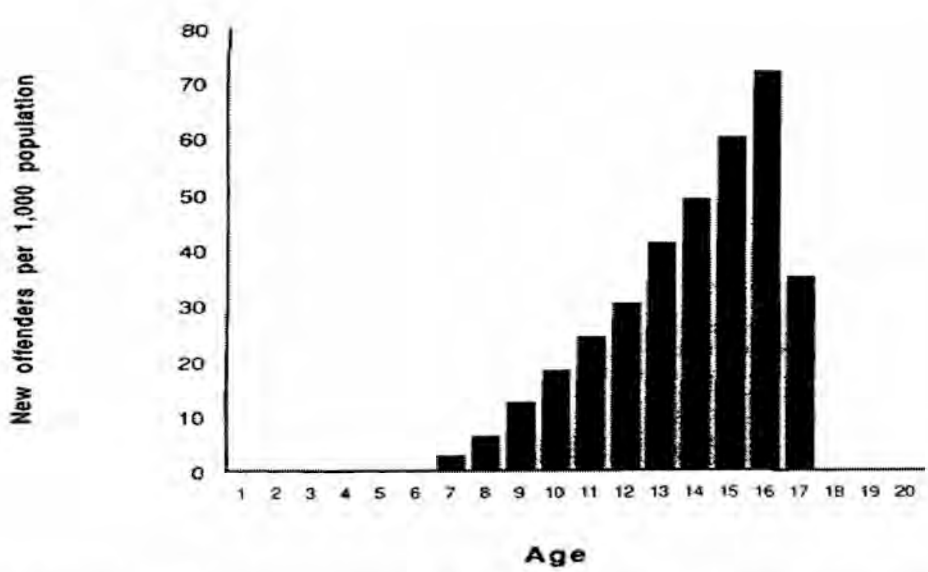


Figure 1.2. Number of first arrests by age in Philadelphia cohort of 9,945 boys (reproduced from Moffitt, 1993). Original legend reads "The rate of new male offenders at each age per 1,000 male population. (Onset of offending was defined as the age at which a child was first taken into custody and designated delinquent by the police. Rates are based on a cohort of 9,945 boys born in 1945 in Philadelphia, Pennsylvania. From *Delinqency In a Birth Cohort* (p. 132) by M.E. Wolfgang, R.M. Figlio, and T. Sellin, 1972, Chicago: The University of Chicago Press. Copyright 1972 by The University of Chicago, Adapted by permission.)"

Based on these findings, and the findings from self-report studies that participation in antisocial behaviour is much higher than the official statistics suggest (Hood & Sparks, 1970; Klein, 1989), such that it appears to represent 'normal adolescent behaviour' (Elliott, Ageton, Huizinga, Knowles, & Canter, 1983), Moffitt proposed that two types of adolescent offenders exist. The first involves demonstration of early behaviour problems which persist through adolescence and into adulthood (life-course persistent). The second is characterized by ASB participation that is limited to the adolescent years (adolescence-limited). In her seminal work, Moffitt (1993) proposed that approximately 90% of adolescent offenders could be identified as adolescence-limited, which she illustrated graphically (reprinted here as Figure 1.3) as a very small number of individuals persisting in ASB until adulthood, and incrementally larger number of adolescents participating in ASB for correspondingly shorter periods of time.

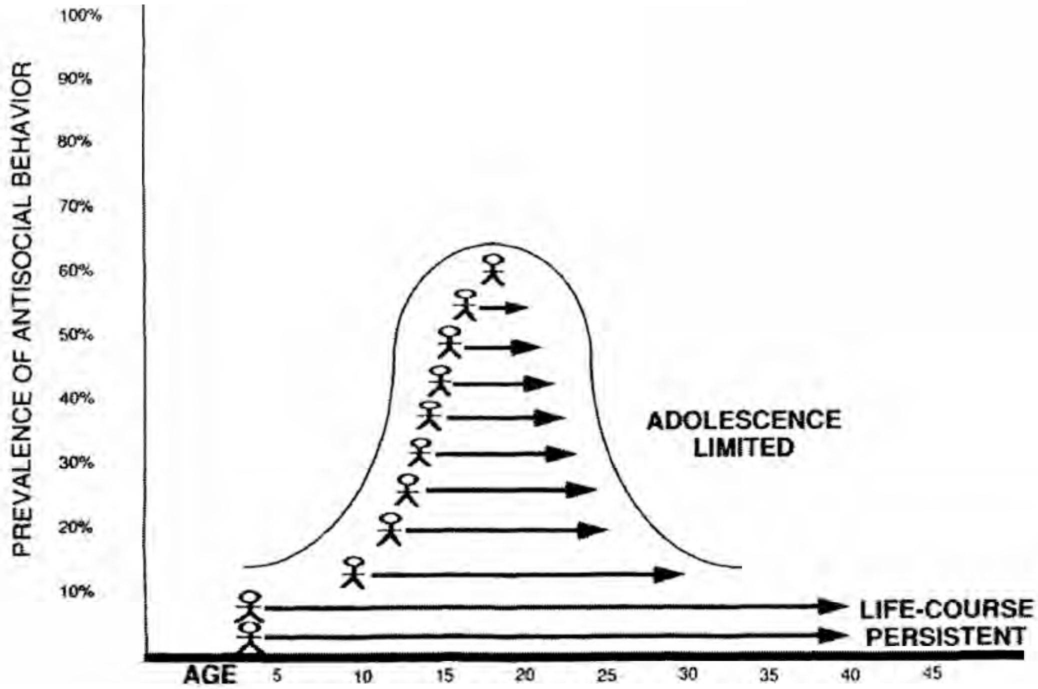


Figure 1.3. Moffitt's (1993) hypothetical illustration of percentage of adolescents participating in ASB by age. Original legend reads "Hypothetical illustration of the changing prevalence of participation in antisocial behavior across the life course. (The solid line represents the known curve of crime over age. The arrows represent the duration of participation in antisocial behaviour by individuals.)"

Wolfgang et al. (1972), reported that over half the arrests recorded by age eighteen for a cohort of 9,945 boys born in Philadelphia were accounted for by only 627 boys – representing only six per cent of the cohort. Since this pioneering research in 1972, the finding that a small number of offenders account for a disproportionately large number of offences has consistently been found (e.g. Broidy et al., 2003; Moffitt & Caspi, 2001). New South Wales (NSW) cohort studies have found that these very few offenders account for a large proportion of the total court appearances. For example, Coumarelos (1994) found that among 33,900 juvenile offenders appearing in NSW courts between 1982 and 1986, almost half of the appearances (45.4%) were accounted for by the 15 per cent of juveniles who had more than two appearances. Recently, Hua et al. (2006) found that among a 1984 cohort sample of 8,105 male and female NSW young offenders, nine percent of these young offenders appeared in court five times or more and 2.3% appeared in court 10 times or more; thus a very small proportion of the sample accounted for a large proportion of the cohort's total court appearances (36% and 15% respectively). Hua et al. also found that within this cohort sample, a large proportion of court appearances (45%) were accounted for by those adolescents who appeared in court only once. Given that it is the small proportion of repeat offenders who place the greatest burden on financial resources, Hua et al. suggest that judicial practices should be tailored to direct more resources toward reducing reoffending among this minority of adolescents, and that the large proportion of adolescents who do not reoffend be diverted from the court system.

Although official police and court statistics probably provide the most reliable measure of the prevalence of adolescent ASB, several researchers have argued that it is important to incorporate self-reports of ASB activity to gain a more accurate view of adolescent ASB patterns. Thus, the findings regarding frequency, career length and severity of adolescent ASB is reviewed here by examining data collected from community and custodial self-report studies, as well as the juvenile crime literature.

Since Blumstein et al.'s (1986) review, a number of studies have attempted to calculate the prevalence of ASB in the general population. Blumstein et al. cite several studies from the United States which show that between 25 and 47% of males are arrested before the age of 18, and between 26 to 28% of the general population of US males receive a conviction in a juvenile court. Wolfgang, et al. (1972) reported that amongst a sample of 9,945 Philadelphian boys born in 1945, 35% had at least one recorded police contact for a non-traffic offence before the age of 18. The measurement of prevalence is complicated by the fact that not all police contacts lead to arrests, and not all charges lead to a conviction. This may account for differences in internationally-reported conviction rates. For example, *conviction* rate reports of 25% of United Kingdom males born in 1963 (Tarling, 1993) is substantially higher than the Australian figures of 16% of NSW males born in 1984 who received at least one *court appearance* before the age of 18 (Hua et al., 2006), and the *arrest rates* for South Australian males born in 1972 and 1984 of 21% and 25% respectively (Morgan & Gardner, 1992; Skrzypiec & Wundersitz, 2005).

There is strong evidence that the majority of juvenile offenders who come into contact with the criminal justice system do so only once. For example, even when the offence was serious enough to result in a conviction, Coumarelos (1994) found that among 33,900 juvenile offenders appearing in NSW courts between 1982 and 1986, 70% of juveniles had no subsequent criminal appearances, while less than 10% had three or more appearances. Coumarelos' study is one of many studies which have found that participation in crime amongst juveniles is extremely transitory. Even among repeat offenders, Coumarelos found that for 80% of these, the average criminal career length was less than one year in duration.

Adolescent participation in crime is also distinctly different from participation by adults in the seriousness of the types of offences committed. For example, Mukherjee (1986) examined youth crime trends in Australia between 1964 and 1983 and found that, compared with adults, juveniles were under-represented in arrests for serious violent offences such as homicide and serious assault and over-represented in arrests for burglary and motor vehicle theft. Even for those very few youths who are repeat offenders, violent offences are rare (Freeman, 1996). Like Freeman, Coumarelos (1994) found that the majority of offences committed by young people were property offences (break and enter; stealing) and motor vehicle theft, or an offense against good order.

Although much can be gained from examining the official crime statistics, these figures represent a somewhat biased account in that they are only reporting ASB that is serious enough to result in contact with the law. Furthermore, many individuals commit crimes that remain undetected; therefore the data from crime statistics are limited to those individuals who were apprehended for their crimes (e.g. Coumarelos, 1994; Hua & Fitzgerald, 2006). Fortunately, researchers have found that individuals provide what appear to be honest and reliable reports on their own ASB participation when anonymity is guaranteed (e.g. Baker, 1998). Despite early criticisms that self-report data are severely limited by response bias (i.e. that people are not willing to report on their own antisocial behaviour and that any responses would not represent an accurate portrayal of actual participation rates), several studies with adolescents and adults have found that self-reported offending is reported reliably and is a valid indicator of delinquent behaviour (Hirschi, Hindelang, & Weis, 1982; Loza & Loza-Fanous, 2001).

In Australia, only a few studies have examined adolescent ASB from community self-reports. Most of these studies are cross-sectional in nature in which several age groups are compared to one another at a single point in time. Longitudinal studies are preferred because they allow for researchers to follow identified individuals across time to determine whether there are any particular developmental periods associated with particular types of behaviour, and avoid cohort differences which can be confused with developmental effects. However, longitudinal studies are costly and involve the allocation of extensive resources over time, and are subject to other methodological limitations (e.g. attrition, practice effects). Therefore, the results from a selection of both types of community self-report studies are reviewed here.

In 1998, Baker published data collected from 5,178 NSW secondary school students regarding their participation in a variety of antisocial and criminal activities including assault, malicious damage and all types of theft. Baker found that participation in these acts was widespread amongst NSW secondary students; the majority of students reported participating in at least one act. Participation rates for the preceding 12 months within each offence type were also relatively high; both assaults and malicious damage shared participation rates of nearly 30%, with 15% of respondents having sold or received stolen goods. Participation in theft was lower – nine percent reported participating in shoplifting, break and enter, or motor vehicle theft. However, for most students reporting participation in crime, offending was limited in the number of different types of offences (1 to 2 different types of offences), and infrequent offending (1 to 2 times per offence in the past 12 months). Due to a small proportion of students reporting comparatively higher participation rates, the mean participation rates were slightly higher at four times per offence in the preceding 12 months, and five times in the students' lifetime. Consistent with reported crime figures, across all age groups (grades 7 to 12), males participated at a higher rate than females, and participated in more serious offences (e.g. break and enter and motor vehicle theft compared to shoplifting for females).

Baker (1998) found that participation in each type of offence tended to peak around 14 to 16 years of age for both boys and girls. Baker notes that this peak age of participation found among secondary students is lower than the peak age of adolescents who appear in NSW Children's Court (16 to 17 years), and hypothesizes that this may be because juveniles are involved in crime for some time before they come into contact with the law, or alternatively, that those adolescents who appear in Children's Court are not represented in community samples because they have dropped out of the school system by age 16.

Another method of determining peak age of ASB participation was utilized by Smart, et al. (2004) in their longitudinal study which identified that across all age groups, approximately half of the community sample of 1,300 Victorian adolescent boys and girls reported participation in at least one antisocial act in the previous 12 months, and that adolescents reported participation in different types of ASB at different ages. Participants were followed up at three times during adolescence: at 13 – 14 years, 15 – 16 years, and 17 – 18 years. Smart and her colleagues incrementally included various antisocial acts to the interview survey for the older age groups based on the premise that younger age groups would not typically be engaging in such acts. For example, self-report on ASB participation for the previous 12 months ranged from acts such as skipping school, graffiti, cigarette smoking, and fighting for 12 – 13 year olds; shoplifting, binge drinking, and being charged by police for 15 – 16 year olds; and selling drugs, being drug dependent, or appearance in the Children's Court for 17 – 18 year olds. This method of matching ASB-type to particular age groups was also used in the current study (see Chapter 4).

Smart et al. (2004) found that offences such as theft and graffiti-drawing reached a peak-participation rate in mid adolescence and then began to decline, whilst reported participation in activities such as driving a car without permission, increased steadily as adolescents grew older. Participation rates of fighting were similar between early and mid adolescence and began to decline in late adolescence, while truancy rates were much higher in older age groups. Only a few adolescents in the sample reported committing three or more different types of antisocial acts: 12% at 13-14 years and 20% at 15-16 and 17-18 years. The highest number of different antisocial acts reported by adolescents increased steadily as adolescents grew older: 8 (13-14 years), 11 (15-16 years), and 13 (17-18 years). Smart et al. classified adolescents into one of three groups of ASB participators 'low' (no or low level of participation across all age groups; 80% of respondents), 'experimental' (three or more different types of ASB at 13 – 14 or 15 – 16 years, but desisted by 17 – 18 years; 8% of respondents), and 'persistent' (three or more different types of ASB across all age groups; 12% of respondents). Although Smart et al. noted that a group of 'persistent' offenders, who compared to 'experimental' participators, participated in higher rates of ASB across all age groups, they also concluded that 'experimental' participators transitioned in and out of various types of ASB participation, indicating a wide range of ASB participation amongst this group.

One limitation of Smart et al.'s (2004) follow-up study is that, to date, the adolescents have not reported ASB participation past the age of 17 – 18 years. As noted previously, the literature in this area typically defines a persistent offender as an individual who continues to participate in ASB into adulthood. Thus, it is possible that had this particular sample of adolescents been followed-up at age 21, a reduction in participation could occur among some of the adolescents who were classified as 'persistent' participators at age 17 – 18. Smart et al.'s findings have, however, highlighted the need for considering that not all antisocial acts are equal in their level of severity. Smart et al's findings confirmed that a large majority of adolescents report participation in particular acts (e.g. smoking, skipping school) at such high rates as to having to be considered as a normative aspect of adolescence. A particular strength of their study was the ability to discriminate between low or high participators by including age-sensitive ASB acts for different age groups. This method was adopted, and slightly adapted, for the current study by not only including age-appropriate ASB responses, but also considering the severity of different types of ASB across age groups. The identification of adolescents who are participating in ASB by severity-level can contribute largely to differentiating between individuals who are participating in non-normative behaviour (even for an adolescent), but also to aid in determining whether certain individuals are participating in what can be considered a comparatively high level of ASB for their particular age.

Smart et al. (2004) found that almost half of interviewed adolescents reported participation in some form of ASB in the previous 12 months. The comparable rate found in custodial samples is much higher. A NSW study which interviewed 247 juveniles (includes only nine females) who were serving a control order between September 1993 and March 1994 found that lifetime (i.e. ever participated in) participation rates were 86% for shoplifting, 90% for break and enter and 79% for motor vehicle theft (Salmelainen, 1995). These results are not surprising given that these adolescents have committed offences serious enough to warrant the issue of a control order. However, of interest, is the finding that the frequency rates of offending were very high; a large proportion of offenders had committed each offence multiple times within the previous six months. One-quarter (24%) of the respondents reported shoplifting in the previous six months, over one-half (59%) reported a motor vehicle theft (MVT), and almost three-quarters 72%) reported committing a break and enter (B&E) offence. The large majority of offenders reported committing less than one offence per week (shoplifters, 48%; B&E, 68%; MVT, 70%). Among those offenders who reported participation rates of one or more offences per week, the majority of these were reports of less than 10 offences per week, but include reports of up to 35 break and enters and 45 motor vehicle thefts per week by some respondents.

Importantly, Salmelainen (1995) reported mean age of first participation in each of these three offences. Reported mean age for first participation in shoplifting was 10.7 years (s = 2.7 years); whereas, on average, respondents were aged 13.1 years (s = 2.0 years) at the time of committing their first B&E, and 13.9 years (s = 1.9 years) at the time of committing their first MVT. These findings combined with Smart et al.'s (2004) findings indicate that participation in certain types of ASB is age-dependent, with older-aged adolescents participating in more serious types of crime. However, the majority of adolescent ASB research has focused simply on aggregate numbers of antisocial acts, and the trajectory linkage from childhood to adolescence and adulthood (see for example, Broidy et al., 2003). Fewer studies have addressed the question of how ASB participation levels of severity and frequency differ across different adolescent age groups.

Adolescent Antisocial Attitudes

For the purposes of this program of research, antisocial attitudes are operationalized as those characteristic of a psychopathic personality. A psychopathic personality has been shown to be one of the best predictors of recidivism and future violent behaviour among adults in the criminal population (see Dolan & Doyle, 2000 for a meta-analytic review). This finding has led many researchers to investigate the relationship between adult psychopathy and conduct problems in children and adolescents (Frick, Obrien, Wootton, & McBurnett, 1994; Hinshaw & Zupan, 1997; Lynam, 1996; Lynam, 1997, 1998). The rationale for early identification of the psychopath is largely based on the relative stability of personality over the life-span (e.g. Caspi & Roberts, 2001) and the evidence that, in general, intervention at younger ages is more successful than among adults (see Dowden & Andrews, 2000). This is particularly relevant to identification of the psychopathic personality; research with incarcerated adults has found that the psychopath is particularly resistant to rehabilitation efforts, compared to non-psychopathic offenders (Heilbrun et al., 1998; Ogloff, Wong, & Greenwood). Thus, if personality is more malleable at younger ages (e.g. Lewis, 2001a; Lewis, 2001b), then to maximize the effectiveness of any intervention, it is argued we should aim to identify the psychopathic individual at the youngest possible age (see Lynam, 1996; Lynam, 1997, 1998; Rutter, 2005; Salekin, 2002; Spain, Douglas, Poythress, & Epstein, 2004).

Research investigating the presence of psychopathic traits in children has supported theoretical propositions that psychopathy is a personality trait that is present in adult populations as well as youth populations (Barry et al., 2000; Christian, Frick, Hill, Tyler, & Frazer, 1997; Frick, Bodin, & Barry, 2000; Frick et al., 1994; Lynam, 1996; Lynam, 1997), and that these traits are critical for designating a group of individuals who exhibit a severe, violent pattern of antisocial behaviour (see Hicks, Rogers, & Cashel, 2000; Marczyk, Heilbrun, Lander, & DeMatteo, 2005). However, the conceptualization of a 'juvenile psychopathy' construct adopted by some researchers in the field (see Frick, 2002; Harpur & Hare, 1994; Lynam, 1996; Lynam, 1997, 1998, 2002; Lynam & Gudonis, 2005) has been criticized by other researchers (Seagrave & Grisso, 2002) who suggest that any prospective personality assessment during the rapidly changing and highly unstable development phase of adolescence is likely to be of questionable validity (see Caspi & Moffitt, 1991; Caspi & Roberts, 2001).

Of particular concern is whether juvenile psychopathy can be construed as a static personality disposition (see Seagrave & Grisso, 2002). Although some studies have found support for the construct validity of psychopathic traits in a sample of adolescents (Kosson, Cyterski, Steuerwald, Neumann, & Walker-Matthews, 2002; Murrie & Cornell, 2002), the predictive validity of this identification has not been that effective, with recidivism follow-up studies failing to show reliable results (Forth, Hart, & Hare, 1990; Marczyk, Heilbrun, Lander, & DeMatteo, 2003). Of most concern is the finding that although adolescents engaging in repetitive violent offending tended to be identified as 'psychopathic', most 'psychopathic' adolescent offenders were not repetitively violent (see Hicks et al., 2000).

Additionally, some researchers question not only the temporal stability of juvenile psychopathy as a personality trait, but also the appropriateness of the item content in risk assessment instruments (see Edens, Skeem, Cruise, & Cauffman, 2001; Seagrave & Grisso, 2002). For example, constructs considered to be characteristic of psychopathic offenders, such as impulsivity, lack of goals, lack of empathy, irresponsibility, and a grandiose sense of self-worth, are common personality traits evident during the identity development phase of adolescence (see for example Arnett, 1992; Skeem & Cauffman, 2003; Zuckerman, Eyesenck, & Eyesenck, 1978). Thus, the predictive validity of risk assessment instruments that are designed to measure the likelihood that an adolescent will engage in chronic and/or violent criminal behaviour later in life may be compromised by developmentally-specific features of the adolescent period. Although some adolescents are predisposed to participate in a chronic and/or violent pattern of offending (Frick, 2002; Frick et al., 2003; Frick & Marsee, 2006; Frick, Stickle, Dandreaux, Farrell, & Kimonis, 2005; Harpur & Hare, 1994; Lahey & Loeber, 1997; Loeber & Farrington, 1997; Lynam, 1996; Lynam, 1997, 1998, 2002; Lynam et al., 2007; Lynam & Gudonis, 2005), participation in ASB among the majority of adolescents is limited to this developmental phase. Identification of these characterizing features as indicators of psychopathy could result in some adolescence-limited individuals being falsely categorized as a life-course offender. Thus, it is critical that the practice of juvenile-psychopathy assessments is informed by an in-depth exploration of how these identifying characteristics are represented in the adolescent population generally, and the extent that developmental processes, (such as the onset of puberty) are associated with these characteristics.

Pubertal Development and Antisocial Behaviour and Attitudes

Several studies have found that ASB participation (e.g. Caspi et al., 1993; Caspi & Moffitt, 1991; Felson & Haynie, 2002; Ge et al., 2002; Graber et al., 1997; Piquero & Brezina, 2001; Williams & Dunlop, 1999) along with many other behavioural changes (e.g. sensation-seeking, substance use, and depression; Ge, Conger, & Elder, 2001; Martin et al., 2002; Petersen, Sarigiani, & Kennedy, 1991), is associated not with a particular age, but with the onset of pubertal development. In a review, Buchanan, Eccles, and Becker (1992), described the period of adolescence as being characterized by more intense moods, more mood changes, and more erratic levels of energy and restlessness. It was also concluded that there appears to be a relationship between hormone levels and behaviour patterns, as well as other factors, influencing this relationship (e.g. child's temperament and family characteristics). One key contributing factor, however, appears to be the timing of pubertal development. Thus, two bodies of research investigating the effects of pubertal development on behaviour have emerged: the effects that occur as a result of transitioning into the onset of pubertal development (pubertal *status* or *stage*), and the effects that occur as a result of the relative timing (i.e. early, on-time, or late) of pubertal development onset (pubertal *timing*).

Although there is widespread agreement that a relationship exists between pubertal development and antisocial behaviour, there is disagreement regarding the explanation for this relationship. Early research proposed that the relationship between pubertal development and both internalizing and eternalizing behaviour was explained by biological changes which occur during this developmental phase (Gunnar & Collins, 1988; Hill, 1982; Lerner & Foch, 1987). However, the biological changes of pubertal development are also accompanied by psychological challenges; for example, girls have a tendency to alter their self-definitions based on their experience of the onset of menarche and breast growth (e.g. increase in self-esteem, superior adjustment, and the importance of adult roles such as marriage, children, and careers; Brooksgunn & Warren, 1988). Related research also found that these personal self-perceptions, that arise as a function of pubertal status, are significantly affected by differences in received response from parents and peers (Blyth, Simmons, & Zakin, 1985; Hill, 1988; Hill, Holmbeck, Marlow, Green, & Lynch, 1985; Simmons & Blyth, 1987). Thus, several studies have explored the effects of pubertal development onset on various types of behaviour from both biological causes (e.g. Brooksgunn & Warren, 1989; Dawes et al., 1999; Susman et al., 1987; Udry & Talbert, 1988) and the resulting bio-social causes (e.g. Caspi & Moffitt, 1991; Felson & Haynie, 2002; Haynie, 2003; Romans, Martin, Gendall, & Herbison, 2003).

Pubertal Development and Antisocial Behaviour

The majority of studies investigating the link between pubertal development and behaviour have been longitudinal health surveys conducted with children and adolescents. For example, Caspi and Moffitt (1991) collected data from 501 girls who were enrolled in the Dunedin (New Zealand) Multidisciplinary Health and Development Study. Mothers reported that 164 of these girls had reached menarche by age 13, and by age 15, 348 girls had reached menarche based on their own retrospective self-reports. Using menarche-onset as a measure of puberty onset, Caspi and Moffitt (1991) found that girls' behavior problems increased as a function of puberty onset across the period of middle adolescence. With the exception of late-maturers, girls were rated as having more behaviour problems at age 15 than at age 13 and puberty onset was associated with a higher engagement in delinquent activities. These results are consistent with earlier findings by Stattin and Magnusson (1990) that norm-breaking and socially deviant behaviours are associated with the onset of menarche in adolescent girls.

In a follow up study, Caspi et al. (1993) investigated girls' biological and social contexts to determine the cause of the effects of pubertal change on behaviour. Among 297 girls interviewed in the earlier Dunedin study, Caspi et al found that the prevalence of offending increased during and after puberty onset for all girls, but particularly for those girls enrolled in a mixed-sex, as opposed to an all-girls, school. Caspi et al., thus, expanded on the earlier theory that pubertal development represents a stressful event leading to behavioural problems, to include the effects of peer pressure (as role modeled by boys) to participate in deviant behaviours. Caspi et al. concluded that "biological age may matter more than chronological age for girls' delinquency" (p 29), and proposed that it is the socialization processes arising from the biological changes during pubertal development that account for girls' (and possibly boys) delinquency during adolescence. Caspi et al.'s explanation is consistent with Moffitt's (1993) bio-social explanations for the adolescence-limited offender that during adolescence, adolescent boys and girls are thrust from childhood into adulthood and cope with this dramatic development change by mimicry of adult behaviours (e.g. smoking, alcohol use), but are not cognitively prepared and thus experience problems adapting. The maturity gap results in overcompensation and dramatic displays of adult-like behaviour.

Other studies have examined specific contextual links between pubertal development and delinquency, and have found several moderating environmental factors, such as parent-relationship, deviant peers, and academic performance (e.g. Haynie, 2003). In a sample of 5,477 girls, Haynie examined the effects of advancement of pubertal development status on three types of delinquency: party (smoking, drinking, truancy); minor (graffiti, theft < $50, shoplifting); serious (burglary, robbery, selling drugs, assault with weapon), and found that for each unit increase in pubertal development, a corresponding 5% increase in both party and minor delinquency was observed. There was no relationship between pubertal onset and participation in major delinquency; however (as discussed below), a significant relationship was found for the effects of pubertal timing.

Despite the lack of agreement regarding the reasons for the relationship between pubertal development and ASB, several international studies with very large sample sizes (from the general population) have also found that pubertal status predicts delinquency in mixed groups of boys and girls (Ge et al., 2002, N = 867 African-Americans); (Storvoll & Wichstrom, 2002, N = 9,342 Norwegians), and a few studies investigating this relationship for boys only have also found significant results. For example, in a longitudinal sample of 2,213 males Piquero and Brezina (2001) found that the interaction of association with peers and onset of pubertal development, predicted rebellious (but not aggressive) delinquency in boys. Piquero and Brezina also examined whether changes in pubertal development predict higher delinquency by comparing two groups of boys. At Time 1 (mean age = 15 years), both groups were 'immature' but, by Time 2 (1.5 years later), one group had matured; results indicated a significant ($p < .01$) increase in behaviour change among those boys who matured (M = .17) compared to those who remained immature (M = -02).

Similarly, in a follow-up health survey of 5,700 male respondents, Felson and Haynie (2002) found strong significant effects of puberty development on all delinquency measures for boys, particularly violence and property crime. Felson and Haynie concluded that the effects of pubertal developmental alone are comparatively equivalent to the effects of school performance and peer delinquency, and stronger than any effect of family structure, socioeconomic status, or race. However, particularly noteworthy was the finding that the effects of pubertal development were consistently stronger among early-developing boys, suggesting that *early* puberty development may be a risk factor for delinquency.

The majority of the above-noted studies also examined the effects of pubertal timing on behaviour and found consistent results for the influence of early pubertal timing on behaviour, particularly among girls. It has been suggested that early-developing girls are more vulnerable to a lifetime of emotional problems extending far beyond the period of puberty-onset. For example, in a 6-year longitudinal study with 231 girls, Ge, et al. (2001) and Broidy et al. (2003) found that early-onset puberty predicted higher levels of depression that persisted longer than for on-time or late-maturing girls. Likewise, in a sample of 33,000 Finnish 14 to 16 year old adolescents, Kaltiala-Heino, et al. (2003), found that depression was predicted by early pubertal timing in girls and early *or* late pubertal timing in boys.

Similar findings have been found when investigating the effects of pubertal timing on externalizing behaviour in adolescents. Graber, et al. (1997) found that early maturing girls (N = 1,709) had a lifetime history of disruptive behaviour and substance abuse at twice the rate of either on-time or late maturing girls, and compared to on-time girls, had significantly higher rates (lifetime and current) for most psychiatric disorders including depression and eating disorders. In the earlier mentioned studies which investigated the relationship between pubertal *status* and ASB, it was also found that early-maturing girls were at most risk for ASB participation. For example, Caspi and Moffit (1991) and Caspi et al. (1993) found that girls who matured early (menarche before or at age 12 years old) were rated by parents as having the most behavior problems compared to on-time and late-onset groups. Similarly, Haynie (2003) found that relative to on-time maturing peers, early-maturing girls reported a slight increase in participation in party delinquency, and a large increase in minor (27% increase), and serious (45% increase), delinquency.

The findings regarding the effects of pubertal timing on externalizing behaviour for boys vary slightly from that found with girls. For example, Williams and Dunlop (1999) found that, compared to on-time maturers, boys who matured either early *or* late, obtained significantly higher scores on items measuring crime, school oppositional behaviors, and total delinquency. However, in a Norwegian sample of 3,862 adolescents, Wichstrom (2001) found that early pubertal timing predicted greater alcohol use for both boys and girls, and across both sexes, late-maturers reported significantly less alcohol use than early or on-time adolescents. In a recent study, Ge, Brody, Conger, and Simons (2006) found that both pubertal status and timing were significantly associated with both internalizing and externalizing symptoms, for boys as well as girls. Early-maturing boys experienced the highest levels of symptoms, followed by on-time boys, and late-maturing boys reported the fewest symptoms.

Pubertal Development and Antisocial Attitudes

Although no known studies have investigated the effects of pubertal development on attitudes that are characteristics of a psychopathic personality (e.g. narcissism, callousness, deceitfulness), a few studies have examined the relationship between pubertal development and other attitudes[1] such as a tendency toward impulsivity, irritability, and sensation seeking. For example, in a sample of 208 adolescents (aged 11 – 14), Martin et al. (2002) found that sensation seeking attitudes mediated the association between pubertal development stage and participation in drug and alcohol use for both girls and boys. In addition, a few studies have found a relationship between pubertal development and irritability and impulsivity. In girl samples, irritability has been found to be associated with both pubertal stage (Dorn, Crockett, & Petersen, 1988) and pubertal timing (Sonis et al., 1985) In other samples of adolescent girls, a link has been found between impulsiveness and pubertal stage and timing. For example, Petersen and Crockett, (1985) found that impulsivity was higher in girls just before the onset of menarche. Other studies have suggested that the instability of hormones at the early stages of puberty is associated with an increase in impulsiveness in girls. For example, from hormonal assays, Brooks-Gunn and Warren (1989) found that increases occurred during the most rapid rises in hormone levels.

The literature reviewed here shows that the prevalence of ASB during adolescence is significantly higher than during adulthood (Moffitt, 1993; Moffitt & Caspi, 2001; Wolfgang et al., 1972), that the majority of adolescents discontinue their participation in ASB upon achieving adulthood (e.g. Blumstein et al., 1988; Blumstein et al., 1985; Farrington, 1997), that a very large proportion of the adolescent population participates in a variety of antisocial acts (Baker, 1998; Hua et al., 2006), and that this phenomenon has occurred for generations (Loeber, Farrington, Stouthamer-Loeber, Moffitt, & Caspi, 1998; Winterdyk, 2000; Wolfgang et al., 1972). Although several theoretical explanations have been proposed for this phenomenon (see Winterdyk, 2000), the past couple of decades has seen increased support for the idea that the pubertal development process is a likely contributor (e.g. Buchanan et al., 1992; Caspi et al., 1993; Caspi & Moffitt, 1991; Felson & Haynie, 2002; Haynie, 2003; Williams & Dunlop, 1999). However, the aetiology of this association is not clear. Some researchers (e.g. Caspi & Moffitt, 1991; Ge et al., 2002), explain this relationship as a

[1] a layman's definition of attitude: a complex mental state involving beliefs and feelings and values and dispositions to act in certain ways (wordnet.princeton.edu)

function of the combined influence of sociological processes on biological processes (i.e. biosocial) as the adolescent moves into adulthood.

Other evidence suggests however that the association between pubertal development and ASB may be explained by the effects of hormones released during the pubertal development phase of adolescence (e.g. Buchanan et al., 1992). Thus, rather than the biosocial effects of physical maturation and the timing of that maturation as an explanation for ASB participation, an alternative is that it is the physiological effects of pubertal development onset alone that explains these processes. Whereas some researchers theorize that early timing for adolescents means they are 'pushed' into these roles before they are cognitively mature enough to deal with it, a physiological perspective suggests that it is the relative immaturity of the brain itself and the interaction of the release of hormones on immature brain structures that causes problematic behaviour. The findings that clinical mood disorders share this same association with pubertal stage and timing, provides some support for the suggestion that it is the release of hormones in the brain that affects adolescent behaviour rather than their changing social roles. As explained by Buchanan et al. (1992), behaviour may be influenced by the release of hormones on the central nervous system structures that are involved in regulating perceptive processes and affective responses. Buchanan et al., (among others) propose that, unlike other general hormones, receptors for puberty-specific hormones (i.e. gonadal and adrenal steroid hormones) are found throughout the brain and specifically in those regions that are responsible for affective behaviours (e.g. amygdale and hypothalamus, and hippocampus). The next chapter explains how the effects of pubertal hormones may result in an increase in antisocial behaviour and attitudes, and reviews the evidence for this position.

Chapter 2: Pubertal Development and the Executive Function 'Dip'

This chapter provides a review of the literature regarding the relationship between ASB and executive functioning, and recent findings for a decrease in executive function (executive function 'dip') that may occur during adolescence. The reviewed research provides evidence for this executive function 'dip' and how it is associated with pubertal development. This chapter is divided into three sections, 1) executive function and antisocial behaviour and attitudes, 2) pubertal development and brain structure, and 3) the executive function 'dip'. The first section provides a brief background regarding the relationship between emotional processing and antisocial attitudes, executive function and ASB, (and the role of the frontal lobe regions of the brain), and what is meant by the term executive function. The second section of this chapter briefly discusses the suggestions by some researchers of evidence for a relationship between pubertal development onset and structural changes in the adolescent brain. The third section of the chapter summarizes the evidence for an executive functioning/emotional processing 'dip' occurring in adolescence from the few studies published in this area, and applies this evidence to provide an executive function 'dip' model for the relationship between pubertal development and ASB participation during adolescence.

Executive Function and Antisocial Behaviour and Attitudes

Several competing models of executive functioning exist (see Miyake et al., 2000 for a review), and these differences in definition present a considerable challenge for reliable measurement (see Burgess, Alderman, Evans, Emslie, & Wilson, 1998; Duncan, Johnson, Swales, & Freer, 1997; Teuber, 1972). For example, Duncan, Burgess, and Emslie (1995) propose that executive function is similar to what is commonly known as 'fluid intelligence', and represents a goal-oriented process which involves incorporating certain actions to fulfill an organized plan. In contrast, Norman and Shallice (1986) propose a selection-for-action system in which a supervisory-attentional system selects the most appropriate behaviour from a list of competing possible actions, and all unselected actions must be inhibited. However, a commonality to these competing models is the assumption that executive function is a very broad and encompassing term, sometimes referred to as the 'central executive', because it is thought to represent the control centre for other cognitive processes in the brain (Baddeley, 1996). In this thesis, Miyake et al.'s (2000) influential model of executive functioning will be used, which regards executive functioning as consisting of three basic processes: Inhibition, Shifting, and Updating (working memory). As Miyake et al. describes, these three processes encompass the many higher order functions of the frontal lobe regions of the brain, which are responsible for planning, attending to, and organizing our behaviour (see Chapter 7 for details).

Particularly relevant to the current study is the finding that impairment to the frontal lobe region of the brain affects the role that executive function plays in decision-making and in initiating appropriate behaviour and inhibiting inappropriate behaviour in certain situations. The significance of frontal lobe impairment and the impact on behaviour was first recorded in 1848 when a railroad worker by the name of Phineas Gage was injured in an explosion that drove a metal tamping iron through the front portion of his skull (see Macmillan, 1986 for a review). Although Gage survived the accident and appeared within the normal range of cognitive functioning, friends and family noted dramatic changes in Gage's social behaviour from a conscientious, considerate, and industrious individual to someone who was ill-tempered, impulsive, and could not follow through on planned activities. This naturally-occurring case study of brain injury and behaviour led to a plethora of studies which have found associations between frontal lobe damage and impaired social behaviours among diverse samples such as head-injury patients (e.g. Henry & Crawford, 2004a), progressive dementia in the aged (Henry & Phillips, 2006) and violent criminals (e.g. review by Raine, 2002).

Executive Function and Antisocial Behaviour

Particularly relevant to the current study are findings that criminal behaviour is related to executive function deficits (Brower & Price, 2001; e.g. Leon-Carrion, Javier, & Ramos, 2003; Raine, Brennan, & Mednick, 1994, 1997; Raine, Lencz, Bihrle, LaCasse, & Colletti, 2000; Raine et al., 2005). Specifically, it has been found that ASB is related to the planning and control functions of the frontal lobes and the role of the orbitofrontal cortex in aggressive behavioral inhibition and fear-conditioning processes (Brower & Price, 2001; Raine et al., 2000). For example, using structural magnetic resonance imaging (MRI), Raine et al. (2000) found that participants who had been diagnosed with Antisocial Personality Disorder had an 11 to 14% reduction in prefrontal gray matter compared with other groups (matched control group, substance-dependent group, and a psychiatric control group). And in a critical review of published articles relating evidence of frontal lobe dysfunction with violence or crime, Brower and Price (2001) found an association between aggressive dyscontrol and brain injury, especially involving the frontal lobes, and that focal orbitofrontal injury was specifically associated with increased aggression.

Raine (2002) provides a comprehensive review of the relationship between ASB and executive function with 39 examples of biosocial interaction effects found in research with children and adults. Two main interactive themes are discussed. When biological (e.g. genetic, obstetric complications, prefrontal and hemispheric cortices, neurological, hormonal) and social (family, peers, community) interactions are considered, Raine found that biological risk factors alone, and in interaction with social risk factors, predicted the rate of antisocial and violent behavior. These findings also revealed support for a main effect of a biological predisposing factor, particularly in the ability to explain the prevalence of ASB among those individuals from a favourable-home environment. For example, Raine, Stoddard, Bihrle, and Buchsbaum (1998) found that murderers from deprived homes show relatively good prefrontal conditioning, whereas murderers from good homes show significantly poorer (14.2%) functioning in the right orbital cortex. Furthermore, Raine, et al. (2001) found that among abused individuals, violent offenders displayed reduced functioning in the right temporal cortex whereas those individuals who refrained from serious violence displayed relatively higher activation in the right temporal lobe and lower activation in the left temporal lobe. Thus, although an unfavourable or abusive environment can be a risk factor for the development of ASB, there is evidence to suggest that brain function deficits alone can sometimes predict participation in ASB.

In addition to the more extreme examples of the relationship between executive function deficits and violent behaviour, executive function impairment has also been shown to result in deficits in the ability to respond appropriately in social situations (e.g. Channon, Pratt, & Robertson, 2003; Liss et al., 2001; Morgan & Lilienfeld, 2000; Pantelis et al., 2004; Pennington & Ozonoff, 1996). In a variety of samples, executive function deficits are evident in displays of impulsive actions and socially inappropriate behaviour in which the individual acts on self-fulfilling desires without considering how the behaviour impacts on the environment and other individuals. It has been found that the ability to control behaviour, and make appropriate (e.g. pro-social) decisions is significantly impaired in individuals who have suffered frontal lobe damage, including physical brain trauma (e.g. Stuss & Gow, 1992), and degenerative diseases such as Alzheimer's and Parkinson's disease (e.g. Troyer & Moscovitch, 1996).

Some of these studies have employed self-report or observational measures to assess affect and social judgment (Shallice & Burgess, 1991). The majority of studies investigating executive function impairment, however, have used cognitive tasks to measure planning and organization skills (e.g. Wisconsin Card-Sorting Task, Kimberg, D'Esposito, & Farah, 1997), impulsivity and inhibitory responses (e.g. The Stroop Task, Stroop, 1935), and working memory range (e.g. Digit Span, Wechsler, 1997). However, some theorists (e.g. Blair & Cipolotti, 2000) stress that the role of executive function in social cognition is something that can only be assessed in real-life 'presently-occurring' situations and cannot be measured using the typical paradigms of substituting cognitive tests, and thus the existing theories cannot be supported by these 'pseudo-measures' of executive function. Notwithstanding this critical limitation, the consensus among executive function theorists at present seems to be that these cognitive measures are the most reliable measures available currently, and that these limitations should not deter further research despite the cautionary conclusions that must be drawn from the findings (see Miyake et al., 2000).

Emotional Processing and Antisocial Attitudes

Several studies have also focused on deficits in the ability to recognize emotional expressions of sadness and fear, (but not angry or happy expressions) among children with psychopathic tendencies (e.g. Stevens, Charman, & Blair, 2001). Although the majority of emotional processing research involves assessing participants' ability to recognize facial expressions (e.g. Blair, Morris, Frith, Perrett, & Dolan, 1999), or to infer the social cognitions of others (Blair, Zelazo, & Greenberg, 2005; Blair, Sellars, Strickland, Clark, & et al., 1996; Blair, 2005; Blair & Perschardt, 2002; Richell et al., 2003), the measurement of emotional processing also includes brain imaging techniques, such as functional Magnetic Resonance Imaging (fMRI;) and Positron Emission Tomography scans (PET; for a review see Phan, Wager, Taylor, & Liberzon, 2002), which are able to identify activation of particular regions in the brain (e.g. amygdala) associated with these functions.

For example, in a critical review of animal, human lesion, and functional neuroimaging studies, (Phillips, Drevets, Rauch, & Lane, 2003) found that the neurobiological basis of the different processes underlying emotion perception may be particularly dependent upon the functioning of two neural systems. Phillips et al. found that the identification of the emotional significance of a stimulus and the production of an affective state in response to it were dependent on neural systems including the amygdala and the prefrontal cortex. The findings from studies such as these show that in addition to problems in controlling behaviour, deficits in emotional processing may reflect frontal lobe impairment. Thus, if adolescents do experience disruption to frontal lobe functioning during the onset of pubertal development, processes such as emotional affect and empathic response should also be disrupted.

Pubertal Development and Brain Structure

Puberty is characterized by the release of hormones which affect the central nervous system (see for example, Romeo, 2003), and it has been suggested that these hormones influence areas in the brain specifically related to behaviour and emotion (see Buchanan et al., 1992 for a review). Structural brain changes occurring during adolescence, appear to coincide with the onset of puberty (see Raine, 2002; Spear, 2000a, 2000b; Walker, 2002), and some studies have found that these changes are associated with temporary declines in cognitive performance during adolescence (see Blakemore & Choudhury, 2006 for a review). It is therefore possible that structural changes in the frontal lobes during puberty (Giedd et al., 1999) result in fluctuations in executive function performance and emotional processing abilities (McGivern et al., 2002). Studies employing a range of methodologies provide evidence for cognitive changes during adolescence These include brain imaging studies (Bunge, Dudukovic, Thomason, Vaidya, & Gabrieli, 2002; Giedd et al., 1999; Gurd et al., 2002; Phan et al., 2002; Raine et al., 2001; Rubia et al., 2000; Sowell, Trauner, Gamst, & Jernigan, 2002), and facial recognition tasks (Carey et al., 1980; Diamond & Carey, 1977; Stevens et al., 2001).

These studies have discovered that the adolescent brain undergoes a second reorganizational transformation similar to that occurring in early childhood (Bourgeois, Goldman-Rakic, & Rakic, 1994; Huttenlocher, 1979; Woo, Pucak, Kye, Matus, & Lewis, 1997; Zecevic & Rakic, 2001). Post-mortem examination of pre-adult brains has revealed dramatic structural changes in the pre-frontal cortex during puberty and adolescence, and these early findings have been extended by recent MRI studies showing that the adolescent brain undergoes significant changes in white matter and grey matter density. Specifically, several studies with large samples have replicated the findings that the adolescent brain is characterized by dramatic co-occurring increases in white matter and decreases in grey matter as the adolescent brain undergoes synaptic reorganization (Casey et al., 2000; Giedd, 2005; Giedd et al., 1999; Giedd et al., 2006; Giedd, Snell et al., 1996; Giedd, Vaituzis et al., 1996; Reiss, Abrams, Singer, Ross, & Denckla, 1996; Sowell et al., 2003; Sowell, Thompson, Tessner, & Toga, 2001; Sowell et al., 2002).

In addition to these neural developments, major changes in hormonal balance occur during puberty. Correspondingly, several researchers have suggested that executive function impairment during adolescence is associated directly with hormonal activation effects on the adolescent brain. Walker (2002) argues that temporary deficiencies in executive functioning occurring during adolescence can be explained by the pubertal activation of the release of hormones and fluctuations in specific neurotransmitters related to pubertal development. Sex differences in brain structure changes at this age highlight the role of sex steroid hormones in this process (Giedd, Vaituzis et al., 1996). Specifically, hippocampal volume increase in females is associated with the high proportion of estrogen receptors in the hippocampus (Morse, Scheff, & DeKosky, 1986) and, the predominance of androgen receptors in the amygdala accounts for the increase in amygdala volume in males during puberty (Sholl & Kim, 1989). These organizational changes in the brain affecting the limbic system might cause emotional processing deficits and behavioral disruptions: the hypothalamus monitors motivational behaviors, the hippocampus plays a role in the formation of certain types of memories and can influence emotional arousal, and the amygdala is involved in aspects of emotional control (Eichenbaum & Bunsey, 1995).

Thus, it is proposed that behavioural regulation and emotional processing deficits during adolescence are related to developmental processes as the adolescent brain undergoes many age-associated transformations and is fundamentally remodelled during this stage (Casey et al., 2000). In particular, there appears to be strong empirical support for the suggestion that the prefrontal cortex undergoes delayed maturation during the adolescent period of development (e.g. Giedd et al., 1999). In his review of 39 empirical studies of biosocial studies of antisocial and violent behavior in children and adults, Raine (2002) suggests that during puberty, the release of sex steroid hormones and related rapid neurotransmitter fluctuations overloads the synaptic functioning of the frontal lobes resulting in impaired functioning of emotional and behavioural control. Specifically, Raine suggests that late development of the prefrontal cortex during the adolescent period and the concurrent excessive demands placed on the adolescent's social and executive functioning increases the risk of prefrontal dysfunction and externalizing behavior during this stage (Raine, unpublished, as cited in Raine, 2002).

The Executive Function 'Dip'

The central hypothesis in the current study is that, regardless of a structural or a hormonal aetiology, a temporary 'dip' in executive function occurs during adolescence, and this dip accounts for the link between pubertal development and antisocial attitudes and behaviour. This is probably best illustrated by providing an example of adolescent thought and behaviour processes in comparison to those of an adult. Imagine that someone has left their car with the keys in the ignition in a car park. Seeing this, an adult might think that an opportunity for financial gain has been presented, but would then consider the possible consequences if caught, and perhaps the impact of the theft on the victim. By contrast, an adolescent with impaired executive function might only consider that it would be fun to take the car for a ride around town (thrill-seeking; risk-taking), does not consider the possible consequences of getting caught, or even whether he or she has the necessary skills to drive a vehicle (decision-making), acts on the initial impulse (failure of inhibition), and does not consider that someone may be distressed to find their car gone missing or the damage they may do (failure of perspective taking).

Findings in the criminological literature show that, among the most commonly cited reasons for participation in crime by adolescents, is a need or desire for fun or excitement, and money (Agnew, 1990; Belson, 1975; Cromwell, 1994; McCaghy, Giordano, & Knicely Henson, 1977; Nee, 1993), and that money is frequently acquired for other self-gratification activities such as drinking, drug-taking and entertainment (Altschuler & Brounstein, 1991; Bennett & Wright, 1984). Salmelainen (1995) also reported that juvenile offenders' attitudes were very self-focused and had little effect on their future offending behaviour. Although many juveniles did report that they were concerned about the effect of their crime on the likelihood of future employment, there was no association between these concerns and their offending behaviour (i.e. it did not result in a reduction of offending), suggesting that adolescents have poor decision-making skills or control over their own behaviour. Salmelainen's finding that the majority of juvenile offenders said that they had not thought, or did not care about the impact on the victim, further suggests possible impairment to emotional processing functioning in adolescents.

It is argued here that adolescent ASB may be the result of cognitive and emotional impairment temporarily experienced during adolescence due to restructuring in the frontal lobes associated with hormonal-related changes in the brain (see Blakemore & Choudhury, 2006). The evidence that ASB is significantly associated with executive functioning deficits in the aged, and clinical and criminal populations (Broomhall, 2005; Channon et al., 2003; Liss et al., 2001; Pantelis et al., 2004), it is compelling to consider that a similar association may be occurring in adolescent populations despite the limited research evidence to date. Deficits in executive functioning, (and emotional processing) and behaviour, have been found to be associated with abnormal structuring in the frontal lobes of adolescents (Casey et al., 2000), which may be related to neurochemical (horomone or neurotransmitter release), or physical brain structure, disruptions (see Spear, 2000b). These structural changes have been found by some researchers to be associated with developmental changes which follow an inverted U-shape that may coincide with the onset of puberty. For example, in a longitudinal study of participants ranging in age from 4 to 22 years, Giedd et al. (1999) found that grey matter volume increase peaked at around the age of 11 for girls, and age 12 for boys, with a corresponding decrease post-adolescence.

To our knowledge, no studies have directly examined the relationship between ASB and pubertal development as the result of the mediating effects of reduced executive functioning. However, the evidence of an executive function 'dip' during adolescence suggests that this impairment may be the result of pubertal development-related changes in the adolescent brain. Evidence for a 'dip' in executive functioning during adolescence has been found in a range of studies including facial-recognition studies, social cognition studies, behavioural studies, and brain-imaging studies.

For example, McGivern et al. found that children's ability to encode faces improved linearly until age 11. After age 11, performance dropped significantly and did not recover until 14 to16 years old. McGivern et al. (2002) also found that sex differences exist in reaction time of 15 to 17 year olds to assess both facial and linguistic stimuli related to emotion. Specifically, females had significantly longer reaction times compared to males when processing emotions related to both faces and words. This difference appeared to be limited to the late-adolescent period as these sex differences were not present among the 18 to 22 year old sample, suggesting that the developmental period during and immediately following release of sex hormones is associated with this emotional processing deficit. McGivern et al. (2002) argue that the release of steroid hormones at puberty induces the reorganization of neural circuits in the prefrontal cortex and that this neural reorganization affects emotional processing in the orbitofrontal region, but not abstract reasoning in the dorsolateral region of the brain. Although McGivern et al. propose that this temporary deficit may be a function of pubertal development, this hypothesis has not been tested.

McGivern et al.'s (2002) findings are consistent with previous studies investigating developmental changes in facial recognition ability. For example, Diamond and Carey (1977) found that although facial recognition improved linearly with age as a function of isolated features (from age 6 to 10, with little improvement past age 10), older subjects (12, 14,16) performed worse than younger subjects when facial expression was varied. Thus, Diamond and Carey concluded that among older subjects in their sample there appeared to be a deficit in the ability to differentiate between facial characteristics and facial expressions. However, it seems that declines in facial recognition performance occur in adolescence even when facial expression and isolated features (glasses, facial hair), are held constant (Carey et al., 1980). Carey et al. found that the capacity to encode faces improved between ages 6 and 10, declined at age 12 and 14, and improved again at age 16. In a similar study, Diamond, Carey, and Back (1983) found that face encoding was less efficient in pubescent girls compared with pre- and post-pubescent girls who were matched for age. Diamond et al suggested that the decline in performance at mid-puberty could be attributed to a reorganisation of face representation due to changes in self-awareness and awareness of other people resulting from bodily changes occurring at puberty; or alternatively that hormonal changes at puberty may have a direct impact on cognitive performance.

This 'dip' in emotional processing has relevance for 'theory of mind' processes during the adolescent period (see Gallagher & Frith, 2003). The theory of mind hypothesis is described by Baron-Cohen (1995) as the ability to infer another individual's internal affective or cognitive state from observed cues. Frith and Frith (2001) describe theory of mind as the ability to understand others' minds by attributing mental states such as beliefs, desires and intentions to other people. Choudhury, Blakemore, and Charman (2006) found that the development of social perspective in adolescents continued to improve linearly from childhood into adulthood. Citing MRI studies showing that the brain is subject to considerable structural development during adolescence, in particular regions that are implicated in social cognition, (e.g. prefrontal cortex), Choudhury, et al. (2006) hypothesized that compared to adults, adolescents would perform more poorly on perspective-taking tasks. In a study with conducted with 112 participants, aged 8-36 years, Choudhury et al. found that compared to adults, adolescents took significantly longer to perform social judgments of both first person (participant's own point of view) and third person (from that of another person) types, and that adolescents too significantly longer to perform third-person judgments than to perform first-person judgments. Choudhury et al. concluded that this significant decrease in the difference between first-person and third-person perspective-taking during adolescence may reflect cognitive and behavioural features that are particularly associated with adolescent developmental period.

Although some studies have found a linear increase in executive function performance from infancy to childhood (for a review, see Zelazo, Carter, Reznick, & Frye, 1997), and from childhood to adolescence (Levin et al., 1991), studies which include adolescent participants have been less consistent (Becker, Isaac, & Hynd, 1987; Williams, Ponesse, Schachar, Logan, & Tannock, 1999). For example, in a recent study by Lehto, Juujarvi, Kooistra, and Pulkkinen (2003), small improvements with age were observed in a sample of 8 to 13 year olds, however little or no improvement was observed from age 11 to 13. Furthermore, Lehto et al.'s data indicates that, from age 11 to 13, on some measures, particularly measures of inhibition, small dips in performance occurred. These findings could suggest an adolescent executive functioning dip; however, as older adolescents were not included in this study, it is unknown whether this is a dip in performance that is later recovered in late adolescence.

Blakemore and Choudhury (2006) note that very few studies have investigated changes in executive function skills during adolescence. The studies undertaken have reported that performance on tasks that impose substantial demands on inhibitory control (Leon-Carrion, Garcia-Orza, & Perez-Santamaria, 2004; Luna, Garver, Urban, Lazar, & Sweeney, 2004), processing speed (Luna et al., 2004), and working memory and decision-making (Conklin, Luciana, Hooper, & Yarger, 2007; Hooper, Luciana, Conklin, & Yarger, 2004; Luciana, Conklin, Hooper, & Yarger, 2005), continues to develop during adolescence. Although some studies indicate that development undergoes a large improvement from childhood to adolescence, followed by a plateau between adolescence and early adulthood (Luna et al., 2004), others have indicated that adolescents between the ages of 11 and 17 demonstrated a linear improvement in performance on some tasks but not others (Anderson, Anderson, Northam, Jacobs, & Catroppa, 2001). Thus, the developmental progression of executive function during adolescence remains unclear, however the evidence from behavioural studies is not entirely incompatible with the view that during adolescence there may be a performance dip in some executive functioning tasks.

Further evidence suggesting a possible adolescent dip in inhibitory control is found in some neuropsychological studies. Using fMRI analysis and response inhibition tasks (e.g. Go/No-Go task), developmental differences have been observed in prefrontal cortex activation (Casey et al., 2000; Rubia et al., 2000; Tamm, Menon, & Reiss, 2002). Although the developmental trajectory of response inhibition indicates that scores on measures of inhibition significantly improve with age, the lack of correlation between orbitofrontal activation increases, and reaction time decreases, suggest that there may be nonlinear changes in the data when adolescents are included in the analysis (Tamm et al., 2002). The majority of these studies have provided evidence for the link between activation of frontal cortex areas of the brain and performance on executive function tasks. For example, used extensively in experimental and clinical studies, word-generation tasks have been consistently linked to prefrontal cortex activation (Brown et al., 2005). As an example, Gaillard et al. (2000) found that children did not perform as well on a verbal fluency task (generating as many words starting with a particular letter as quickly as possible) as adults, but also that on average, children showed 60% greater activation in the prefrontal cortex whilst performing this task in a fMRI scanner.

Several studies focused on tasks which include decision-making, and risk-taking behaviour have concluded that slower response times by adolescents in comparison to adults in these tasks is related to greater reliance on brain regions in the prefrontal cortex. For example, Bjork et al. (2004) found that, compared to adults, adolescents were more driven by the need for extreme incentives. Their findings that adolescents also showed lower activation in areas of the brain associated with motivation, led Bjork et al. to conclude that adolescent decision-making is influenced by the need for higher incentives because of low activity in these brain regions. Baird, Fugelsang, and Bennett (2005, as cited in Blakemore & Choudhury, 2006) investigated risk-taking behaviour in adolescents to explain the poor decision-making performance that is often observed in this group. In their risk-decision scenarios (e.g. 'Swimming with sharks'), Baird et al. found that adolescents took significantly longer than adults to indicate that this was 'not a good idea'.

Although more research needs to be conducted in this area to test the relationship between hormonal factors and social behaviours (see Buchanan et al., 1992), these findings suggest that adolescents may be experiencing a temporary deficit in their ability to plan and control their social behaviour during periods of rapid brain restructuring occurring around the time of puberty. There is also some evidence to suggest that these impairments may be longer lasting in adolescents who experience this developmental phase earlier than the norm. For example, Blakemore and

Choudhury (2006) propose that the interaction between adolescent brain changes and social cognition may be two-way. They suggest that during this time of cognitive reorganization, "...what is perceived as important in the social world around us also changes and leaves its imprint on the [synaptic] pruning process" (p 302). Thus, an adolescent who experiences a relatively 'early' pubertal development process which creates additional impact on the already overloaded changing adolescent brain, may experience excessive and longer-lasting impairment than those adolescents who mature relatively on-time or relatively late.

To summarize, it is proposed that (antisocial) behavioural, and attitudinal changes in adolescents may be mediated by changes in brain structure and function due to the increase in secretion of gonadal hormones during puberty in adolescents because these hormones have an organizational effect as well as an activational effect on the brain (see Walker, 2002). The reviewed studies provide empirical evidence that the adolescent phase of development is characteristically different than that of the child and adult stages. These studies provide evidence for a 'dip' in some executive function abilities and emotional processing tasks that may be occurring at the time of pubertal development onset, and suggests that this is a question worthy of further study. Thus, based on the evidence that a relationship exists between executive function and ASB, between pubertal development and executive function, and between pubertal development and ASB, it is proposed that the relationship between pubertal development and ASB is mediated by a temporary 'dip' in executive function during adolescence.

Research Aims and Hypotheses

Aims

The overarching aim of this research is to examine whether executive function and impairment provides a mechanism to explain the association between pubertal development and ASB among adolescents. The research presented in this thesis aims to clarify and extend on previous research investigating the possibility that during puberty, adolescents experience disruption to executive functioning, and that this 'dip' in executive functioning can explain the increase in antisocial behaviour during adolescence. Specifically, the current study investigates whether participation in adolescent antisocial behaviour is associated with the onset of puberty, rather than a particular age, whether this association might be explained by a temporary disruption in adolescents' normal pattern of executive functioning development during puberty, and whether adolescent ASB is associated with executive functioning deficits. This study also seeks to investigate whether an increase in antisocial attitudes during adolescence is associated with a 'dip' in emotional processing. This research also seeks to establish whether any persistent effects are associated with pubertal development timing. Specifically, it is a purpose of this study to establish whether adolescents who mature earlier than normal are at increased risk for persistent executive function deficits, and persistent increases in antisocial attitudes and behaviours than adolescents who mature within or later than normal.

Hypotheses

Executive Function & Antisocial Behaviour

It is predicted that higher ASB participation will be associated with lower executive functioning. Specifically, those adolescents who report relatively 'high' ASB participation will score significantly lower on tests of executive function than adolescents who report relatively low ASB participation.

Pubertal Development Onset

Pubertal Development & Antisocial Behaviour. It is predicted that the onset of puberty will be associated with increases in antisocial behaviour. Specifically, compared to pre and post-pubertal adolescents, those adolescents who are mid-pubertal will report significantly higher antisocial behaviour participation.

Pubertal Development & Executive Function. It is predicted that the onset of puberty will be associated with temporary impairments in executive function. Specifically, compared to pre and post-pubertal adolescents, those adolescents who are mid-pubertal will obtain significantly lower scores on executive function measures.

Pubertal Development & Antisocial Attitudes. The findings that emotional processing abilities may be temporarily impaired by pubertal development processes are also investigated in the current study. The current study proposes that adolescents may be experiencing a temporary increase in antisocial attitudes which resemble 'psychopathic' traits (e.g. reduced empathic response) during puberty onset that diminishes as they approach young adulthood. It is hypothesized that compared to pre and post-pubertal adolescents, those adolescents who are mid-pubertal will report significantly higher antisocial attitudes.

Pubertal Development Timing

It is further hypothesized that the early onset of puberty accentuates the impairment to executive function and thus will be associated with persistent impairment to executive function and antisocial attitudes and behaviour. Based on preliminary findings by Raine (2002)and Blakemore and Choudhury (2006), it is also predicted that, although most adolescents recover from this temporary dip in functioning and that participation in ASB subsequently decreases, for some adolescents who experience *early* pubertal development, recovery is delayed (or prevented) and antisocial attitude and behaviour patterns persist into adulthood. Therefore, this study seeks to investigate whether early pubertal development onset is associated with persistent executive function impairment and persistent antisocial attitudes and behaviour.

Pubertal Development & ASB Mediated by Executive Function

Finally, in addition to the hypothesized relationships between pubertal development and executive function, executive function and ASB, and pubertal development and ASB, it is hypothesized that reductions in executive functioning mediate relationships between pubertal development and ASB participation. Therefore, it is predicted that ASB participation variance associated with pubertal development onset and timing, is partially or wholly explained by the previously significant relationship between pubertal development and executive function and executive function and ASB participation.

SECTION 2: METHOD

The method for conducting this research is described in the next two chapters. Chapter 3 summarizes the method and results from a pilot study conducted with a sample of 194 first-year university students, and briefly describes and summarizes the materials that were used in the primary study. Chapter 4 outlines the design of the primary study conducted for this thesis, describes the participant selection and recruitment of 323 children and adolescents, and briefly describes additional measures used in the primary study. Chapters 5, 6, and 7 (Section 3: Data Treatment) provide a detailed and thorough description of the materials used in the study to measure pubertal development, executive function, and antisocial behaviour and attitudes, including the method of selection and design for each measure, and how the variables were operationalized. In this section, therefore, Chapters 3 and 4, place more emphasis on describing participant recruitment and the procedure employed in the pilot and primary studies respectively.

Chapter 3: Young Adult 'Pilot Study'

The primary aim of the research described in this thesis was to examine the relationships between pubertal development, executive function, and antisocial behaviour and attitudes, in children and adolescents. Prior to receiving approval from ethics committees to conduct the research in New South Wales public schools, a pilot study was conducted with first year psychology students enrolled at the University of New South Wales. One of the goals of this pilot study was to train interviewers for the school sample, but the primary goal was to establish measurement validity and reliability of all four constructs before implementing the study with children and adolescents. This chapter discusses the method used to select, test, and analyze the measures of antisocial attitudes and behaviour, executive function, and pubertal development. Brief details of the procedure and data analyses methods used in this pilot study are included to demonstrate how the final measures were chosen for the 'school study'.

Pubertal development, antisocial behaviour, and antisocial attitudes were measured via self-report questionnaires. Executive function was measured by the administration of several tests which have been identified in the literature as measuring four constructs of executive functioning (Planning, Updating, Inhibition, and Shifting; see Miyake et al., 2000), and by administering cognitive tests unrelated to executive function (e.g. vocabulary) as a 'control' for individual differences in general intellectual functioning (for example, Higgins, Peterson, Pihl, & Lee, 2007). This chapter is divided into three sections. The Materials & Measurement section describes the items and scoring of each measure used in the pilot study along with a brief description of how the instrument or test, measures the construct of interest. The Participants & Procedure section describes how participants were recruited and how interviews were conducted. The Design & Analysis section explains the outcome of the pilot study with an emphasis on how well each of the selected measures performed.

Materials and Measurement

The materials used in the study consist of three self-report surveys and six cognitive measures, (four measures of executive function, and two 'control' measures of general intellectual function). The self-report measures were constructed by the experimenter and included the following components:

- Personal Information Sheet (includes pubertal development items; Appendix 3.1),
- Antisocial Attitudes Scale (Appendix 3.2), and
- Antisocial Behaviour Scale (Appendix 3.3).

The four measures of executive function were:

- Verbal Fluency (Semantic Fluency & Letter-Number Switching; Appendix 3.4),
- and standardized tests from the published literature
    - Stroop Test (Stroop, 1935),
    - Letter-Number Sequencing Task (WAIS-III subtest; Wechsler, 1997),
    - Porteus Mazes (Porteus, 1950),

and both of the control measures were selected from the published literature:

- Peabody Picture Vocabulary Test (Dunn & Dunn, 1997), and
- Picture Arrangement Task (WAIS-III subtest; Wechsler, 1997).

Self-Report Measures

Personal Information Sheet

The Personal Information Sheet (Appendix 3.1) is divided into four sections: Personality Change (Section A; this data set is not analyzed in this thesis), Socio-Economic Status (Section B), Pubertal Development (Section C), and Family Structure (Section D). All data collected on the Personal Information Sheet represents responses from participants regarding current and retrospective events occurring during childhood and adolescence. The Personal Information Sheet provides data for the measurement of pubertal onset age and pubertal timing, and data on expected covariates associated with these changes.

Socio-Economic Status & Family Structure. Previous research has found a negative correlation between socio-economic status (SES) and ASB participation (e.g. Hay, Fortson, Hollist, Altheimer, & Schaible, 2006), and some evidence has been found for a relationship between SES and pubertal timing (e.g. Ge, Conger, & Elder, 1996); therefore, participants' retrospective, self-reported SES was included as a possible covariate in analyses investigating relationships between ASB and pubertal development. Participants provided retrospective responses of their perceived economic standing while living at home. Participants were asked to rate on a 7-point likert scale their childhood SES relative to other families (e.g. poorer than average, average, richer than average).

Participants also indicated whether any family-structure changes (e.g. parental divorce, single-parent home, presence of step-father) occurred during their childhood, and what age they were at the time these events occurred. Previous research has found a relationship between absence of father (Bogaert, 2005; Comings, Muhleman, Johnson, & MacMurray, 2002; Kanazawa, 2001; Romans et al., 2003) and the presence of a non-related male, in the household (Ellis, 2002; Ellis & Garber, 2000; Ellis, McFadyen-Ketchum, Dodge, Pettit, & Bates, 1999) and the age of girls' pubertal development. Specifically, there is some evidence to suggest that the presence of a non-related male in the home may contribute to early-onset of puberty in girls (Ellis & Garber, 2000).

Pubertal Onset. The age at which participants retrospectively recall experiencing physical changes associated with puberty are used as measures of the age of pubertal onset. A 'general' puberty onset age was collected from both males and females. However, as individuals may vary in their definition of puberty onset, (and their recollection may be impaired by the passage of time), data were also collected on events believed to be more memorable to participants. Participants were asked to recall at what age their voice changed (males), or when breast development began (females). Another significant occurrence during pubertal development for females is menarche, which is the first occurrence of menstruation (e.g. Bancroft, 2006). An equally significant event for males is spermarche, which is the presence of first ejaculation (includes nocturnal emissions; e.g. Bancroft, 2006). Respondents provided an age in years (e.g. 12.5) for each event, and indicated level of confidence in their recollection accuracy (0 to 100%).

Pubertal Timing. Whereas Pubertal Onset is defined as the age at which physical changes associated with puberty occur, Pubertal Timing is defined as the timing of these events relevant to one's peers. Research in this field typically identifies three pubertal-timing groups: early, on-time, or late. However, the method of classification varies between studies. The two most common methods are to either ask participants to self-report on their own pubertal timing (see Graber, Petersen, & Brooks-Gunn, (1996); Silbereisen & Kracke, 1997), or to classify respondents based on the age at which pubertal onset occurred (e.g. Ge et al., 2006; Kaltiala-Heino, Kosunen, & Rimpela, 2003; Kaltiala-Heino, Marttunen et al., 2003). Both of these methods were used in this pilot study. For example, participants were asked, "Relative to your peers, did you mature 'earlier than your peers', 'with your peers', or 'later than your peers'?". The second method is to classify participants into one of three groups based on their reported age of puberty onset in relation to their same sex peers within the sample. Thus, in addition to participants' self-classification, they were placed into early, on-time, and late pubertal groups by stratifying groups based on frequency analysis using the cut-points as described below (in Design & Analysis section).

Antisocial Attitudes Scale

The Antisocial Attitudes Scale (ASAS; Appendix 3.2) is a 32-item, self-report questionnaire designed by the experimenter to measure the presence of antisocial attitudes. Antisocial attitudes are usually associated with antisocial behaviour (e.g. Mills & Kroner, 2006). As reviewed in Chapter 2, there is evidence to suggest that adolescents may experience temporary disruption in social affect and cognition processes. Thus, it was proposed that these emotional processing impairments are similar to the constructs measured by instruments designed to identify psychopathic traits in juvenile offenders and callous-unemotional traits in 'community' adolescents and children (e.g. Youth Psychopathic Traits Inventory, Andershed, Kerr, Stattin, & Levander, 2002); (Antisocial-Process Screening Device, Frick & Hare, 2001); and (Child Psychopathy Scale, Lynam, 1997).

Researchers broadly define these traits as representing a personality style in which one's actions have a negative effect on others (e.g. Frick et al., 1994). Characteristically, those who obtain high scores on this construct tend to think of themselves as superior to and, more important than, other people (e.g. narcissistic), with a lack of personal insight or ability to recognize or respond to the feelings of others (e.g. lack of empathy). Other examples of traits associated with this construct include pathological lying, irresponsibility, and impulsivity (e.g. Frick et al., 1994). Therefore, construction of the ASAS was broadly based on the Psychopathy Checklist: Youth Version (PCL:YV; Forth, Kosson, & Hare, 2003b), designed to measure the construct of psychopathy in juvenile offenders. The ASAS includes two questions to represent each of 16 of 20 items on the PCL:YV (items 12, 18, 19, and 20 of the PCL:YV were excluded as they referred to 'early behaviour problems' and to 'serious criminal behaviour').

Based on the factor structure of the PCL:YV, items on the ASAS were designed to represent two overarching constructs associated with a 'callous' personality. For example, Factor 1 of the PCL:YV refers to interpersonal characteristics such as grandiosity, pathological lying, callousness, and manipulation for personal gain. Thus, the ASAS item, *"I can usually get other people to give me what I want"* represents a measure of the 'manipulative' item on the PCL:YV. Items characteristic of Factor 2 on the PCL:YV, include measures of impulsivity (e.g. *"Sometimes, even though I know something is not a good idea, I can't stop myself from doing it"*). It was hypothesized that items from the PCL:YV measuring promiscuity and relationship instability might represent a distinct group of individuals. Previous research has found an association between sexual behaviour and ASB participation, but also with other variables such as family structure and parenting practices `(e.g. Biglan et al., 1990). Therefore ASAS items such as *"I like to maintain more than one romantic/sexual relationship at a time"* were hypothesized to represent a third separate factor on the ASAS. For each of the 32 items on the ASAS, respondents were required to indicate on a 4-point scale how strongly they agreed with the statement from *"0" "Doesn't apply at all"* to *"3" "Applies most of the time or very well"*. Thus, the range of possible scores on the ASAS is 0 to 96.

Antisocial Behaviour Scale

The Antisocial Behaviour Scale (ASBS) is a modified version of the 40-item Self-Reported Behaviour Scale (SRBS, Mak, 1993) (Mak, 1993). The SRBS was selected because it has been validated on an Australian sample of delinquent, and non-delinquent, youth (Carroll, Durkin, Houghton, & Hattie, 1996; Mak, 1993). Nineteen items from the SRBS were excluded from the ASBS as they referred to behaviours only appropriate for younger age groups (i.e. children and adolescents). Examples of these items include "Run away from home at least overnight" and "Made abusive phone calls, e.g. saying nasty or obscene things?". Fourteen additional items were included in the measure to develop a more comprehensive measure of antisocial behaviour for this group of young adults. Examples of these items include "Sold or bought stolen goods", Grown or sold drugs", Hit your parent or teacher", and "Taken someone's purse or wallet".

Thus, a total of 35 items were included in the ASBS examining a variety of types of delinquent behaviours (e.g. truancy, bullying) or criminal activity (ranging from vandalism and petty theft to weapon use and physical assault). Respondents were instructed to answer Yes or No to indicate if they had ever participated in the behaviour. For items that were positively endorsed, respondents were instructed to indicate how old they were at when they first participated in the behaviour, and the age they were when they last participated, in the behaviour. Participants responded by circling responses provided from ages in the range of *"9 or younger"* to *"25 or older"*.

As reviewed in Chapter 1, measuring ASB participation is rather complex, and comprehensive measurement includes prevalence, frequency, duration, and the 'seriousness' of the acts committed (see Blumstein et al., 1986). The measure designed for use in the current study provides several measures of ASB (see Chapter 12: Discussion), but only three are discussed for the purposes of establishing reliability and validity of measurement in this pilot study: 1) Total ASB, 2) First Age ASB, and 3) Average First Age ASB. Total ASB is measured as the total number of individual antisocial acts (but not the number of times engaged in each act). Age of beginning ASB participation is defined as the first age of any ASB (First Age ASB). Average first age is defined as the first age of participation across all antisocial acts participated in (Average First Age ASB).

Cognitive Measures

Executive-Functioning Measures

As reviewed in Chapter 2, executive functioning refers to the higher order functions of the brain and the mental capacity to control and purposefully apply one's own cognitive abilities. As reviewed by Miyake et al. (2000), executive functioning is a broad term which refers to several different executive functions. These include the ability to sustain or flexibly redirect attention, the inhibition of inappropriate responses, the ability to plan future behaviour, and to flexibly switch among problem-solving strategies, and the ability to initiate and execute these strategies. Although higher level concepts like 'planning' are often included in assessments of executive functioning, Miyake et al. suggest that three executive functions, shifting, updating, and response inhibition, are the fundamental underlying executive processes, and are easier to operationalize than planning. Thus, executive function tasks were selected to measure the executive function constructs of planning, shifting, updating, and inhibition; the tasks used in this study were chosen after a thorough review of the executive function literature to identify which measures were considered both reliable and valid measures that could be used with children (from age 9) and adults.

Verbal Fluency (Shifting, Inhibition, Planning). Verbal fluency is measured in the current study with two versions of this task: Semantic Fluency and Letter-Number Switching (Appendix 3.4a and 3.4b). Verbal fluency tests have been found to be a valid measure of fluency and fluency-shifting and very quick to administer (see Henry & Crawford, 2004a; Henry & Crawford, 2004b). Although the Wisconsin Card Sorting Task is the most commonly used measure of shifting, it is very time consuming, and has proven less sensitive to frontal dysfunction (see Mountain & Snow, 1993) than standard tests of extra-alternating fluency (see Henry & Crawford, 2004a). For both fluency tasks, participants were required to generate as many words as possible within a time limit of 60 seconds, while inhibiting certain responses. For example, participants were instructed to not repeat any words, (including a variation of the same word), and to not include any words that were a proper noun (e.g. name of people, place or thing) or words of profanity.

The *Semantic Fluency* task required participants to generate as many words as possible from the category 'fruits and vegetables'. An example was provided to participants first using the category 'animals' (e.g. "bear, dog, cat, tiger", but not "Tigger"). The *Letter-Number Switching* task required participants to switch between counting from the number '1', and reciting the alphabet starting with the letter 'A' (e.g. 1 – A – 2 – B - 3 – C). Participants were instructed that if they reached the end of the alphabet before the expiration of the 60-second time limit, they were to continue counting from the number they had reached, and to start at the beginning of the alphabet again (e.g. Z-26-A-27-B-28). Participants were also instructed to continue as best they could if they realized they had made an error (e.g. 1-A-2-B-3-D). Both verbal fluency tasks were each scored by counting the correct number of responses made within the 60-second time limit (*Semantic Fluency and L-N Switch*).

The Stroop Test (Inihibition). The Stroop (1935) task is a widely used test of response inhibition (see MacLeod, 1991 for an inegrative review) as it requires participants to suppress an automatic response in order to perform a less automatic one. Two stimulus sheets were presented one at a time. The first task required participants to *read a list of colour-name words* that were printed in a colour of ink different to the colour name (*control task*). For example, for the word BLUE written in *red* ink, the participant was required to say "BLUE". The second task required participants to *name the colour of ink* that the word was printed in rather than read the printed word itself (*inhibition condition*). For example, for the word BLUE written in red ink, the participant was required to say "RED". Reading words is an automatic response, thus most individuals take significantly longer in the second task which requires them to inhibit the natural response to read the word and, instead, name the colour of contrasting ink in which it is printed. The Stroop test measures response inhibition by calculating the increase in time to compete and number of errors in the inhibition condition relative to the control condition (*Stroop*).

Letter-Number Sequencing (Updating). The Letter-Number Sequencing (LNS) WAIS-III subtest was included as a measure the "Updating" (i.e. working memory) facet of executive function as it requires the individual to hold and manipulate information in memory (Lehto et al., 2003). The LNS was administered according to the instructions provided in the WAIS-III(R) manual, which requires participants to hold and re-sequence information in working memory prior to repeating it back to the examiner. Prior to the administration of the test, an example is provided to examinees: *"I am going to say a group of numbers and letters. After I say them, you are to put them in number order first, and then alphabetical order and repeat them back to me. For example, if I say 9 - C – 3, then your answer should be 3 – 9 – C; the numbers in order first, then the letters in alphabetical order".* All participants begin at level 1, which contains a total of two characters (numbers and/or letters). Each item level contains three trials, and the examinee receives a score of zero to three based on the number of trials repeated correctly. Each examinee proceeds to the subsequent level of difficulty (an additional number of characters) if at least one of the three trials is repeated correctly. When all three trials are failed within a level, the test is discontinued. The range of possible raw scores on the LNS is zero to 30. Although, age-standardized scores can be obtained from the WAIS-III norm tables, raw scores were used as the measure for the current study.

Porteus Mazes (Planning). The Porteus Maze test (1959) was designed to measure planning behaviour. Previous studies have found this instrument to be quite sensitive to frontal lobe damage (Smith & Kinder, 1959; Levin, Song, Ewing-Cobbs, & Roberson, 2001). Two versions were used in the study, Adult I, and Adult – Extension. Consistent with instructions for administration of this test, participants were instructed to find their way through a printed maze from the START to the EXIT, working as quickly as they could, and avoiding errors whilst tracing the correct route using a pencil. Errors were defined as crossing walls, and entering blind alleys. Participants were instructed that if they entered a blind alley they must not lift the pencil, but trace their way back to where they made the error and continue from that point. Scores for the two versions of the Porteus Maze test were recorded as total time to complete the maze (Porteus Maze1 and Porteus Maze2).

Non-executive Function (Control) Measures

Peabody Picture Vocabulary Test. The Peabody Picture Vocabulary Test (PPVT) was included as a control measure (i.e. non-executive functioning) as previous research findings indicate that vocabulary is not a test of executive function (see for example, Weyandt & Willis, 1994), and does not involve activation of the frontal lobes (according to functional MRI analysis results, e.g. Rubia et al., 2000). The PPVT has been found by several studies to be strongly positively correlated with measures of full-scale IQ (e.g. WAIS-III and WISC-III) with adults (e.g. Bell, Lassiter, Matthews, & Hutchinson, 2001; Lassiter, Bell, Hutchinson, & Matthews, 2001), and children (e.g. Carvajal, Hayes, Miller, & Wiebe, 1993; Dunn & Dunn, 1997). Carvajal et al. found statistically significant correlation coefficients of .75, .76, and .60, respectively, between the PPVT standardized scores and the WASC-III Vocabulary subtest scaled scores, and the WISC-III Verbal and Full Scale IQs for a sample of 33 children enrolled in Grades 3, 4, and 5. More recently, Dunn and Dunn found correlations ranging from .82 to .92 with the Verbal, Performance, and Full scale IQ scales on the Wechsler Intelligence Scale for Children—Third Edition; .76 to .91 with crystallized, fluid, and composite IQ tests on the Kaufman Adolescent and Adult Intelligence Test; and .62 to .82 with the Kaufman Brief Intelligence Test vocabulary, matrices, and composite tests.

The PPVT is an un-timed, norm-referenced, wide-range test of vocabulary. The test is designed for persons aged 2 ½ through 90+ years, and is used primarily as a screening test of verbal ability. The PPVT was standardized in America on a stratified sample of 2,725 persons, (2,000 children and adolescents and 725 persons over age 19). There are 204 test items grouped into 17 sets of 12 items each. The item-sets are arranged in order of increasing difficulty. Each item consists of four black-and-white illustrations arranged on a page. The task is to select the picture that best represents the meaning of a stimulus word presented orally by the examiner. Examinees progress through each of the 17 sets of 12 items, and Testing is discontinued when the participant obtains 8 or more errors within a set of 12 items. The PPVT was administered and scored according to the instruction manual. A raw vocabulary score was calculated by subtracting the number of incorrect responses from the last item number in the set completed. Participant's raw score was then converted to an age-norm-referenced standard score (to represent general intellectual functioning).

Picture Arrangement. Picture Arrangement (WAIS-III; Wechsler, 1997) was included as a second control measure of general intellectual functioning as this test has been validated as a good measure of performance (i.e. non-verbal) intelligence. Previous research indicates that no performance differences exist on Picture Arrangement subtest scores of the between groups of individuals who have impaired executive functioning and those that do not (see for example Janowsky, Shimamura, Kritchevsky, & Squire, 1989). The Picture Arrangement subtest contains 15 sets of stimulus cards, and was administered and scored as specified in the instruction manual. Each item consists of a set of (3 to 5) picture cards that when arranged correctly depict a story in story-board format. The cards were presented to the participant in a specified mixed-up order, and the participant was instructed to rearrange the cards create the most logical story. Completion time was recorded, but participants were not explicitly told that they were being timed. Participants received a score of 0, 1, or 2 for each sequence, and age-standardized scores were obtained for total scores from the WAIS-III norm tables (PA).

Participants and Procedure

Participants

The materials described above were piloted on 192 first-year university students over the period of two university semesters. From a total pool of approximately 1500 first year psychology students, 77 males (ages 17 to 35, M = 20) and 115 females (ages 17 to 42, M = 20) volunteered to participate in exchange for course credit via an on-line advertisement for participation in the study, which was entitled "Does your behaviour as a teenager affect how you think today?". Interviews were conducted either by the experimenter or by one of four psychology undergraduate students under the supervision of the experimenter. To ensure inter-rater reliability, all interviewers received extensive training (approximately 5 hours) in the administration of self-report surveys and cognitive tests, and were provided a standardized protocol manual. Prior to conducting data analysis, the data was inspected for any rater-effects. There were no significant or important differences between interviewers on any data collected (in particular, scores on executive functioning measures).

Procedure

It was explained to participants that their participation was voluntary, and that they could withdraw from the study at any time. It was also explained that the validity of the experiment required them to be as honest as possible in their responses, and that it was better to omit answers rather than to provide false information. To encourage honest reporting, participants were shown that data collected contained no identifying information, and all completed materials were placed in a sealed envelope containing only their participant number.

At the start of the 60-minute interview, the procedure was explained to participants, and their consent was obtained (Appendix 3.5). They then completed three self-report questionnaires (~15 minutes), and then were administered six cognitive functioning tests (~35 minutes); they then received a detailed debriefing in which the aims and hypotheses were explained and how the measures they completed related to the design of the study. The self-report instruments and cognitive tests were always administered to participants in the same order to minimise any influencing effects between the measures. For example, the Antisocial Attitudes Scale (entitled 'Personality Inventory') was administered prior to the Antisocial Behaviour Scale to control for any possible effects of reflecting on one's antisocial behaviour participation prior to reporting one's attitudes (e.g. an individual may believe they are more antisocial after reporting on their own participation in a range of 35 antisocial acts). Participants then completed the Personality Inventory Sheet. All cognitive functioning tests were then administered in the same order to all participants. Participants were first administered the PPVT and Picture Arrangement subtest as these tests take relatively longer than the other tests to administer (approximately 5 to 10 minutes each). The LNS subtest was administered next, followed by the Stroop. The Porteus Mazes were administered next, and lastly the participants completed the tests of verbal fluency (Semantic Fluency and Letter-Number Switching).

Design and Analysis

The analyses reported here are limited only to the assessment of the appropriateness of the measures selected for use in the study. Both the Antisocial Behaviour Scale (ASBS) and the Antisocial Attitudes Scale (ASAS) were tested for internal reliability. For both the pubertal development, and the cognitive functioning measures, internal validity was assessed by examining the intercorrelation coefficients; it was hypothesized that significant positive correlations between different measures of the same construct would indicate valid measurement of these constructs.

Given that published studies have found support for the relationship between ASB participation and pubertal onset and timing (Caspi et al., 1993; Caspi & Moffitt, 1991; Felson & Haynie, 2002; Haynie, 2003; Williams & Dunlop, 1999), and executive function impairment and ASB (Barker et al., 2007; Bergeron & Valliant, 2001; Brower & Price, 2001; Leon-Carrion et al., 2003; Morgan & Lilienfeld, 2000; Raine et al., 1994, 1997; Raine et al., 2000; Raine et al., 2005; Seguin & Zelazo, 2005), it was hypothesized that evidence of these relationships would indicate support for construct validity of these measures. Given the established association between ASB and antisocial attitudes (see Mills & Kroner, 2006), it was hypothesized that valid measurement of antisocial attitudes by self report questionnaire would be evidenced by a significant positive correlation with ASB participation scores. Given that males typically participate in a higher level of ASB participation than females (Blumstein & Cohen, 1987; Blumstein et al., 1988; Blumstein et al., 1986; Blumstein et al., 1985; Hua et al., 2006; Hua & Fitzgerald, 2006; Moffitt & Caspi, 2001; Moffitt et al., 2002), and that females typically attain puberty at younger ages than males (DeRose & Brooks-Gunn, 2006), separate analyses were performed for males and females on these variables.

Demographic Variables

Sex Differences in Self-Report Measures

Females reported a significantly earlier pubertal onset age than males ($t_{169} = 3.148$, $p < .001$), and males reported significantly higher participation in antisocial behaviour ($Z_{190} = 5.834$, $p < .0005$)[2] and significantly higher antisocial attitudes ($t_{190} = 3.591$, $p < .0005$) than females. Refer to Table 3.1 for descriptive data on pubertal development and antisocial variables for males and females.

Table 3.1. Number of participants, means, and standard deviations for pubertal development and antisocial variables for males and females.

	Puberty Onset			Total ASB			Total ASA		
Sex	N	Mean	SD	N	Mean	SD	N	Mean	SD
Female	99	12.2	1.19	115	2.9	3.03	115	25.1	9.12
Male	72	12.8	1.08	77	6.3	4.74	77	30.1	9.89

[2] analyzed using Mann-Whitney U test for skewed distribution

Family Structure

As mentioned in the Materials & Measurement section earlier in this chapter, previous findings suggest that the absence of a biological father (Bogaert, 2005; Comings et al., 2002; Kanazawa, 2001; Romans et al., 2003), or presence of a non-related male (Ellis, 2002; Ellis & Garber, 2000; Ellis et al., 1999) in the household may be associated with earlier pubertal onset in girls. To test for a possible relationship between father absence and for non-related male-presence on girls' pubertal development, t-tests were performed on these variables for females only. Results revealed that there was no evidence to suggest that the absence of a biological father alone was related to girls' age of pubertal onset (t_{14} = .617, p =.27, one-tailed); however, among girls who reported an absent biological father, girls who reported the presence of a non-related male in the home reported an earlier age (M = 11.6; n = 10) of puberty onset (t_{17} =1 .827, p <.05, one-tailed; *Cohen's* δ = .41) than girls who reported no non-related male in the home (M = 12.3; n = 8). This finding extends previous research findings in this area, and contributes to measurement validity of retrospective self-report pubertal development in the current study.

Socio-Economic Status

There was no relationship between self-reported socio-economic status and pubertal onset age or socio-economic status and participation in ASB for males or females (see Table 3.2).

Table 3.2. Correlations for puberty onset age, total ASB, and first age of ASB participation with socio-economic status for males and females.

	Socio-economic Status					
	Males			Females		
	rho	*p*	*n*	*rho*	*p*	*n*
Puberty Onset	.143	.119	70	.061	.276	97
Total ASB	.177	.062	77	.041	.332	115
First Age ASB	.044	.353	75	-.044	.333	98

Internal Reliability and Validity

Antisocial Variables

Item analysis was performed to test the internal reliability of the ASBS and the ASAS. The assessment of scale reliability is based on the correlations between the individual items that make up the scale, relative to the variances of the items. The statistic, 'Cronbach's scale if item deleted', is a good indication of the 'fit' of individual items; if Cronbach's alpha coefficient (Cronbach, 1951) is raised by the deletion of a variable, the researcher should consider dropping it. The literature reviewing assessments of internal reliability generally consider a Cronbach's alpha coefficient above .70 to be an 'acceptable' value, and above .80 a 'good' value, for a research instrument (Cronbach, Gleser, Nanda, & Rajaratnam, 1972).

For both females and males, 'good' alpha coefficients were obtained for the both the ASBS (.81; .86), and the ASAS (.78; .82). Cronbach's alpha was not increased by deleting any of the items on either of the two scales for males or females. Thus, the scales were determined reliable measures for the pilot study and as appropriate for use in the study with children and adolescents.

Pubertal Development Variables

For the age of onset of puberty (Puberty Onset), the mean age reported by females was 12.2 and for boys slightly older at 12.8 years (Refer to Table 3.3). It is possible that females associate indications of breast growth as evidence of puberty onset, as the mean age reported for this event was also 12.2 years, but menarche was reported as occurring on average approximately 6 months following breast growth. (A full description of pubertal development norms and expected progression is provided in Chapter 5). For males, the mean age of spermarche reported was 13.5 years, and average age of voice change was 13.9 years (a full year later than the average age of puberty onset reported by females. The standard deviations for these measures were relatively small (approximately 1 to1.5 years) on all pubertal variables.

Table 3.3. Minimum, maximum, and mean age (including standard deviations) for self-reported onset of pubertal development markers for males and females.

Descriptive Statistic	Females			Males		
	Puberty Onset	Breast Growth	Menarche	Puberty Onset	Voice Change	Spermarche
Minimum	10.0	9.0	10.0	10.0	11.0	11.0
Maximum	16.0	17.0	19.0	15.0	18.0	18.0
Mean	12.2	12.2	12.9	12.8	13.9	13.5
Std. Deviation	1.19	1.56	1.43	1.08	1.48	1.27
N	99	98	97	72	69	70

As expected, the general puberty onset variable and the other two developmental markers (menarche and breast growth for females [n = 97]; spermarche and voice change for males [n = 70]) were positively and strongly correlated (all $p < .001$; see Table 3.4 for coefficients). Noteworthy, however, were the larger correlation coefficients found for females ($r = .67$ to $.77$) in comparison to males ($r = .52$ to $.57$).

Table 3.4. Correlations between self-reported pubertal development markers for males and females.

	Males		Females	
	Spermarche	Voice Change	Menarche	Breast Growth
Puberty Onset	.566	.515	.771	.678
Spermarche		.525		
Menarche				.672

Examining the frequency data for self-classification[3] by participants into early, on-time, or late, pubertal timing groups, a fairly normal distribution was found for both males and females (see Self-Reported Timing with Peers column in Table 3.5). Approximately 20 – 25% of participants classified themselves as either early or late-timers, respectively; whereas approximately 50% of participants perceived themselves as having matured on-time relative to their peers.

[3] Note that it is possible that a small minority of participants may be making comparisons within a dissimilar-aged peer group (e.g. were advanced or held back a grade in school).

Table 3.5. Frequency data for self-classification, and for computed classification, into early, on-time, and late pubertal timing groups for males and females.

Pubertal Timing Group	Self-Report Timing with Peers			Pubertal Timing Relative to Sample		
	Frequency	Percent	Valid Percent	Frequency	Percent	Valid Percent
		Males			*Females*	
Earlier than peers	16	20.5	21.6	31	27.0	27.7
With peers	40	51.3	54.1	52	45.2	46.4
Later than peers	18	23.1	24.3	29	25.2	25.9
Total	74	94.9	100.0	112	97.4	100.0
Missing	4	5.1		3	2.6	
Total	78	100.0		115	100.0	

Using this frequency classification of approximately 25% in early and late, and 50% in the on-time group, and participants' self-report puberty onset age, frequency analysis cut-off scores of approximately 25%, 50%, and 25% resulted in the classification criteria as shown in Table 3.6. Interestingly, a large number of participants were reclassified when determining pubertal timing based on this classification method in comparison to participants' self-perception (see Table 3.7). Males were more likely than females (47.3% versus 37.5%) to have placed themselves in a category other than the one calculated based on their self-reported onset age relative to same-sex peers in the current sample. The majority of these reclassifications (38%) were identified as participants having perceived themselves as maturing later than their peers, when the comparison to same-sex peers in the sample classified them as having matured on-time (males, 35.3% of reclassifications; females, 40.5% of reclassifications). However, the overall percentage in pubertal timing groups remained approximately the same (see Pubertal Timing Relative to Sample column in Table 3.5).

Table 3.6. Classification criteria for pubertal timing groups based on 25%, 50%, and 25% cut-off frequency analysis of self-reported puberty onset age for males and females.

Pubertal Timing Group	Pubertal Timing Relative to Sample	
	Puberty Onset Age	
	Males	*Females*
Earlier than peers	Age 11 years and younger	Age 11 years and younger
With peers	Between 11 and 14 years	Between 11 and 13.5 years
Later than peers	Age 14 years and older	Age 13.5 years and older

Table 3.7. Percentage of participants reclassified from self-perceived pubertal timing groups into pubertal timing groups computed from sample-referenced reports of puberty onset age (for males and females).

Self-Report Timing with Peers	Pubertal Timing Relative to Sample	Males		Females		Total	
Earlier than peers	With peers	8	23.5%	9	24.3%	17	23.9%
With peers	Earlier than peers	2	5.9%	10	27.0%	12	16.9%
Later than peers	With peers	12	35.3%	15	40.5%	27	38.0%
With peers	Later than peers	12	35.3%	2	5.4%	14	19.7%
Later than peers	Earlier than peers			1	2.7%	1	1.4%
Total Reclassifications		34	47.3%	37	37.5%	71	41.8%
Total Responses		74	100.0%	96	100.0%	170	100.0%

Based on this analysis, it was determined that the retrospective self-reports of participants' own perceptions of pubertal timing in relation to their peers was an unreliable measure. Thus, for the purpose of this pilot study, pubertal timing was operationalized by categorizing participants into pubertal timing groups based on their self-reported age of puberty onset (i.e. computed pubertal timing relative to sample). A more thorough analysis of pubertal timing classification for the study with children and adolescents will be examined in the chapter describing data treatment of pubertal development variables (Chapter 5).

Cognitive Functioning Variables

No differences were expected between males and females on cognitive tasks, thus all analyses involving cognitive functioning variables included both males and females.

Executive Function. The scores on the Stroop and Porteus Maze tests were computed as the time to complete the test, which means that poorer performance was represented by higher scores. For the sake of measurement consistency (with the other cognitive functioning variables) these scores were reversed so that a higher score represents better performance. As listed in Table 3.8, the two fluency tasks (Semantic Fluency and Letter-Number Switching), the Stroop, and the Letter-Number Sequencing task were significantly positively correlated with each other at $p < .05$ to $p < .001$ ($r = .16$ to $.32$). However, the Porteus Maze tests did not significantly correlate with any of the other executive function tasks ($p = .11$ to $.32$). This suggests that the Porteus Maze tasks may not be a reliable measure of executive function, or simply are not measuring a construct similar to that of the other executive function variables.

Table 3.8. Correlations between executive function variables for males and females combined.

	L-N Switch	Stroop	LNS	Porteus Maze1	Porteus Maze2
Semantic Fluency	.200*(n = 100)	.207* (n = 98)	.211* (n = 100)	.(a)	.(a)
L-N Switch		.163 (n = 100)	.321***(n = 102)	.(a)	.(a)
Stroop			.215** (n = 186)	.050 (n = 87)	.073 (n = 88)
LNS				.134 (n = 86)	.123 (n = 87)
Porteus Maze1					.095 (n = 88)

* Correlation is significant at the 0.05 level (1-tailed).
** Correlation is significant at the 0.01 level (1-tailed).
*** Correlation is significant at the 0.001 level (1-tailed).
a Cannot be computed because at least one of the variables is constant.
^Although the correlations between executive function measures are low (e.g. ~.2), the fact that several correlations reached statistical significance was encouraging given that previous research has consistently found weak associations among the different types of executive functioning tasks (Miyake et al, 2000; this is discussed in detail in Chapter 7).

Non-Executive Function. The Peabody Picture Vocabulary Test (PPVT) and the Picture Arrangement subtest (PA) were designed to measure general intellectual functioning, distinct from executive functioning, and as such these measures should be positively correlated with the standardized scores for Letter-Number Sequencing, but uncorrelated with the executive function measures. Table 3.9 displays the correlations between these variables, which reveal that, as expected, PPVT scores were significantly positively correlated with the standardized scores for the Letter-Number Sequencing tasks, and uncorrelated with scores on the executive function variables retained for analysis (i.e. excluding Porteus Mazes task). However, PA scores were not correlated with PPVT scores or with standardized Letter-Number Sequencing scores, suggesting that PA is not measuring a related construct, and thus PPVT may be the better measure of general intellectual functioning for the purposes of this research.

Table 3.9. Correlations between non-executive function measures and executive function measures for all participants.

		PA	Letter-Number Sequencing (stdzd)	Semantic Fluency	L-N Switch	Stroop
PPVT	Pearson's r	.146	.235**	.019	.164	.078
	Significance (*p*)	.086	.001	.427	.050	.142
	Participants (N)	90	190	100	102	188
PA	Pearson's r		.091	.(a)	.(a)	.122
	Significance (*p*)		.198			.130
	Participants (N)		88			88

** Correlation is significant at the 0.01 level (1-tailed).

a Cannot be computed because at least one of the variables is constant.

Construct Validity

Antisocial Variables

Antisocial Behaviour. It was expected that participants who reported an earlier age of first participation in ASB would also report significantly higher total ASB participation. Because older participants would have a greater number of years to participate in ASB (thereby reporting higher ASB participation as a function of their current age), the current age of the participant was partialled out when performing correlation analysis.

As predicted, a significant relationship between age of first participation and total ASB score was found for males (r = -.196, p < .05), but this relationship did not hold for females (r = - .038, p = .38).

Antisocial Attitudes. Mean scores on all ASA Factors and Total ASA were significantly positively correlated with each other for both males and females at p <.001 (r value in range of .45 to .96; Refer to Table 3.10). Mean scores on all ASA Factors and Total ASA were also significantly positively correlated with mean scores for total ASB participation for both males and females at p <.05 to p <.001 (r = .27 to .60). Thus, it was concluded that the ASAS was a valid measure of antisocial attitudes.

Table 3.10. Correlations between ASA total and factor-total scores and total ASB for males and females.

	Factor 1: Interpersonal	Factor 2: Behavioural	Total Factor 1 & 2	Factor 3: Relationship Behaviour	ASA Total
		Females (n = 106)			
Total ASB	.191*	.427***	.363***	.273**	.341***
ASA Factor 1: Interpersonal		.556***	.856***	.462***	.788***
ASA Factor 2: Behavioural			.905***	.497***	.842***
ASA Factor 3: Relationship				.545***	.926***
ASA Total Factor 1 & 2					.685***
		Males (n = 73)			
Total ASB	.461***	.553***	.598***	.292***	.581***
ASA Factor 1: Interpersonal		.451***	.836***	.523***	.845***
ASA Factor 2: Behavioural			.867***	.369***	.787***
ASA Factor 3: Relationship				.519***	.618***
ASA Total Factor 1 & 2					.956***

* Correlation is significant at the 0.05 level (1-tailed).

** Correlation is significant at the 0.01 level (1-tailed).

*** Correlation is significant at the 0.001 level (1-tailed).

Executive Function Variables

Antisocial Behaviour & Executive Function. As a test of external construct validity, total ASB scores were correlated with executive function scores while accounting for the shared variance in individual differences in general intellectual functioning by partialling out PPVT scores. It was expected that participants who obtained lower scores on executive function tasks would report higher participation in ASB. Referring to Table 3.11, the results indicate no significant association between executive function scores and Total ASB scores for females. However, males with high ASB participation obtained significantly lower scores on the Letter-Number Sequencing task ($r = -.281$, $p < .05$) and the Semantic Fluency task ($r = -.326$, $p < .05$), and correlations with the Letter-Number Switching approached significance ($r = -.256$, $p = .055$). As a further test of the validity of PPVT as a valid control measure (as opposed to PA), the set of analyses was repeated partialling out PA rather than PPVT. The results revealed no significant associations between ASB participation and executive function variables when PA was partialled out. Thus, although not conclusive, these findings provide support for the construct validity of executive function measurement, and the retention of PPVT, but not PA, as a control for general intellectual functioning.

Table 3.11. Correlations between Total ASB and executive function variables controlling for general intellectual functioning (PPVT vs PA) for males and females.

		Males							
		PPVT partialled out ($df = 38$)				PA partialled out ($df = 28$)			
		Executive Function Task							
		LNS	Stroop	Semantic Fluency	L-N Switch	LNS	Stroop	Semantic Fluency	L-N Switch
Total ASB	Pearson's r	-.281*	.020	-.326*	-.256	.214	-.015	.147	.010
	Significance *(p)*	.040	.452	.020	.055	.128	.470	.219	.479

		Females							
		PPVT partialled out ($df = 54$)				PA partialled out ($df = 51$)			
		Executive Function Task							
		LNS	Stroop	Semantic Fluency	L-N Switch	LNS	Stroop	Semantic Fluency	L-N Switch
Total ASB	Pearson's r	-.129	-.025	.142	.102	-.031	-.032	.052	-.013
	Significance *(p)*	.172	.427	.149	.228	.412	.411	.355	.464

* Correlation is significant at the 0.05 level (1-tailed).

Typically, the association between executive function impairments and ASB participation is found in populations with either significant impairments to executive function (Pantelis et al., 2004), or in populations with high levels of participation in ASB such as groups of violent offenders, (e.g. Broomhall, 2005), or delinquent youth, (e.g. Moffitt & Henry, 1989). Prior to the data reported here, the only evidence that this relationship also occurs in a normal population is a recent publication by Barker et al. (2007) who followed 698 men from ages 12 to 24 and found that a small proportion (13%) of the total sample reported high frequency of physical violence that was also significantly negatively related to executive function performance. The evidence of a correlation between executive function and ASB reported here provide the first known indication of a relationship between executive functioning and ASB for a normal population of young adult males.

Pubertal Development Variables

Puberty Onset & First ASB Participation. It was expected that participants who reported an earlier age of puberty onset would also report a significantly younger age of first participation in ASB. Because participants reported a range of first participation age across the ASB items, an average first age of participation was computed (Average First Age ASB). A significant positive correlation was found between the age of puberty onset and the average First Age ASB participation for males ($r = .271$, $p < .05$), and for females ($r = .202$, $p < .05$).

Pubertal Timing & Total ASB Participation. It was expected that in comparison to those who matured on-time, or later than their peers, early-maturing participants would report significantly higher ASB participation. This prediction was tested using analysis of covariance to account for the shared variance with current age and socio-economic status. The first set of analyses was conducted using participants' self-reported Perceived Pubertal Timing relative to their peers. Table 3.12 displays the non-significant F-test and planned comparison results for males and females. The analyses were then repeated using pubertal timing groups computed from participants' self-reported age of puberty onset (participants were categorized as early, on-time, or late relative to their same-sex peers in the current sample; Pubertal Timing, see Figure 3.1). Pubertal timing was not significantly associated with self-reported ASB participation for males ($F_{(7,62)} = 2.106$, $p = .16$). Although the overall effect of pubertal timing on ASB participation was not significant for females ($F_{(5,84)} = 1.055$, $p = .40$), planned contrasts revealed that early-maturing females reported significantly greater ASB participation than females who matured on time ($t = -1.863$, $p < .05$) or late ($t = -2.571$, $p < .05$).

Table 3.12. Pubertal timing group differences on total ASB participation, overall analysis of covariance including planned contrasts for self-reported timing groups vs pubertal timing groups computed as relative to sample for males and females.

	Self-Report Timing with Peers						Pubertal Timing Relative to Sample					
	Males			Females			Males			Females		
Contrast	*(F) (t)*	*df*	*p*	*(F) (t)*	*df*	*p*	*(F) (t)*	*df*	*p*	*(F) (t)*	*df*	*p*
All timing groups	.586	2,69	.559	1.332	2,106	.668	2.106	7,62	.159	1.055	5,84	.399
Early vs On-time	1.352		.339	-0.772		.255	2.238		.295	-1.863		.036
Early vs Late	.343		.835	-1.207		.113	-.646		.771	-2.571		.030

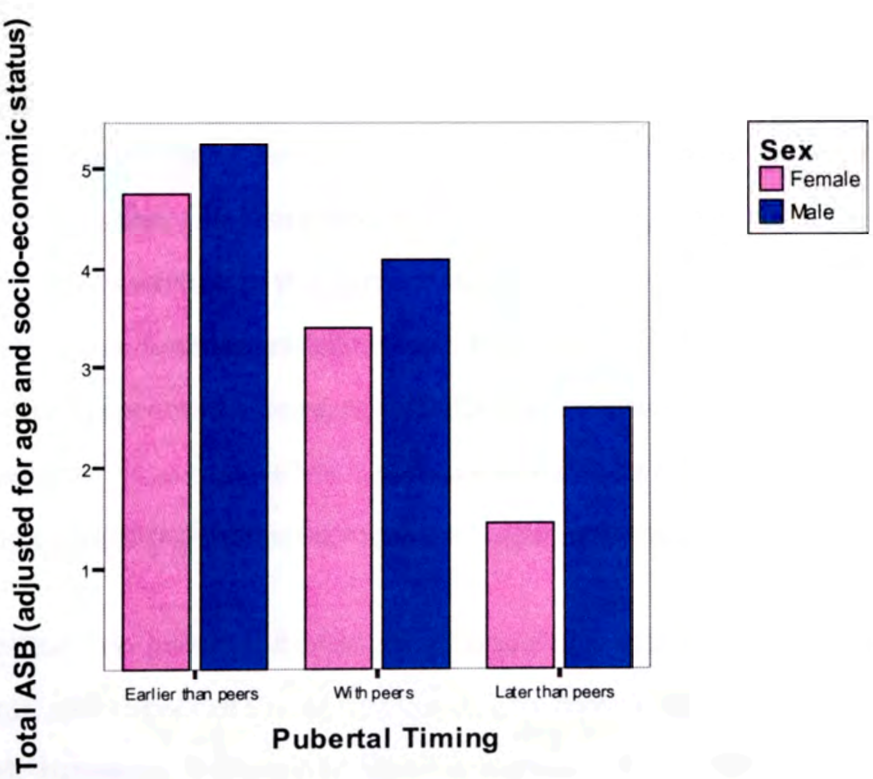


Figure 3.1. Total ASB (adjusted for age and socio-economic status) by (relative to sample) pubertal timing group for males and females.

Discussion

The results from the pilot study conducted with young adults enrolled in first year university studies indicate that effective measurement of the four constructs involved in the current study (pubertal development, executive function, and antisocial behaviour and attitudes) was obtained. Tests of internal reliability of the ASBS and the ASAS revealed that these measures had good internal consistency; and correlation analyses conducted with total ASB scores and first age of ASB participation, and with ASA subtest and total scores revealed good construct validity. It is important to note that an obvious limitation of this study is that participants volunteered for the study, thus, the results may be affected by this self-selection bias. Furthermore, the pubertal development data is limited by participants' ability to accurately recall the age they were at which particular events occurred. These limitations are discussed in detail in the General Discussion (Chapter 12).

The executive function variables revealed adequate measurement of this construct, and the strength of the correlations between executive function variables was good given the low correlations obtained in previous studies (see Miyake et al., 2000). As discussed previously (see Chapter 2), it is very difficult to attain precise measurement of executive function; this issue would seem particularly salient in a non-clinical sample such as is being examined in the current study. Therefore, the results obtained for the retained executive function variables (and the general intellectual function control, PPVT), were interpreted as being satisfactory for inclusion in the study with children and adolescents. However, it was concluded that additional measures should be included to replace the non-valid measures used in the pilot study.

Self-report data on pubertal development onset *age* appeared to be reliable and valid. Participants' self-report of the age of the pubertal development events were highly correlated. However, it is unclear whether participant-reported self-perceptions of pubertal *timing* represented a reliable measure of this construct. When participants were classified into pubertal timing groups based on their self-reported pubertal onset age, the results were inconsistent with their own perceptions of timing. Although participants were making comparisons to a different reference group (i.e. peers whilst growing up, versus the current sample of university-student peers), the absence of a relationship between participants' pubertal timing reports and ASB participation provides further evidence to suggest that self reports of pubertal timing may be unreliable. The evidence supporting relationships between computed categories of pubertal timing and ASB participation (i.e. early-maturing girls participated in greater ASB than both on-time and late-maturing girls), suggests that the computed pubertal timing variable is a more reliable measure than participants' perceptions. This is consistent with previous research which has found that although retrospective reports of pubertal events are typically fairly reliable (Gilger, Geary, & Eisele, 1991), perceptions of one's own pubertal timing is not as reliable, regardless of whether these perceptions are conducted retrospectively or at the time these events are occurring (Coleman & Coleman, 2002).

In addition to providing supporting data for the measurement of the constructs themselves, the analyses reported in the current chapter provides evidence in support of the associations between executive function and ASB, and between pubertal development and ASB. Thus, it was concluded that the measures were suitable for inclusion in the study with children and adolescents (school study). However, it was determined that additional tests of executive function were required and that the constructs of pubertal development and ASB required further investigation. Specifically, a replacement measure for the measurement of the planning construct was needed, and it was decided that measurement of switching and inhibition could be enhanced by expanding the verbal fluency and the Stroop measures to include additional conditions. These changes are explained in further detail in the next chapter (Chapter 4) which describes the method for conducting the study with children and adolescents in community public schools.

Chapter 4: The 'School Study'

The previous chapter (Chapter 3) introduced the constructs being measured (pubertal development, executive function, and antisocial behaviour and attitudes), in the study with children and adolescents (school study) and the method of measurement including study design and materials. The preliminary analyses conducted in Chapter 3 confirmed that the measures were valid for measurement of the four constructs, but also found that some measures should be replaced or expanded upon. In particular, it was determined that Porteus Mazes was not a valid measure of executive function in the pilot study, and it was concluded that in addition to replacing this measure with an alternative measure for the shifting construct (i.e. Trail Making Test), existing measures of inhibition and shifting should be expanded (i.e. additions to verbal fluency tasks and to the Stroop task). The school study was designed to measure current relationships between pubertal development, executive function, and antisocial behaviour and attitudes in addition to the effects of historical events such as relative timing of pubertal development on current executive function and ASB participation. Therefore, the pubertal development and ASB measures were modified to include items to measure these variables. The aim of this chapter is to explain the additional and modified measures used in the school study and the design and procedure for conducting the study. The next section of this thesis, Section 3: Data Treatment, outlines in detail how and why each measure was chosen for inclusion in the study and explains the method of transforming the data collected into meaningful measurement of the relevant constructs.

Materials and Measurement

Similar to the pilot study, the materials used in the study consist of three self-report surveys measuring the constructs of pubertal development, antisocial attitudes, and antisocial behaviour. The school study implemented four types of executive function measurement (described below), and one control measure for general intellectual functioning (the Peabody Picture Vocabulary Test). Similar to the pilot study, the executive function measures in the school study include the Stroop (1935), Letter-

Number Sequencing subtest of the Weschler Intelligence Scale for Children (WISC-IV; Wechsler, 2003), and tests of Verbal Fluency. The Porteus Mazes (1950) executive function test was replaced with a measure of shifting behaviour, (Trail Making Test; Reitan, 1971). As in the pilot study, the Peabody Picture Vocabulary Test (PPVT; Dunn & Dunn, 1997) was included as a control measure of general intellectual function. However, the Picture Arrangement subtest (Wechsler, 1997) used in the pilot study was not included in the school study. This section of the chapter describes the additional executive function measures (i.e. the Trail Making Test and additions to Stroop and Verbal Fluency), and the modifications to the self-report measures included in the school study.

Cognitive Functioning Measures

Non-Executive Functioning Measures

PPVT. The administration of the PPVT remained unchanged from the description provided in Chapter 3. Of all the tests administered, the PPVT took the longest time to administer at approximately 10 minutes in duration.

Executive Functioning Measures

Letter-Number Sequencing. The LNS subtest used in the school study was from the Weschler Intelligence Test for Children (WISC-IV), rather than the Weschler Intelligence Test for Adults (as in the pilot study); however the administration and scoring procedures are virtually the same for both tests. The administration time was approximately three to five minutes.

Stroop. The interference condition of the Stroop remained unchanged; participants were required to name out loud the colour of the ink in which each of a list of colour-names was printed, whilst inhibiting the automatic response of reading the name of the colour-name (e.g. the correct response for the word RED written in blue ink is 'Blue'). However, the control condition used in the pilot study was modified for use in the school study. As in the pilot study, the first control condition required participants to read a list of colour names which were printed in the *same* colour (e.g. BLUE written in blue ink and RED printed in red ink), rather than a contrasting colour of ink (e.g. BLUE written in red ink). For the purposes of the school study, an additional control condition was included in which participants were required to *name the colour of the ink* in which a short *row of X's* were printed. This change was incorporated into the school study to account for possible developmental effects on reading ability in the first control condition (see Leon-Carrion et al., 2004). Scoring details are described in Section 3: Data Treatment (Chapter 7). The total time for provision of instructions and the administration of two control conditions and the interference condition was approximately four to six minutes.

Trail Making Test. The Trail Making Test is comprised of two parts: Part A and Part B (Appendix 4.1). Trail Making Test – Part A (TMT-A) simply requires the participant to connect numbered circles in sequential order from 1 to 15 in as little time as possible (control condition). The task in Trail Making Test – Part B (TMT-B) is to connect a series of circles containing numbers and letters in a specified order (i.e. 1-A-2-B-3-C...) as quickly as possible. This experimental version of the TMT is expected to measure inhibition and set-shifting. The score derived for each trail is the number of seconds required to complete the task. Total time to administer, including instructions, is approximately one minute.

Fluency Tasks. Three types of verbal fluency tasks (four measures in total) were included in the administration of executive function tasks. Similar to the pilot study, participants were administered the *semantic fluency* task, which required participants to generate words belonging to the category of 'fruits and vegetables' (e.g. apple, banana, carrot, pear), and the *alpha-number alternating* task which required participants to shift between reciting the alphabet and counting from the number one (i.e. 1-A-2-B-3-C...). An additional *alternating* task, the *semantic-phonemic alternating* task, was also included, which required participants to generate responses whilst switching between reciting words from the category 'animals' and words beginning with the letter 's' (e.g. bear, sun, dog, sing, cat, song), and a *phonemic fluency* task which required participants to generate words beginning with the letter 't' (Appendix 4.2). Similar to the pilot study, participants were given a 60-second time limit and were instructed to avoid errors (i.e. 'rude' words, proper nouns, and repetitions). Scoring details are provided in Chapter 7. The administration of four fluency tasks (1-minute each) and related instructions took approximately five minutes in duration.

Self-Report Measures

Pubertal Development Questionnaire

Separate pubertal development questionnaires were designed for administration to boys (Appendix 4.3a) and girls (Appendix 4.3b). The first page of the two questionnaires were similar, and asked for information on 'growth spurt' and skin changes. Boys and girls in Grade 4 were only administered this first page of the questionnaire. For older boys, the second page contained items referring to voice change and spermarche, and for girls, items referred to breast growth and menarche. For both boys and girls, the third page contained line drawings related to two pubertal events: genital growth for boys, and breast growth for girls, and pubic hair growth for both boys and girls. The items measured are explained in detail in Chapter 5 with reference to developmental norms in the published literature. A brief explanation is provided here to familiarize the reader with the types of items that participants were required to report on. To ease any potential embarrassment, the questionnaire contained the following statement that was also read aloud prior to administering the questionnaire: "There is no exact age when everyone experiences puberty. This differs from person to person. Girls can expect puberty between the ages of 8 and 17. Boys can expect puberty between the ages of 10 and 18." On the majority of items, participants provided responses that indicated the specific pubertal stage they were currently in, and the age at which specific events occurred. For items requiring retrospective recall (i.e. "How old were you when this occurred?"), participants provided an age in years and months, and were asked to indicate how confident they were that they had remembered correctly, ranging from 0%-Not all confident to 100%-Very confident. This data allowed the calculation of several variables including pubertal onset age (the age at which puberty began), current pubertal stage, and pubertal timing (early, on-time, or late). The operationalization of these pubertal development variables is explained in detail in Chapter 5.

Pubertal Stage Variables.

Peak Height Velocity, Skin Changes and Acne. All participants were asked to provide the age at which they recalled the first incidence of a sudden increase in height ('growth spurt'), the age at which they first noticed skin changes ('skin changes'), and to select one of five stages of skin changes, ranging from 1) No Changes Yet, to 5) Yes, but Clearing ('acne').

Menarche and Hair Growth (Girls). Girls in Grade 5 and above were asked whether menarche had occurred, and to provide the age at which this occurred. Girls in Grade 5 and above were also asked to select one of five stages of secondary hair growth, ranging from 1) No, has not started, to 5) Yes, started more than one year ago.

Spermarche and Voice Change (Boys). Boys in Grade 5 and above were asked whether they had ever experienced an ejaculation (including nocturnal emission), and to provide the age at which this occurred. Boys in Grade 5 and above were asked to select one of five stages of voice change, ranging from 1) No change has occurred/sounds the same, to 5) My voice is as low as an adult man's voice.

Line-Drawings (Girls and Boys). Girls indicated current stage of breast development by selecting one of five line-drawn pictures ranging from 1) The breasts are flat, to 5) Fully developed. Boys indicated current stage of genital growth by selecting one of five line-drawings ranging from 1) No change to 5) As large as a full-grown man. Both girls and boys indicated current stage of secondary hair growth by selecting one of five line-drawings ranging from 1) No hairs, to 5) The hair has spread over the thighs (Line drawings adopted from Taylor et al., 2001).

Antisocial Attitudes Scale

The 32-item Antisocial Attitudes Scale (ASAS; Appendix 3.2) designed by the experimenter was unchanged from that used in the pilot study. However a small change was made to administration so that children in primary school (grades 4, 5, and 6) were administered a shorter version (28 items), compared to the full version (32 items) given to older children. Items relating to Factor 3: Relationship Behaviour were excluded in the version for younger children as it was considered unlikely (and inappropriate) for children aged 12 and under have experience with items related to promiscuity and relationship instability.

Antisocial Behaviour Scale

Two modified versions of the ASBS used in the pilot study are included in the Appendices: the Adolescent Antisocial Behaviour Scale (AASBS; Appendix 4.4a) for use with high-school students, and the Child Antisocial Behaviour Scale (CASBS; Appendix 4.4b) for use with primary-school students. The AASBS contains all 40-items from the Self-Reported Behaviour Scale (SRBS, Mak, 1993), plus the 14 additional items included on the ASBS (another 6 items were included on the scale used with high-school girls, but two were later dropped, see Chapter 6 for details). Thus, the AASBS for use with high-school boys contained 54 items, and the AASBS for use with high-school girls contained 60 items. The CASBS contained a total of 40 items; however, 11 of the items included in Mak's original scale were deemed inappropriate for the younger age group of primary-school children (ages 9 to 12) and were replaced with items from the AASBS. Examples of items dropped were "Driven an unregistered car?", "Bought beer, wine, spirits or other kinds of liquor?", "Used LSD?", and "Forced someone to do sexual things with you when that person did not want to?". Examples of items substituted include "Drank alcohol without parent's permission?", Smoked cigarettes?", and "Asked people on the street, mall, etc. for money, food etc?".

The ASB scales were also modified from the original ASBS in the types of responses provided for each item. On the child version, primary-school children only responded

Yes or No to the question "Have you ever....". High-school boys and girls however, completed a questionnaire very similar to the one used in the pilot study with young adults. Two modifications were made to the ASBS for use with adolescents: unlike the young adults, adolescent respondents were not asked to provide the 'last age' they participated in the behaviour, but instead were asked to indicate whether they had participated in the behaviour in the past 12 months. Thus, the AASBS required respondents to answer 1) Yes or No to each item, 2) whether they had participated in the past 12 months, and 3) what age they were the first time they participated in the behaviour. The inclusion of 'past 12 month participation' provided a measure of current ASB for high-school participants. Although originally this information was also included on the measure for primary-school respondents, it was necessary to eliminate this option from the CASBS to obtain approval from ethics committees who were concerned about the duration of the interview for younger children.

Consent and Controls

Ethics & Ethical Approval

Prior to contacting participants and their parents, ethics committee approval to conduct the study in NSW public schools and permission to contact school principals was sought from the NSW Department of Education & Training (DET). The DET ethics committee expressed concerns about the sensitive nature of the research, and that the duration of the interview was kept to an appropriate length of time for the age of participants (for example the shorter version of the ASB measure as described above). In response to the ethics committee's concerns, the experimenter prepared a reply addressing in detail each of the concerns as encompassing four broad categories:

1) the overall design and intention of the proposed research.
2) the suitability of some of the measurement instruments associated with this study.
3) the wording of some of the documents is either inappropriate or unacceptable.
4) the number of participants required and the time required of the participants.

For example, DET ethics committee was reassured that measures included in the study would not be used to predict adolescent criminal behaviour, and were provided with documentation supporting the validity of the proposed relationships under investigation, including the initial results from the pilot study. Concerns regarding the suitability of ASB and pubertal development measures for use with younger pupils were addressed by removing some ASB items from the questionnaire used with primary school students. Additionally, separate protocol measures for this younger age-group were suggested, and research evidence was presented regarding the value of generating discussion between parents and children on the topic of pubertal development. It was explained that the best method of measuring pubertal development (e.g. line drawings) were derived from a standardized test (Taylor et al., 2001) used extensively in similar research studies in schools. Finally, it was proposed that as in similar studies (Dorn, Susman, Nottelmann, Inoff-Germain, & Chrousos, 1990), parents might find that "discussion of the normative features of pubertal development gave adolescents and their parents an opportunity to ask questions, and perhaps reduce anxiety, about many aspects of pubertal development". As access to schools was critical for the success of the school study, wherever possible, problematic wording was either eliminated or re-worded. In all other instances, the experimenter expressed willingness to consider suggestions offered by DET to tailor the research proposal to represent a study that they could agree to.

With this approach, and some modifications to the interview instruments to ensure interview sessions were not too lengthy, approval was granted to seek permission from school principals in Sydney (metropolitan) public schools to conduct the study during school hours. Approval was granted to include an offer of a small incentive to participants - a voucher for free soft drink or cookie at the local Subway restaurant and a voucher for a free 'New Release' DVD rental from the local Block Buster video rental store. Several schools were canvassed by the researcher (Appendix 4.5). Some school principals were reluctant due to time pressures or other concerns, but a total of five school principals (three high-school and two primary-school) agreed to assist the study by providing interview rooms and allowing consent form packages to be sent home with students.

Recruitment of Participants

At the time of the study, there were approximately 1,100 students enrolled at the boys' high school, 1,000 students at each of the two girls' high schools, and 500 at each of the two primary schools, that participated in the study. A total of 326 girls (9 to 16.7 years, mean age = 13.2, SD = 2.02) and boys (9.2 to 17.6 years, mean age = 13.9, SD = 2.34) were recruited from these five schools. A total of 85 girls were recruited from the two girls' high schools (average response rate = 4.25% and comprises 26% of total sample), and 92 students were recruited from the two primary schools (average response rate = 9.2% and comprises 28.3% of total sample). The largest single group was recruited from the boys high school (n = 149 comprises 45.7% of sample), providing a 13.5% response rate by this secondary school. One possible reason for the higher response rate in this school is that this particular high school is what is known in the state of New South Wales as a 'selective' high school. Selective high schools provide an educationally enriched environment for highly achieving, academically gifted students, and entry into these schools is determined by the student's results on a Selective High Schools Test. Selective high schools are thought to attract children from families who have a higher than average interest in their children's progress at school, and it may be that these parents place a relatively higher value on activities which are seen to support educational research, such as the current study.

Support from School Principals

The principle researchers met with school principals and school counselors at each of the participating schools to review the materials and the school-specific protocols to be used. The proposed protocol of administration of the self-report questionnaires and the cognitive functioning tasks in two separate interview sessions was accepted by all schools. Discussed in detail below (see Procedure), conducting the two-part interviews for 326 students involved approximately 300 hours of testing in total. The principle researcher was responsible for coordinating and conducting all interviews, with the exception of approximately 30 individual interviews conducted by a research assistant who had been trained for that purpose in the pilot study.

School principals offered assistance by arranging interview rooms and coordinating with school office staff. In addition to the hours of testing, many additional hours were involved in coordinating with school office staff to arrange notification of the study to parents, distribution and collection of materials to parents directly or via students, arranging interview schedules, and locating students in the school at separate times for group interviews and individual interviews. School principals (or deputy vice principles) were instrumental in the success of recruiting the large number of children and adolescents who volunteered their time to participate in this study.

Information Night for Parents. The two participating primary schools provided further support for the study by posting announcements in school newsletters or sending home letters to parents informing them of the study and inviting them to an 'Information Night' where they could learn more about the study and ask questions of the principle researchers. The two principle researchers hosted the information nights, and the experimenter provided a 30-minute presentation and distributed examples of the tests and questionnaires used in the study. Parents were told about the aims of the study and the pilot data were discussed. In high-schools, rather than hosting an 'information night', a procedure was arranged in which parents could request a copy of the self-report measures be sent home for their preview.

Consent Form Packages

Consent form packages included a small (A4 size) poster describing the study (Appendix 4.6), an information sheet and consent form (including withdrawal form; Appendix 4.7), and a parent demographic sheet (Appendix 4.8). It was explained in the information letter that parents were not required to complete the demographic sheet for their child to participate in the study (i.e. it was supplementary), but that the information was useful. The DET ethics committee recommended against collecting data on parents' earnings or education level. Therefore, data was collected regarding the occupation of each of two parents/caregivers. Parents were also asked to indicate whether their child had ever been diagnosed with autism, attention deficit disorder, or a learning disability, and to indicate whether their child was living with father, with mother, and/or with an unrelated male or female. For all participants in the study, the parent provided consent, and the child assented, to voluntarily participate in the study during school hours. No participants withdrew from the study at any stage.

Procedure

Student returned signed consent (including parental consent) forms to the school office for collection by the experimenter. From returned consent forms, participant lists were prepared for the schools indicating the name, date of birth, and (for primary schools) teachers' class of each student. Lists were prepared in a manner to cause minimal disruption to the school, teachers, and student classes. The first part of the study involved the administration of the three self-report questionnaires to groups of same-aged, same-sex participants in a 30-minute 'interview' session. The size and number of these groups varied from school to school; for example, in one girls' high school, the majority of participants were administered the questionnaires in one large group of approximately 40 students, whereas, in primary schools, the groups usually ranged in size from five to eight participants at a time. The majority of group sessions were conducted in the boys' high school, and ranged in size from 12 to 20 boys in each group. The second part of the study involved the administration of the executive function and 'control' tests. These 30-minute individual sessions were conducted subsequent to the completion of self-report questionnaires either on the same day or within a few weeks. Individual 'interview' sessions were conducted in a quiet room free from distraction. A brief description of the protocol for each interview is described below.

Group Interview

Prior to conducting the group interview, an identity card was produced for each participant, which in addition to containing their name, grade, and date of birth, contained an identification number. This participant identification number was recorded on each of two envelopes which contained the set of self-report questionnaires, and the set of scoring sheets for the cognitive tasks. At each group interview, participants were instructed to sit at the desk (spaced at a distance to prevent viewing others' responses) which displayed their identification card. On each desk was also an empty envelope for participants' completed questionnaires, and a pencil. It was explained to participants that as a group they would complete each questionnaire at the same time and insert the completed questionnaire into the envelope prior to the administration of the next questionnaire. Participants were instructed to seal their envelope once they had completed all questionnaires and then to hand it the experimenter. It was explained that the only identifying information attached to their completed questionnaires was the number on the envelope and that these envelopes would not be opened until after they had completed the second part of the study. It was explained that the identification cards which linked their identification number to their name would only be retained until they had completed the second part of the study, at which time they would be given the card. It was explained to participants that this procedure enabled us to match their responses from the two separate interviews whilst ensuring that no identifying information was attached to any of the information they provided.

Prior to the administration of the self-report questionnaires, rapport was developed with the participants, and the purpose of the study was briefly explained. Participants were told that the information they provided would be used to investigate patterns in thought and behaviour occurring at the time of pubertal development, and it was explained that the success of the study was dependent on their honest and accurate responses. Participants were instructed that if they were uncomfortable providing responses to any of the items on the questionnaires, they could leave the item (or the entire questionnaire) unanswered, and that they could withdraw from the study at any time. All questionnaires were administered in the same order across all participant groups, and the instructions for completing each questionnaire were read out immediately prior to its administration. For the Antisocial Attitudes Scale, participants were simply instructed how to complete the questionnaire (i.e. circle the response that best describes you), and were talked through the first item as an example. For the antisocial behaviour scales, participants were similarly provided with an example of how to complete the questionnaire and were reminded that they did not have to answer any items, but were assured that no one, including parents and school authorities, would see their responses. Prior to the administration of the Pubertal Development Questionnaire, the participants were talked through the types of responses required. The experimenter tried to create a relaxed and comfortable atmosphere by explaining that although puberty is an embarrassing topic, it is something that everyone experiences. She reminded participants that responses were confidential and not to look on to others' responses, or to ask participants about their responses later. Participants placed all questionnaires into the envelopes provided and were thanked for their participation and were told that they would be contacted shortly to participate in the second phase of the study. Participants were told that they would be provided more information about the study after they completed the second interview, and that it was important that they not discuss the questionnaires with other students. All participants completed the group questionnaires; however, one 12-year old boy was excused from the group interview session because of his difficulty in taking the task seriously when presented with the pubertal development questionnaire. The boy later contacted the experimenter and completed the pubertal development questionnaire during the individual interview session prior to administration of the cognitive tests.

Individual Interview. Prior to administration of the cognitive tasks, rapport was developed with individual participants and they were reminded about the protocol of the study. Participants were given their identification card and participation incentive (i.e. vouchers) to keep. It was explained to participants that a series of five different cognitive tasks were going to be administered, ranging from approximately 2 to 10 minutes in duration, and that the entire administration would last approximately 25 minutes. It was explained that individual results could not be provided and that although their level of intelligence was not being measured, they should attempt to do their best on all tasks. Participants were instructed that they did not have to complete any of the individual tasks and that they could withdraw their participation at any time. They were then asked if they had any questions about the procedure before beginning.

All cognitive tasks were administered in the same order to all participants. Participants were first administered the PPVT; it was expected that the administration of the PPVT first would help to relax students as participants in the pilot study reported that it was the easiest of all the tasks administered. The LNS task was administered next as this task also provides few indications to the participant regarding individual performance, but is a relatively challenging task. The three conditions of the Stroop were administered next, which was a relatively more frustrating task for participants. TMT-A and TMT-B (a relatively short task) followed the Stroop, and lastly the participants completed the four tests of verbal fluency (semantic, phonemic, semantic-phonemic alternating, and alpha-numeric alternating).

Participants were given a brief debriefing, both orally and in writing (Appendix 4.9), and were asked not to discuss the tasks with future participants. They were told that they would be given a full debriefing when the study was completed in their school. Schools were provided with a two-page letter (Appendix 4.10) for each participating child and a thank you letter for the school principal (Appendix 4.11) when all participant interviews were completed. In addition to explaining the hypotheses and expected outcomes of the study and how the various instruments related to these outcomes, it was explained that their school would receive a brief report of the outcomes of the study once data analysis was completed. Across all schools, all interviews were completed within a period of approximately 12 months, and all schools received a brief outcome report at the same time - approximately 6 to 12 months following completion of participant interviews (Appendix 4.12).

SECTION 3: DATA TREATMENT

In this section of the thesis, detailed descriptive data are presented on each variable to provide insight into the characteristics of the sample. Because of differences in age, and in some cases, the preferences of individual school principals, some questionnaire items on the pubertal development, and the antisocial behaviour measures differed in form, and content. Therefore, a number of items required transformation, as well as the computation of new variables, to enable comparisons across all age groups. These transformations are explained in detail in the appropriate chapter section, i.e. Chapter 5: Pubertal Development; Chapter 6: Antisocial Behaviour and Attitudes, and Chapter 7: Executive Function. Before performing these analyses, initial analyses describing the demographic characteristics of participants was undertaken. Descriptive results for participant socio-economic status (SES), family structure, and age characteristics are described below.

Socio-Economic Status

The method of classifying socio-economic status from occupation categories was adopted from the method used by the Australian government's Department of Education, Science and Training (DEST) for identifying students from low socio-economic status backgrounds (Jones, 2001). The method involves collapsing occupation classification categories into eight broad occupation classes from a list of 117 categories developed by Jones and McMillan (2001) to represent the 1,076 occupation categories in the Australian Bureau of Statistics Australian Standard Classification of Occupations (ASCO2; ABS, 1997). These 117 categories were labeled ANU4 categories (this classification scheme represents the third modification of the first occupational status scale developed for use in Australia at the Australia National University). Appendix 3.0.1. lists the 117 ANU4 categories and a cross-reference list of these to the eight DEST categories. Jones and McMillan (2001) discuss in depth the historical background of socio-economic stratifications and the process involved in developing the ANU4 scale. Relevant to this thesis is that Jones and McMillan theorize that the ANU4 scale is an improvement on previous methods because it is "a socioeconomic index based on a scaling of occupation that maximizes the indirect effect of educational attainment on income, while minimising its direct effect." (p 457) Thus, it is proposed that the method of measuring SES by transforming parental occupation into ANU4 classifications is theoretically valid.

The parent demographic information form allowed for both parent occupations to be listed. Each of these occupations was coded into one of the eight DEST occupation categories by referring to the cross-reference index to the 117 ANU4 categories. Homemakers, retirees, and the unemployed were placed in a ninth category of 'no occupation'. When two parent occupations were provided, the average was taken and rounded up to the nearest whole integer. For example, if parent 1 was listed as a nurse (DEST category 2), and parent 2 was listed as a clerk (DEST category 6), the child's SES would be computed as a 4. Table 3.1 lists the eight occupation category descriptions; consistent with the method used by DEST, participants were categorized into either a high (1 to 4), moderate (4 to 6), or low (7 to 9) SES category. The percentage of participants in each of these occupation categories is listed by school type and for the overall sample. The distribution in each school type is very similar with approximately 60% of parents listing a high SES occupation, of which half of these were in the top-ranking occupation category comprised of individuals who work in the health, education, and legal fields. A further 20% of the respondents listed occupations which placed them in the moderate SES category. The low SES bracket is under-represented in this sample; less than 10% of parents listed an occupation in these occupation categories. Across all school types, less than 10% of participants were missing a response on this item.

Table 3.0.1. Distribution by school type in socio-economic categories and occupations.

SES Category & Occupation Description	Percent Primary Boys & Girls	HS Boys	HS Girls	Total
High SES				
1 Health; Education; Legal	30.0	31.3	27.7	30.0
2 Nurses; Professionals: Social, Business, Computing	20.0	23.6	22.9	22.4
3 Elected/appointed Officials, Senior Management	12.2	4.2	7.2	7.3
High SES Sub-Total	62.2	59.0	57.8	59.7
Moderate SES				
4 Artists; Business Consultants	5.6	5.6	3.6	5.0
5 Shop, Office & Hospitality; Electrical Tradespeople	7.8	11.8	14.5	11.4
6 Building/Auto/ Misc Tradespeople, Secretaries, Clerks	7.8	7.6	9.6	8.2
Moderate SES Sub -Total	21.1	25.0	27.7	24.6
Low SES				
7 Transport/Service workers, Tradespeople, Skilled	2.2	2.1	2.4	2.2
8 Other service workers, Machine Operators, Labourers	3.3	2.8	4.8	3.5
9 Unemployed, Housewife, Retired	2.2	.7	2.4	1.6
Low SES Sub-Total	7.8	5.6	9.6	7.3
Total	91.1	89.6	95.2	91.5
Missing	8.9	10.4	4.8	8.5
Total	100.0	100.0	100.0	100.0

Analysis of variance[4] post-hoc comparisons revealed no significant differences in SES between the three school types; Table 3.0.2 displays mean ratings on a scale from 1 to 9, with 1 equal to the highest SES category (i.e. Health, Education, Legal professions), and 9 equal to the lowest SES category (e.g. unemployed), and the (non-significant) differences between these mean ratings.

[4] ***using the Kruskal-Wallis test, the same result was found; there were no significant differences in SES between school types ($H_2 = 1.100$, $p = .58$).***

Table 3.0.2. Socio-economic status by school type and comparison of mean differences.

	SES Scale: 1 to 9 - Highest = 1; Lowest = 9					
	Descriptive Statistics			ANOVA: Multiple Comparisons		
(I) School Type	N	Mean	SD	(J) School Type	Mean Difference (I-J)	Sig.
High School Boys	132	2.9	2.06	High School Girls	-.324	.278
				Primary Girls and Boys	-.047	.873
High School Girls	79	3.2	2.19	High School Boys	.324	.278
				Primary Girls & Boys	.277	.404
Primary Girls & Boys	81	2.9	2.05	High School Boys	.047	.873
				High School Girls	-.277	.404
Total (all schools)	292	3.0	2.09			

Family Structure

Parents provided responses on items regarding the family structure of the child's home. Responses which indicated that the child did not 1) live with both parents and 2) lived with mother were coded as 'Father Absent'. Parents were also asked if an unrelated adult lived in the home, and whether this unrelated person was male or female. Over 30% of the girls in this sample were identified as living in a father absent home, compared to only 12.5% of boys (Table 3.0.3). A very small proportion of these children were identified as living in a home with an unrelated male (e.g. less than 5% of all girls, and only 17% of father absent girls). Given this very low number of participants (n = 6) it was not possible to test the hypothesis that living with an unrelated male is associated with early puberty in girls.

Table 3.0.3. Number and percent of girls and boys living in a father absent home, and proportion of these children living with an unrelated male.

	Females			Males		
	Frequency	Percent	Valid Percent	Frequency	Percent	Valid Percent
			Father absent			
No	79	64.2	68.1	161	79.3	87.5
Yes	37	30.1	31.9	23	11.3	12.5
Subtotal	116	94.3	100.0	184	90.6	100.0
Missing	7	5.7		19	9.4	
Total	123	100.0		203	100.0	
			Unrelated Male lives in the home			
No	29	78.4	82.9	20	87.0	90.9
Yes	6	16.2	17.1	2	8.7	9.1
Subtotal	35	94.6	100.0	22	95.7	100.0
Missing	2	5.4		1	4.3	
Total	37	100.0		23	100.0	

Cultural Background

In total, 70% of the participants reported either an Asian (31.3%) or Australian/European (39.0%) cultural background (see Table 3.0.4). When boys and girls are examined separately however, less than 10% of girls in the sample reported an Asian cultural background (compared to ~63% Australian/European), but almost 45% of the boys in the sample reported an Asian cultural background, compared to 25% reporting an Australian/European background. Across the entire sample, less than 10% of respondents reported an Australian/Other (8.3%), European/North American (4.0%), Other (7.4%), or provided no data (7.7%). Less than 2% of the sample reported either an Aboriginal/Torres Straight Islander (1.5%) or Arabic (.9%) cultural background (the majority of these were girls).

Table 3.0.4. Number and proportion of participants by cultural backgound for girls and boys.

	Girls		Boys		Total	
Cultural Background	N	Percent	N	Percent	N	Percent
Aboriginal/Torres Straight Islander	4	3.3	1	.5	5	1.5
Arabic	2	1.6	1	.5	3	.9
Asian	11	8.9	91	44.8	102	31.3
Australian/European	77	62.6	50	24.6	127	39.0
Australian/Other	7	5.7	20	9.9	27	8.3
European/North American	6	4.9	7	3.4	13	4.0
Other	12	9.8	12	5.9	24	7.4
Missing	4	3.3	21	10.3	25	7.7
Total	123	100.0	203	100.0	326	100.0

Participant Age Distribution

Participant date of birth was collected and recorded in years and months, and was treated as a continuous variable for data analysis purposes. However, for the purposes of this description of the distribution, participants were placed into 'half-yearly' age groups, e.g. participants between the age of 9 years, zero months (9.0), and 9 years, 5 months (9.42) were placed into age group '9', whereas participants between the age of 9 years, 6 months (9.5), and 9 years, 11 months (9.92) were placed in age group '9.5'.

The distribution of participants by age group for girls, and boys, is shown in Table 3.0.5. For girls, approximately one-third (30.9%) of the sample were in the age groups 9.0 through 11.5, one-third (35.8%) in the age groups 12.0 through 14.0, and 33.3% in the age groups 14.5 thru 16.5; there were no 17 year old girls in the sample. For boys, approximately one-third (35%) of the sample places in the age groups 9.0 through 12.5, one third (30.5%) places in the age groups 13.0 through 15.0, and 34.5% of the sample places in the age groups 16.0 through 17.5.

Table 3.0.5. Number and proportion of participants by half-yearly age group for girls and boys.

	Males			Females		
Age Group	Frequency	Percent	Cumulative Percent	Frequency	Percent	Cumulative Percent
9.0	4	2.0	2.0	5	4.1	4.1
9.5	8	3.9	5.9	4	3.3	7.3
10.0	12	5.9	11.8	8	6.5	13.8
10.5	7	3.4	15.3	4	3.3	17.1
11.0	11	5.4	20.7	7	5.7	22.8
11.5	3	1.5	22.2	10	8.1	30.9
12.0	15	7.4	29.6	4	3.3	34.1
12.5	11	5.4	35.0	13	10.6	44.7
13.0	11	5.4	40.4	8	6.5	51.2
13.5	17	8.4	48.8	7	5.7	56.9
14.0	13	6.4	55.2	12	9.8	66.7
14.5	13	6.4	61.6	17	13.8	80.5
15.0	8	3.9	65.5	8	6.5	87.0
15.5	18	8.9	74.4	9	7.3	94.3
16.0	18	8.9	83.3	3	2.4	96.7
16.5	23	11.3	94.6	4	3.3	100.0
17.0	7	3.4	98.0			
17.5	4	2.0	100.0			
Total	203	100.0		123	100.0	

Boys are over-represented in the sample, particularly in the older age groups. Approximately 62% of the sample were boys (n = 203) and 38% were girls (n = 123). Between the ages of 15.5 and 17.5, there were more than three times as many boys (n = 70) than girls (n = 16). There are approximately the same number of girls as boys in the age range 9.0 thru 11.5 (n = 38 and 45 respectively), and in the age range 12.0 through 14.5 (n = 61 and 80 respectively). The mean age of boys (13.7) is higher than the average age of girls (13.0), and the modal age is 16.5 for boys and 14.5 for girls. Thus, the largest age discrepancy between the genders is in numbers in the oldest age group (15.0 to 17.5; n = 26 and 78 respectively for girls and boys). The additional statistical power afforded by the larger number of higher-age male participants might be beneficial, as pubertal development events are reported less reliably, and later, in boys than they are in girls (see Dorn et al., 1990).

Exclusion of Participants

As described in the following chapters, a small number of participants were excluded from analyses as the data were considered unreliable on one or more measures. It was not necessary to exclude any participants from the analyses of the pubertal development variables. However, nine participants (seven boys, ages 12 to 16; two girls, ages 11 and 14) were excluded from ASB (and all subsequent analyses) because the responses on ASB measures did not pass the lie scale items (see Chapter 6). Finally, four additional children were excluded because they had been identified by parents as having either a learning disability or ADHD; three boys (ages 10, 11, and 12), and one girl (12.5 years) was excluded (see Chapter 7) from data treatment analyses of executive function measurement (and all subsequent analyses) on this basis.

The set of analyses conducted is relatively large, and in several instances not all participants provided data on all measures. The majority of the instances of reduced data are due to the characteristics of the younger sample (e.g. pre-pubertal) and the restrictions on data collection in that age group (e.g. no measure of current ASB due to need for use of a shorter measure). For all analyses, the number and characteristics (e.g. high school girls) of participants included is clearly stated. The analyses are presented in two sections. The next section of this thesis (Section 3) presents the data treatment of the four constructs: pubertal development (Chapter 5), antisocial behaviour and attitudes (Chapter 6), and executive function (Chapter 7). The following section (Section 4) presents the results of the statistical tests of the principal hypotheses of this thesis: pubertal development and antisocial behaviour and attitudes (Chapter 8), pubertal development and executive function (Chapter 9), antisocial behaviour and executive function (Chapter 10), and finally, mediation Analysis (Chapter 11).

Chapter 5: Pubertal Development Variables

Pubertal development was measured via participants' self-report on three types of questionnaire items: descriptive (choice of five statements), pictorial (choice of five line-drawings), and historical (computed from participant's report of onset-age) to provide four measures of pubertal development: pubertal status, pubertal stage, pubertal timing, and pubertal onset age. The questionnaire was described in detail in Chapter 4 (Materials section), and each of these three item-types and the four measures provided are described in detail below. The purpose of this chapter is to explain how participants' responses on these three item-types were converted to a quantifiable measure of pubertal development. The general practice in the published literature is to report on just one of these three types of pubertal development measures. Several researchers (see for example Brooksgunn, Warren, Rosso, & Gargiulo, 1987; Dorn et al., 1990; Dorn, Susman, & Ponirakis, 2003; HermanGiddens et al., 1997; Petersen, Crockett, Richards, & Boxer, 1988; Taylor et al., 2001) have investigated the validity and reliability of adolescent self-reports In comparison to physician-examination on current pubertal status (pre-pubertal, mid-pubertal, post-pubertal), which is customarily measured with reference to five pubertal stages (pre, early, mid, late, post). Several studies have also investigated the relationship between pubertal timing (early, on-time, late) and psychological behaviour (e.g. depression, antisocial behaviour, drug-use and sensation-seeking; for example see Angold, Costello, & Worthman, 1998; Dorn et al., 2003; Ellis, 2004; Ge et al., 1996; Ge et al., 2006; Ge et al., 2003; Graber et al., 1997; Kaltiala-Heino, Marttunen et al., 2003; Williams & Dunlop, 1999). Some studies have also investigated the relationship between the onset of pubertal development and particular behaviours (e.g. antisocial behaviour; for example see Caspi et al., 1993; Caspi & Moffitt, 1991; Dorn et al., 2003; Felson & Haynie, 2002; Ge et al., 2002; Markey, Markey, & Tinsley, 2003; Susman et al., 1987; Wichstrom, 2001; Williams & Dunlop, 1999).

Although four measures of pubertal development are included in the current research study, very little reference is made to current pubertal development *status* (e.g. pre, mid, post-pubertal); the three primary pubertal development measures are 1) current pubertal development *stage*, 2) pubertal development *timing*, and 3) pubertal development *onset age*. Consistent with the majority of the published literature, participants' *current pubertal development status* (pre-pubertal; mid-pubertal; late-pubertal) is represented by one of five *current pubertal development stages* (pre; early; mid; late; post). Current pubertal development stage is a measure which places adolescents into one of five progressive stages marking the typical progression through pubertal development. Participants' *pubertal development timing* is a comparative measure which categorizes the adolescent as maturing 'on-time', early' or 'late'. Three of the above pubertal development measures (i.e. status, stage, and timing) were determined by computing and compiling participants' self-report of development into one of five stages on all three types of items (i.e. descriptive; pictorial; historical). The fourth pubertal measure, *pubertal development onset age,* was computed as the age at which the adolescent reached a mid-pubertal developmental stage as calculated from selected historical items.

This chapter begins by describing the typical progression of pubertal development events with reference to previous research, and explains how this information relates to the three primary measures of pubertal development (stage, timing, and onset age). Next, the detailed method used to classify adolescents into pubertal development stages is described along with the descriptive data on these distributions. The process of investigating the validity and reliability of pubertal stage measurement is then described. The last two sections of this chapter describe how both pubertal onset age and pubertal timing were operationalized and provides descriptive data on these variables.

Typical Progression of Events

Background

Although puberty is often thought of as an event, pubertal development is actually a set of biological and physical changes in sexual maturation that represents the transition from childhood to adulthood and reproductive ability (see for example, Rogol, Roemmich, & Clark, 2002). In addition to gender differences, there are large individual differences in age of pubertal development onset (see Dorn et al., 1990). A number of studies have published normative pubertal development data, particularly in the US, which have established a normative age range in which particular pubertal development markers can be expected to occur (see, for example, Canals, Vigil-Colet, Chico, & Marti-Henneberg, 2005; Dick, Rose, Pulkkinen, & Kaprio, 2001; Dorn et al., 1990; HermanGiddens et al., 1997; Petersen et al., 1988). These previous studies have established that pubertal onset can be expected anytime between the ages of 8 and 17 for girls, and between the ages of 9 and 18 for boys (see also Kakarla & Bradshaw, 2003).

For girls, the first signs of development begin at an average of 9.5 years of age, and for boys, at an average of 11 to 11.5 years of age. Although there is a fair amount of individual variability experienced in the amount of time elapsed between pubertal development events, researchers have identified a typical progression of events in sequence, and timing, for girls and boys respectively (Canals et al., 2005; Dorn et al., 1990; Paikoff & Brooksgunn, 1991; Tanner, 1962). The conclusions of these researchers regarding the typical progression of pubertal development events have been combined and used as a guideline for the current study.

Current Study

Table 5.1 displays how the typical progression of events was coded by each of five pubertal development stages for girls and boys respectively. Consistent with the previous literature, Stage 1 represents pre-pubertal, meaning no changes have occurred, and the final pubertal development stage for both boys (mean age 16 – 18 years) and girls (mean age 15 – 17 years) is Stage 5: post pubertal, which indicates that pubertal development change is complete. There is considerable difference, however, in how girls and boys typically progress through events representing the early, mid, and late pubertal stages.

Girls

According to the literature (e.g. Dorn et al., 1990; HermanGiddens et al., 1997; Paikoff & Brooksgunn, 1991), the first pubertal development marker for girls occurs around the average age of 9.5 years, and is a sudden increase in height (*growth spurt*). Approximately one year following this growth spurt, girls typically experience *skin changes, breast changes,* and *body hair growth* (Stage 2: early pubertal). Typically, about 1 to 1.5 years later, girls reach *peak height* velocity, and within a year following peak height velocity, girls experience *menarche* (Stage 3: mid pubertal). Thus, Stage 2 and 3 represent what is typically referred to as the period of sexual maturation, or *puberty onset* (Herman-Giddens et al, 1997), and occurs at an age of approximately 12 – 13 years for girls. Stage 4: late pubertal is characterized by further breast changes and further hair growth.

Boys

The first pubertal development marker typically for boys is testicular growth (*genital stage*), closely followed by a *growth spurt* and *body hair growth* (Stage 2: early pubertal). Any time within a range of one to three years following testicular growth, boys usually experience their first ejaculation, which in the pubertal development literature is considered a discrete and recognizable event and is referred to as *spermarche* (see Kulin, Frontera, Demers, Batholomew & Lloyd 1989; Nielsen et al 1986). About this same time, (approximate mean age of 13-14 years), boys also begin to experience *skin changes* (Stage 3: mid pubertal). Boys reach *peak height* velocity and experience *voice changes* in Stage 4: late pubertal.

Table 5.1. Pubertal stage categories and typical progression of pubertal development events.

	Stage				
	1	2	3	4	5
	Pre-pubertal	Early pubertal	Mid pubertal	Late pubertal	Post pubertal
Age	Typical progression of events				
			Girls		
< 9.0	No changes				
9.5		Growth spurt			
10.5		Skin changes			
10.5		Breast changes			
11.8		Axillary hair			
12.5			Peak height		
12.5			Menarche		
13 - 15				Further breast/hair growth	
15 - 17					Change complete
			Boys		
< 11.0	No changes				
11-11.5		Genital growth			
11.7		Growth spurt			
12		Axillary hair			
12 - 14			Spermarche		
12 - 14			Skin changes		
13.7				Voice change	
13.8				Peak height	
16 - 18					Change complete

Pubertal Development Measurement

There are a number of ways in which pubertal development has been measured in the adolescent development literature (see Coleman & Coleman, 2002). Most researchers consider physician examination to be the 'gold standard' method (see for example Taylor et al., 2001), and a number of studies have included hormonal assays (Dawes et al., 1999; Paikoff & Brooksgunn, 1991; Susman et al., 1987) to determine pubertal development stage. However, the findings of Dorn and colleagues (1999) that differences in hormone levels between pre- and post-menarche girls (for example) is small relative to the larger intra- and inter-individual variations within these groups, suggests that in many instances, self-report measures may be more reliable than hormonal assays. Thus, self-report was employed in the current study, partly because it is less invasive and less expensive than the above noted methods, but also due to the relative success of self-report measures (see Coleman & Coleman, 2002).

Some studies have found that adolescents' self-report and parent's ratings are less reliable than physician ratings (Brooksgunn et al., 1987; Dorn et al., 1990). However, Taylor and colleagues (2001) found that adolescents were able to place themselves within one stage of physician ratings when shown pictorial line drawing from Tanner's Sexual Maturation Scale (Tanner, 1962). Commonly referred to as 'Tanner's stages', the photographs representing five stages of development for pubic hair development, female breast, and male genitalia, development are considered the best aid to pubertal development self-report (Coleman & Coleman, 2002). As reported in the literature, their use has been restricted, however, by objections raised by parents and school officials in many research proposals. Therefore, to avoid these concerns regarding the use of explicit nude photographs, Taylor and colleagues produced less explicit, line drawings based on Tanner's (1962) photographs.

Prior to the development of Taylor and colleagues' (2001) line drawings, much pubertal development research was performed with the use of The Pubertal Development Scale (PDS; Brooksgunn et al., 1987), which requires participants to place themselves in one of four stages (no development, beginning development, additional development, development past) on five different measures of pubertal development: growth spurt, skin changes, and body hair for both girls and boys, and for girls only, breast changes and menarche, and for boys only, facial hair and voice change.

Pubertal development was measured in the current study by combining the two above methods of self-report with some modifications and extensions. The pubertal development measure used includes items similar to those in the PDS (Brooksgunn et al., 1987), referred to here as *description items*, as well as items using the pictorial line drawings developed by Taylor and colleagues (2001) from Tanner's photographs, referred to here as *pictorial items*. However, for measurement consistency (with Tanner's stages), unlike the PDS, which used a 4-point scale, the description items in this study were measured on a 5-point scale as outlined above.

Participants were also asked to provide an age for which they recalled a particular pubertal event occurring. In addition to computing a pubertal onset age from participant responses (see Pubertal Onset section), a third item-type for pubertal stage was included in the current study which comprises an estimated time of entry into a pubertal stage based on subtracting the 'age of recall' on a particular item from the 'age at time of interview'. The resulting 'number of months elapsed' variable was then transformed into one of five stages for comparison amongst indices (referred to as *historical computation items*); detail of these item transformations is explained below (see Pubertal Stage section).

There are nine pubertal development items in total measuring eight pubertal development indices (the skin changes/acne indice is represented twice; when skin changes occurred [historical item] and current stage of acne [description item]). One of the description items from the questionnaire was dropped from analyses due to method-related problems. As explained in more detail below, the 'body hair' *description* item was completed by only 49 of the 203 boys in the sample. Following the deletion of this *description* item, a total of nine items were included in analyses: two *description* items, three *pictorial* items, and four *historical* computation items.

Pubertal Stage

Table 5.2 lists the items that make up the questions on the pubertal development measure in each of the three item-types (description, pictorial, historical), and shows how we operationalized pubertal development stages 1 to 5 for each item (i.e. pubertal indice). Most items apply to both girls and boys (i.e. growth spurt, skin changes, acne, and body hair). Some items, however, are gender specific; the items relating to voice change, genitalia growth, and spermarche are specific to boys, and the items relating to breast growth and menarche are specific to girls. Thus, in total, four pubertal development items apply to both girls and boys, and five items are gender-specific (2 for girls; 3 for boys), resulting in a total of six items for girls, and seven items for boys, being included in analyses.

For the historical computation items, (i.e. growth spurt, skin changes, spermarche, and menarche), participants reported the age they were when the historical event occurred. Participants were coded into one of five pubertal development stages for growth spurt and skin changes (e.g. Stage 1 if no change had been experienced, or Stage 2 if change had occurred in the past 12 months; refer to Table 5.2). Based on the typical progression of pubertal development events, menarche and spermarche were considered to be Stage 3 events. Thus, only those adolescents who had experienced this sex-specific event, were coded into one of three stages: Stage 3 (occurred in the last 12 months), Stage 4 (occurred in the last 12-24 months), or Stage 5 (occurred 24+ months previously).

Alternatively, description and pictorial items required participants to place themselves into one of five stages for each item. Thus, for six pubertal development items, (acne, voice change, breast growth, genital growth, and body hair), participants placed themselves into one of five pubertal development stages. The method of computing a composite pubertal stage from these items is described in detail below, along with the distribution of participants in each stage for girls and boys separately.

Table 5.2. Operationalization of Pubertal Stages 1 to 5 by category type and item.

Stage (1 – 5)	Category Type & Items		
		Description Items	
	Skin Changes (girls and boys)		Voice Change (boys only)
1	No change		No change
2	1 or 2 blemishes		Starting to change
3	Daily blemishes		Somewhat lower
4	Blemishes clearing		A lot lower
5	Completely cleared		As low as an adult
		Pictorial Items	
	Pubic Hair Growth (girls and boys)	Breast Growth (girls only)	Genital Growth (boys only)
1	No hair	Breasts are flat	No change
2	Very little hair	Small mounds	Scrotum has lowered
3	Quite a lot of hair	Larger mounds	Scrotum is larger
4	Not over thighs	Areola sticks up above	Scrotum is darker & bigger
5	Over thighs	Nipple sticks out beyond	Same size & shape as adult
		Historical Computation Items	
	Growth Spurt (girls and boys)		First Presence of Skin Changes (girls and boys)
1	No change		
2	Change has occurred in previous 12 months		
3	Change has occurred more than 12 months, but less than 24 months previous		
4	Change has occurred more than 24 months, but less than 36 months previous		
5	Change has occurred more than 36 months previous		
	First presence of Menses (Menarche) (girls only)		First Ejaculation (Spermarche) (boys only)
1	No change		
2	No change		
3	Change has occurred in previous 12 months		
4	Change has occurred more than 12 months, but less than 24 months previous		
5	Change has occurred more than 24 months previous		

Sample Distribution by Pubertal Development Stages and Indices

This section outlines for girls and boys separately, descriptive statistics for the sample in terms of how they are distributed across pubertal development stages on each of the pubertal development indices. Although measurement validity is discussed in detail in the next section, some evidence for measurement validity is presented in this section with a discussion of the mean age of adolescents in each stage relative to the expected typical progression through pubertal stages. All participants completed the same questionnaire with the exception of girls and boys in Year 4; to meet Department of Education Ethics Committee guidelines, Year 4 (i.e. 9 or 10 year old) participants were only provided with the questions pertaining to growth spurt and skin changes/acne, and not provided with any items related to body hair growth, breast or voice changes, or menarche/spermarche. As the majority of Year 4 students are younger (age 9) than the mean age at which any changes related to pubertal development are likely to occur, it was assumed that, with few exceptions, the majority of these children would place in Stage 1 on all pubertal development items.

For the purposes of analyses, therefore, Year 4 girls and boys were placed in Stage 1 for all other pubertal development items, unless their responses on growth spurt and skin changes/acne strongly indicated a higher stage. Although some Year 4 children reported Stage 2 on one of three items (growth spurt, acne, skin changes), only one child reported Stage 2 on more than one item. Thus, one Year 4 boy was placed in Stage 2 for voice change, genital growth, and body hair growth.

Girls

The pattern of distribution across and progression through pubertal stages was as expected for girls. However, there was some indication of possible reporting errors, particularly for the acne and body hair items. Although girls progressed within developmental indices as expected, there was evidence of large variability in reported ages across developmental indices. These findings are discussed in detail in this section.

Distribution across stages. Table 5.3 displays the distribution of number and mean age of girls for each pubertal development indice by pubertal development stage. For the majority of items, the girls in this sample are distributed fairly equally across Stages 1 to 5.

<u>*Menarche.*</u> As mentioned previously, girls were coded into one of three menarche stages as this event is considered a mid-pubertal event which does not occur until approximately Stage 3 (i.e. after growth spurt, skin changes, and initial body hair and breast growth). As it is not possible to differentiate Stage 1 from Stage 2 pre-menstrual girls, girls were only placed in either Stage 3, 4 or 5 (if they had experienced menses), or were not coded into a menarche stage. Table 5.3 displays that girls were distributed approximately equally across Stages 3 through 5.

Table 5.3. Distribution of number and mean age by pubertal development item for girls (n = 123).

	Category Type & Items											
Stage	*n*	*%*	*Mean Age*	*SD*	*n*	*%*	*Mean Age*	*SD*	*n*	*%*	*Mean Age*	*SD*
	Description Item				*Pictorial Items*							
	Acne Stage				Breast Growth Stage				Pubic Hair Stage			
1	17	14.3%	10.2	1.29	24	20.0%	10.3	.84	30	25.0%	10.7	1.13
2	49	41.2%	13.8	1.55	26	21.7%	12.5	1.13	21	17.5%	12.6	1.33
3	16	13.4%	13.3	1.64	28	23.3%	14.0	1.55	25	20.8%	13.8	1.29
4	34	28.6%	13.9	1.86	20	16.7%	14.7	1.22	34	28.3%	14.8	1.23
5	3	2.5%	13.5	1.18	22	18.3%	14.8	1.12	10	8.3%	15.1	.87
Total	119	100%	13.2	2.02	120	100%	13.2	2.05	120	100%	13.2	2.04
	Historical Computation Items											
	Growth Spurt Stage				Skin Changes Stage				Menarche Stage			
1	39	32.0%	12.2	1.91	27	22.3%	10.7	1.38				
2	26	21.3%	12.9	2.03	17	14.0%	12.7	1.43				
3	21	17.2%	13.2	1.80	32	26.4%	13.7	1.67	24	31.6%	13.2	1.34
4	19	15.6%	14.7	.88	24	19.8%	14.3	1.31	18	23.7%	14.2	1.47
5	17	13.9%	14.3	1.92	21	17.4%	14.7	1.23	34	44.7%	15.0	1.32
Total	122	100%	13.1	2.01	121	100%	13.2	2.04	76	100%	14.2	1.55

Acne and Skin Changes. An exception to the equal distribution was found within the acne item. A relatively large proportion of girls (41.2%) placed themselves in acne Stage 2, and the mean age for girls in this stage (13.8) is older than for all other stages of acne except for those girls in Stage 4 (13.9). Thus, it appears that a number of the older girls in this sample reported having '1 or 2 blemishes'. One explanation may be that these girls should have placed themselves in acne Stage 4 ('blemishes clearing'), and thus is possibly an error in girls differentiating between Stages 2 and 4. This explanation is supported by the uniform distribution of girls in the skin changes item, which suggested that the historical computation of skin changes indice may be a more reliable measure to use for further analyses in this study (investigated below).

Body Hair. Similar confusion may have arisen for girls whilst placing themselves in the appropriate stage for the body hair pictorial item; only 8.3% of girls placed themselves in Stage 5. This could be due to girls' unfamiliarity with the amount of hair growth they should ultimately expect. It is also possible, however, that some body hair Stage 4 girls were reluctant to place themselves in Stage 5. This latter explanation is consistent with the findings of Taylor and colleagues (2001) that health professionals are more likely to place children at extreme ends of development than are children, who tend to place themselves in the middle stages. Another possibility is that girls are not comfortable with identifying with Stage 5 as the description and illustration of the item might be seen as unfeminine ('hair has spread across the thighs'). Equally possible, however, is that because this sample was restricted in the older age group (only seven, 16-year old girls), girls may have identified themselves correctly, and there may not be many body hair Stage 5 girls in the current sample.

With the exception of body hair Stage 5 (8.3%), and acne Stage 5 (2.5%), there was little other evidence of reluctance by girls to place themselves in the more extreme stages of 1 or 5, rather than stages 2, 3, and 4 on the indices growth spurt, breast growth, and skin changes; an approximate equal amount of girls placed themselves in each of five stages on these indices.

Progression through stages. The mean age of girls for each stage by pubertal indice gives an indication of the validity of measurement, and how this sample of girls compares to samples in similar, previous studies. Within each indice, the mean age of adolescents should increase with each subsequent stage, and we should expect an increase in age across indices to reflect the typical progression of pubertal events, starting with growth spurt, and then skin changes and breast growth, followed by body hair growth in the early pubertal stage, and then menarche in the mid-pubertal stage (refer back to Table 5.1).

Within indices. With the exception of acne Stage 2 (discussed above), for all other indices, the mean age of girls in each stage is older than the mean age of girls in the previous stage, suggesting that the pubertal development measure used in this study have internal validity. For example, the data presented in Table 5.3 indicate that the mean age of girls in breast growth Stage 1 is 10.3 years, and increases to a mean age of 12.5 years in Stage 2, 14.0 years in Stage 3, 14.7 years in Stage 4, and 14.8 years in Stage 5.

Comparison of the mean and the median age (Tables 5.3 and 5.4) and inspection of the box plot and whiskers figures in Figure 5.1, illustrates that, in most instances, the median was very close to the mean, and girls' self-reports were normally distributed within each pubertal indice-stage. The few exceptions were in Stage 1 for growth spurt, acne and skin changes stages, which were slightly skewed to the right, indicating that fewer than expected older girls reported experiencing a growth spurt or skin changes. This is most likely due to older girls' failure to recall the onset of these indices due to the comparatively longer passage of time.

There were a few extreme values present in each pubertal indice, which were primarily to the left of the distribution; thus, the majority of these outliers represent girls who were significantly younger than the median age of girls in that stage. The data treatment of these early-maturing girls is discussed in more detail below (see Pubertal Timing).

Table 5.4. Median age and age range by pubertal development item and stage for girls (n = 123).

Stage	*n*	*Mdn*	*Min*	*Max*	*n*	*Mdn*	*Min*	*Max*	*n*	*Mdn*	*Min*	*Max*
	Description Item				*Pictorial Items*							
	Acne Stage				Breast Growth Stage				Pubic Hair Stage			
1	17	10.0	9.0	14.6	24	10.1	9.0	11.8	30	10.5	9.0	13.3
2	49	14.1	9.9	16.7	26	12.6	10.0	14.3	21	12.8	10.2	14.6
3	16	12.8	10.9	16.7	28	14.4	10.4	16.6	25	14.3	11.1	15.9
4	34	14.3	10.4	16.6	20	14.8	11.9	16.7	34	14.9	11.9	16.7
5	3	12.8	12.8	14.8	22	14.9	12.5	16.7	10	15.1	13.9	16.7
Total	119	13.5	9.0	16.7	120	13.4	9.0	16.7	120	13.4	9.0	16.7
	Historical Computation Items											
	Growth Spurt Stage				Skin Changes Stage				Menarche Stage			
1	39	12.2	9.2	16.0	27	10.2	9.0	14.6				
2	26	12.7	9.0	15.5	17	12.8	10.9	15.2				
3	21	13.3	10.3	16.6	32	13.6	10.4	16.7	24	13.3	10.0	15.0
4	19	14.8	12.5	16.2	24	14.5	10.9	16.6	18	14.6	11.0	16.6
5	17	14.8	10.9	16.7	21	14.9	11.8	16.7	34	15.0	10.1	16.7
Total	122	13.3	9.0	16.7	121	13.3	9.0	16.7	76	14.6	10.0	16.7

Across indices. Consistent with the typical progression of events, girls in menarche Stage 3 are approximately one half-year older than the mean age of girls in Stage 2 on other indices which are expected to occur earlier than menarche (e.g. growth spurt, breast and body hair growth). However, there is no support for an increase in mean age across other indices. For example, the mean age for body hair Stage 2, (12.6) is not older than skin changes (12.8), or growth spurt (12.7). The small difference in mean age across these indices is partially explained by the fact that these three indices are all early-pubertal events and the large amount of variation in age within each stage. For example, growth spurt Stage 2 has a standard deviation of 2.03 (M = 12.68), indicating that approximately 66% of the sample reported experiencing a growth spurt between the ages of 10.7 and 14.7 years of age, and the full range is 6.5 years (age 9.0 to 15.5 years; see Table 5.4 and Figure 5.1). This pattern of a large range in self-reported ages repeats for each pubertal indice stage, with an age range of approximately three (e.g. breast growth Stage 2) to seven years (e.g. growth spurt Stage 1). In other respects, however, the distributions across pubertal indice stages were as expected.

Summary of distribution by pubertal stage for girls. In general, girls advance through the five developmental stages in an ordered progression. There are a few outliers in the data (refer to Figure 5.1), which is to be expected when measuring a construct that has a large amount of variability between individuals. The majority of these Stage 4 and 5 outliers represent younger girls who have developed earlier than their peers; pubertal timing is discussed in detail in a later section of this chapter.

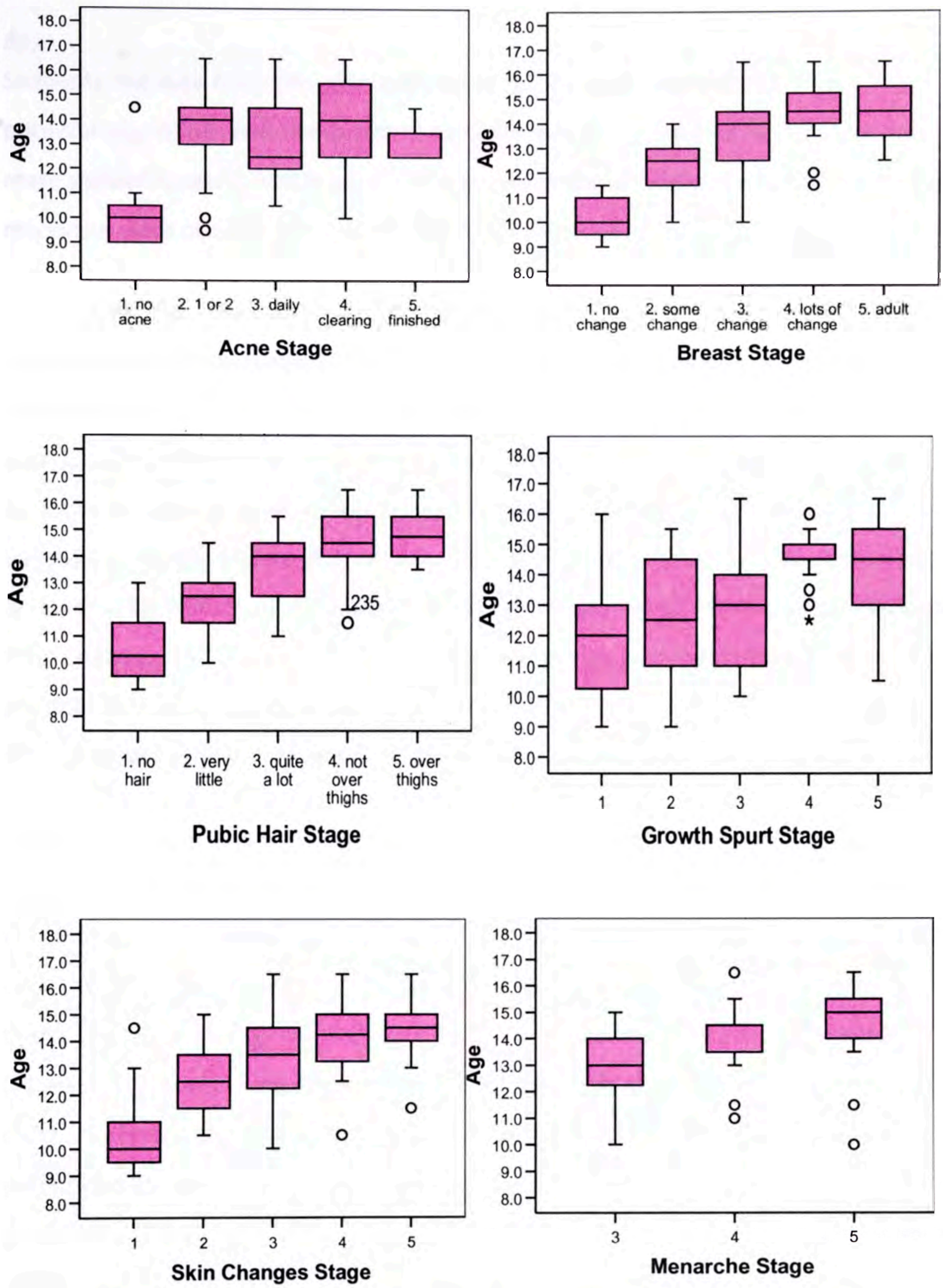


Figure 5.1. Median age and age range by pubertal indice stage for girls (n = 123).

Box length is the interquartile range. Whiskers represent 95% confidence interval.

O represents cases with values between 1.5 and 3 box lengths from the upper or lower edge of the box.

***** represents cases with values more than 3 box lengths from the upper or lower edge of the box.

Boys

Similar to the data from girls, the distribution across, and progression through, pubertal stages followed the expected pattern for boys. Compared to girls, however, more variability was found in boys' self-reported pubertal stages, indicating that boys' responses were possibly less reliable than girls' responses.

Body Hair. Similar to girls, the items measuring acne and body hair were determined to be unreliable and/or redundant. As described earlier in Procedure, the majority of boys (n = 149; 73% of boys) were not provided with the body hair *description item* as it was replaced with spermarche (thought to be a more valid measure of pubertal development (Bancroft, 2006; Gilger et al., 1991; Hirsch, Lunenfeld, Modan, Ovadia, & Shemesh, 1985; Kulin, Frontera, Demers, Bartholomew, & Lloyd, 1989; Nielsen et al., 1986). Thus, the 49 responses on this item were excluded from analyses, and the measure of body hair growth for boys was represented by the *pictorial item* only. Details regarding treatment of the acne item and the descriptive data for all pubertal indices are provided below.

Distribution across stages. Unlike the girls, boys in this sample were not equally distributed across Stages 1 to 5 on the pubertal indices (refer to Table 5.5). Except for the historical computation items (growth spurt, skin changes, spermarche), boys were under-represented in Stage 5. For example, only a small proportion of boys placed themselves in Stage 5 for voice change (7.1%), genital growth (10.7%), and body hair (11.4%). This is surprising given that the mean age for boys in this sample is one year older (14.0 years; n = 203) than for girls (13.0 years; n = 123), the modal age is two years older for boys (16.5) than for girls (14.5), and the sample includes a much larger proportion of boys aged 15.5 years or older (35%; n = 70) in comparison to girls (13%; n = 16).

Genital and Body Hair Growth and Voice Changes. One possible explanation is that the boys were committing more reporting-errors than girls, and that a larger proportion of boys should have placed themselves in Stage 5 on these pubertal development items. This is consistent with Dorn and colleagues (1990) who found that boys were slightly less accurate than girls in self-reports, and in the later stages (i.e. stage 4 and 5) were more likely to place themselves in a lower stage on pictorial items (i.e. reluctant to indicate that they had reached full genital and pubic hair growth). Thus, it appears that a number of boys may have erroneously placed themselves in Stage 4 rather than Stage 5 for genital growth, body hair, and/or voice change indices (refer to Table 5.5). However, it is also possible that the boys have accurately reported their development, and that this sample was slightly later to enter Stage 5 than the age reported previously.

Acne and Skin Changes. Less ambiguous was the reporting anomalies on the acne item. Similar to girls, a relatively large proportion of boys placed themselves in acne Stage 2 (36.7%), and a relatively small proportion of boys placed themselves in acne Stage 5 (4.5%) despite the fairly equal distribution of boys in Stages 1 through 5 on the skin changes item. Thus, as with the girls, it seems likely that boys innacurately reported acne development, and that the skin changes item is a more reliable measure of this pubertal indice in this case.

Spermarche. Similar to the placement of girls into menarche stages, boys were placed into one of three stages (Stage 3 through 5) for the spermarche item. Spermarche typically occurs between one and three years after Stage 2 genital growth, growth spurt, and body hair growth (Bancroft, 2006). Boys who had recently experienced spermarche (i.e. < 12 months previous) were placed into Stage 3 on this item. More than 50% of 130 boys were determined to have reached spermarche Stage 5 (see Table 5.5). Only a small proportion of boys placed themselves in Stage 5 on other pubertal indices of growth spurt, skin changes, and voice change. This is consistent with the pubertal development literature, which describes spermarche as an event occurring relatively early in the typical progression of events, i.e. prior to skin and voice changes, and peak height velocity (Bancroft, 2006; refer to Table 5.1).

Progression through stages. This section examines the distribution of the mean age of boys in each stage across, and within, pubertal indices. Within each indice, the mean age of adolescents should increase with each subsequent stage. Furthermore, a (linear) increase in age should follow the typical progression of pubertal events, starting with genital growth and then a growth spurt and body hair growth in the early pubertal stage, and then spermarche and skin changes in the mid-pubertal stage (refer to Table 5.1).

Table 5.5. Distribution of number and mean age by pubertal development item for boys (n = 203).

	Category Type & Items											
Stage	*n*	%	*M*	*SD*	*n*	%	*M*	*SD*	*n*	%	*M*	*SD*
	Description Items											
	Acne Stage				Voice Change Stage							
1	42	21.1%	11.3	1.70	37	18.7%	11.1	1.72				
2	73	36.7%	14.0	1.94	33	16.6%	12.7	1.60				
3	35	17.6%	15.2	1.72	69	34.7%	14.4	1.80				
4	40	20.1%	15.2	1.96	46	23.2%	15.5	1.60				
5	9	4.5%	14.9	2.44	14	7.1%	16.5	0.67				
Total	199	100%	13.9	2.35	198	100%	13.9	2.34				
	Pictorial Items											
	Genital Growth Stage				Body Hair Stage							
1	24	12.5%	10.3	1.07	27	16.6%	10.5	1.10				
2	21	10.9%	12.3	1.61	25	13.0%	12.4	1.25				
3	65	33.9%	14.4	1.76	45	23.3%	14.2	1.63				
4	61	31.8%	14.8	1.72	69	35.8%	15.3	1.36				
5	21	10.9%	16.1	1.48	22	11.4%	16.5	0.72				
Total	196	100%	13.9	2.34	193	100%	14.0	2.32				
	Historical Computation Items											
	Growth Spurt Stage				Skin Changes Stage				Spermarche Stage			
1	52	25.6%	11.8	1.88	56	27.9%	11.4	1.74				
2	37	18.2%	13.4	1.94	41	20.4%	13.5	1.52				
3	43	21.2%	13.9	1.80	29	14.4%	14.1	1.47	26	20.0%	13.6	1.15
4	29	14.3%	15.1	1.72	32	15.9%	15.5	1.27	31	23.8%	14.8	1.22
5	42	20.7%	16.0	1.55	43	21.4%	16.1	1.50	73	56.2%	15.9	1.31
Total	203	100%	13.9	2.34	201	100%	13.9	2.35	130	100%	15.2	1.57

Within indices. Table 5.5 displays a higher reported mean age for boys in each progressive stage within each pubertal indice, indicating that, (similar to girls), the distribution follows a progression through stages 1 to 5. For example, for the body hair item, there was an average increase in reported age of approximately two years across each of the first three developmental stages: Stage 1 (10.5), Stage 2 (12.4), and Stage 3 (14.2), and a one year increase over each of the final two developmental stages: Stage 4 (15.3) and Stage 5 (16.5). The standard deviation of age within each pubertal development stage were fairly substantial, but slightly lower than those indicated by the girls in this sample. The slightly smaller variation of age within stage may be due to the larger sample of boys compared to girls, rather than improved accuracy in reporting.

As displayed in Table 5.6 and Figure 5.2, the pubertal stage data are widely distributed over the entire age range of the sample of boys. On all indices, the age range within a pubertal development item ranges from approximately four years (e.g. genital growth Stage 1) to approximately seven years (growth spurt Stage 5). The median age is further away from the mean age than in the sample of girls, also indicating a greater amount of variation in reported ages within a particular stage. For example, the median age for acne Stage 5 is 16.0 years, however, the reported mean age is 14.9 years with a standard deviation of 2.4. Thus, the distribution is skewed to the left indicating a larger number of comparatively younger ages being reported for this stage (Figure 5.2).

The large variability in the data is also evidenced by the majority of indice-stages displaying several outliers, particularly in Stage 5. These extreme values are primarily to the left of the distribution; thus, similar to girls, the majority of outliers represent boys who are significantly younger than the median age of boys in that stage and, therefore, represent early-maturing boys. The data from these early-maturing adolescents are expected to have an impact on pubertal-stage data analyses, and is discussed in more detail below (see Pubertal Timing).

Table 5.6.

Median age and age range by pubertal development item and stage for boys (n = 203).

	Category Type & Items											
Stage	*n*	*Mdn*	*Min*	*Max*	*n*	*Mdn*	*Min*	*Max*	*n*	*Mdn*	*Min*	*Max*
	Description Items											
	Acne Stage				Voice Change Stage							
1	42	10.7	9.2	15.7	37	10.3	9.2	15.8				
2	73	14.1	9.4	17.0	33	12.8	10.0	16.8				
3	35	15.6	10.7	17.5	69	14.7	10.1	17.5				
4	40	16.0	9.6	17.6	46	16.0	11.3	17.6				
5	9	16.0	10.8	17.5	14	16.8	14.6	17.1				
Total	199	14.1	9.2	17.6	199	14.1	9.2	17.6				
	Pictorial Items											
	Genital Growth Stage				Body Hair Stage							
1	24	10.0	9.2	13.7	27	10.0	9.2	13.7				
2	21	12.3	10.0	15.9	25	12.4	10.0	16.2				
3	65	14.4	10.3	17.5	45	14.1	10.8	17.6				
4	61	15.1	10.7	17.6	69	15.7	11.3	17.5				
5	21	16.5	12.0	17.6	22	16.5	14.5	17.6				
Total	196	14.1	9.2	17.6	193	14.3	9.2	17.6				
	Historical Computation Items											
	Growth Spurt Stage				Skin Changes Stage				Spermarche Stage			
1	52	11.7	9.2	16.8	56	10.9	9.2	16.2				
2	37	13.7	9.8	16.9	41	13.6	10.0	16.0				
3	43	13.9	10.6	16.3	29	14.3	11.3	16.7	26	13.6	11.6	16.2
4	29	15.7	10.8	17.2	32	15.8	12.2	17.4	31	14.8	12.2	16.8
5	42	16.6	10.2	17.6	43	16.6	10.8	17.6	73	16.2	10.3	17.6
Total	203	14.1	9.2	17.6	201	14.1	9.2	17.6	130	15.7	10.3	17.6

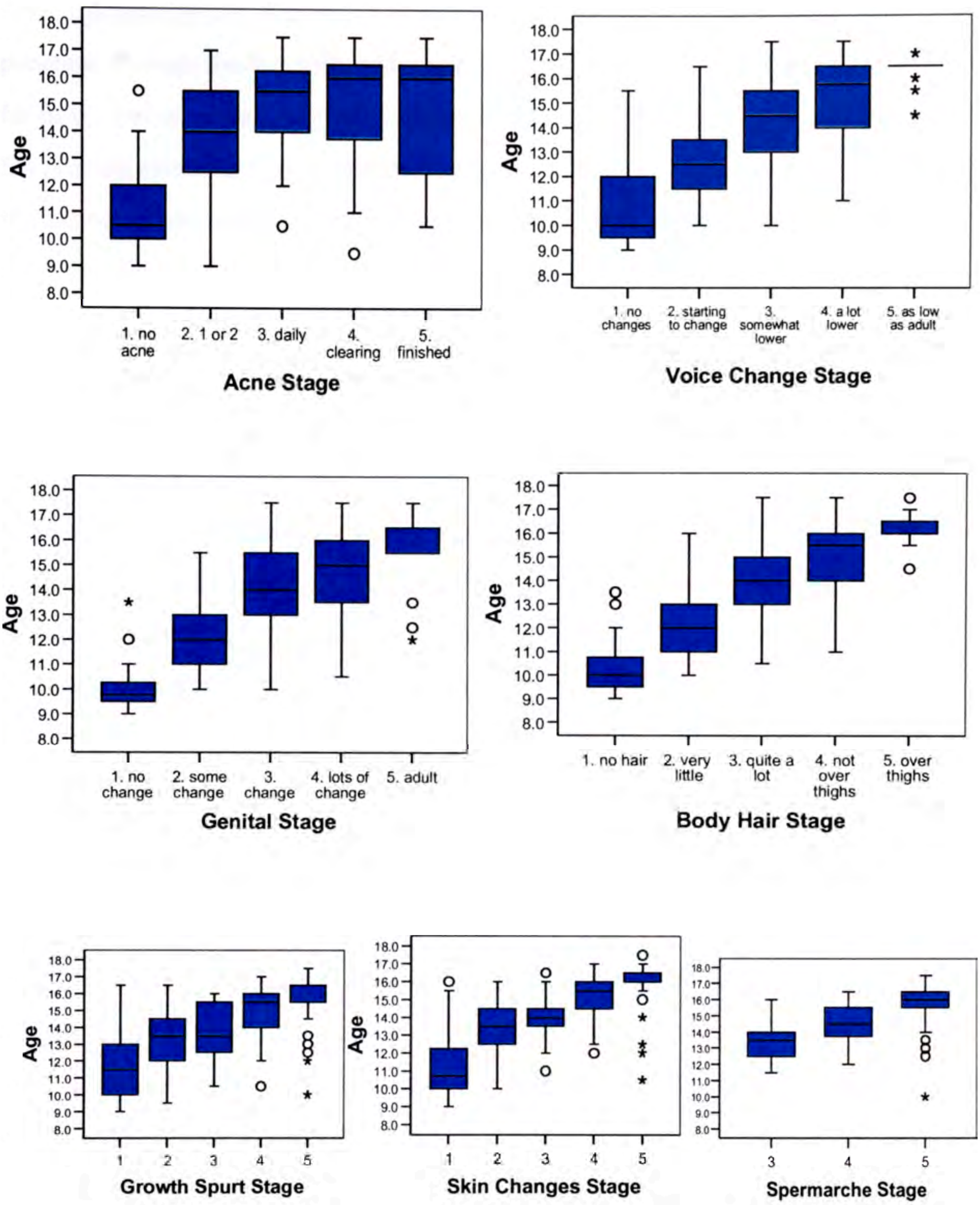


Figure 5.2. Median age and age range by pubertal indice stage for boys (n = 203). Box length is the interquartile range. Whiskers represent 95% confidence interval.

O represents cases with values between 1.5 and 3 box lengths from the upper or lower edge of the box.

***** represents cases with values more than 3 box lengths from the upper or lower edge of the box.

Across indices. Figure 5.2 illustrates the linear progression in boys' age as they progress through the five pubertal stages. Consistent with the data already presented for boys, and consistent with the reported mean age of onset for girls, Tables 5.5 and 5.6 provide evidence that boys reported progressing in a systematic fashion through the expected sequence of pubertal development events, (i.e. lower mean ages reported in each stage of the events expected to occur earlier). As reported in the literature (Bancroft, 2006; Hirsch et al., 1985; Kulin et al., 1989; Nielsen et al., 1986), for Stage 2 events, boys reported younger mean ages for first appearance of genital growth and body hair than for skin changes and growth spurt. Likewise, examination of the later stages reveals that boys reported older mean ages for specific later-occurring events. For example, Stage 4 voice-change and growth-spurt (i.e. peak height velocity) age reports were older than typical earlier-occurring events, such as body hair growth and spermarche. The only unexpected finding was the comparatively low mean age reported for Stage 5 of the acne item (14.9), which is further evidence of the unreliability of this item.

For all stages on all indices, the standard deviation in reported ages was between 1.0 and 2.0, with the exception of Stage 5 on some indices (i.e. acne, voice change, body hair); these reasonably small deviations from the mean indicate that the majority of boys (i.e. approximately 66%) reported ages that were within approximately one year of the reported mean age. Figure 5.2 illustrates that for each indice-stage, the majority of ages were clustered around the median; but the full range of ages reported was relatively large, ranging from approximately 2.5 years (mostly in Stage 5) to approximately 7.5 years. These results are consistent with the reports in the literature (e.g. Bancroft, 2006) citing that a large amount of variability exists between individuals in the age at which pubertal events occur.

Summary of distribution by pubertal stage for boys. Overall, the pubertal development data collected from the boys in this sample indicate that, although somewhat later than is reported generally in the literature, these boys reported following the typical progression of pubertal development events as expected. The Stage 5 outliers represent younger boys who have developed earlier than their peers. These findings are discussed in more detail below in the sections of this chapter that operationalizes pubertal onset age and pubertal timing.

Summary of Distribution by Pubertal Stage

These results indicate that initial data treatment procedures of placing adolescents into pubertal stages based on self-report is valid. By investigating each pubertal indice individually, it was determined that both the acne item, and the (*descriptive*) body-hair item should be dropped from further analyses; it was also concluded that the exclusion of these items did not remove any essential data as these items were redundant with the skin changes item, and the (*pictorial*) body-hair item, respectively.

Further supporting evidence for the typical progression of events is provided in a following section of this chapter, which operationalizes pubertal onset age from the reported mean age of onset for selected pubertal development events. But, first, the next section explains how the data from individual pubertal indices were combined to create a composite 'pubertal stage' variable for girls and boys separately to facilitate subsequent analyses.

Operationalizing Pubertal Stage

This section explains how a composite variable for pubertal stage was constructed, including which questionnaire items were included. Theoretically, a participant's overall pubertal status, or stage, can be computed by combining all pubertal indices and taking the average result. Initial attempts to complete this process revealed a few alternative solutions. Of primary relevance is the important role that discrete events, such as menarche and spermarche, represent, and the refinement of measurement by computing an average half-stage, rather than whole stage (i.e. Stages 1.0, 1.5, 2.0....4.5 in comparison to Stages 1.0, 2.0, 3.0, 4.0). These issues concerning operationalizing pubertal stage for both girls and boys are discussed below.

Exclusion of Pubertal Items

As described above, the examination of the distribution across and within pubertal stage for each indice revealed that the acne item and the *descriptive* (but not the *pictorial)* body hair item were not as reliable as other pubertal indice measures. Thus, the pubertal indice of body hair will be represented by the pictorial item in all future analyses.

Additionally, as stated earlier, there was reason to suspect that measurement error was high for this item, particularly for girls. This variability may best be explained by a large proportion of older girls placing themselves erroneously in the lower Stage 2 (just appearing) when in fact they were nearing completion. Because this pubertal indice was also measured with the skin changes item, acne was excluded from the computation of average pubertal stage in favour of the more reliable skin changes item for both girls and boys.

Thus, the items included in the computations of a composite pubertal stage item were growth spurt, body hair, and skin changes for both boys and girls, breast growth and menarche for girls, and voice change, genital growth, and spermarche for boys. As discussed below, two computations were performed to explore the effects of analyses with and without the menarche/spermarche indice.

Average Pubertal Stage

Whole Stage. Because of the manner in which puberty progresses, it cannot be expected that children will be in the same stage across all pubertal indices as they progress through puberty (Bancroft, 2006). Thus, it was necessary to compute an average stage across all indices for girls and boys respectively. Because menarche/spermarche represents a relatively late maturational event, no participants were coded as Stage 1 or 2; adolescents who had experienced menarche/spermarche were coded as Stage 3, 4, or 5 (refer back to Table 5.2). Thus, Average stage with and without the inclusion of menarche and spermarche was calculated to investigate any possible effects the absence of this data may have had on the respective variable, and these results are displayed in Table 5.7 separately for comparison purposes.

When an average stage was computed across all pubertal indices no participants were identified as Stage 5. The absence of Stage 5 participants is partially explained by the large variability in the data, but also by the absence of data being obtained from older-aged adolescents. Stage 5 represents a post-pubertal stage; although several adolescents in this sample were nearing completion of pubertal development, none reported a post-pubertal stage on all indices.

As was found when individual indices were examined in the previous section above, the data derived from this average stage computation indicates that children reported an older mean age at each stage indicating that they were progressing through pubertal development stages 1 through 4 with age (refer to Table 5.7). Averaging all pubertal indices across five pubertal stages resulted in an approximate equal number of children in each of the first four average-stages. In most cases, between approximately 20 and 30% of children were placed in each of Stages 1 to 3, and 15% of girls placed in Stage 4. This low representation in pubertal Stage 4 by girls is explained by the lower average age amongst girl participants (M = 13.0 years) in comparison to boys (M = 13.7 years).

Comparisons of the two average stage distributions (i.e. with and without menarche or spermarche) reveal that across pubertal stages there is little difference in the proportion of participants within particular stages, or in the average age within a stage. The only notable difference is that some older children (girls and boys) moved to a higher average stage when menarche and spermarche were included in the computation, which resulted in a slightly lower average age in the lower pubertal stages. The only noteworthy result of this shift, however, was an increase in the number of Stage 4 girls from 15.4% to 17.9% of the total sample of girls when menarche was included in the composite.

Table 5.7. Distribution and mean age of Average (Whole) Stage for girls and boys.

Distribution by Average (Whole) Stage								
Stage	*n*	%	*M*	*SD*	*n*	%	*M*	*SD*
				Girls				
	Average Stage excluding Menarche				Average Stage including Menarche			
1	29	23.6%	10.59	1.17	27	22.0%	10.40	.89
2	36	29.3%	12.90	1.06	37	30.1%	12.89	1.10
3	39	31.7%	14.46	1.31	37	30.1%	14.27	1.37
4	19	15.4%	14.98	1.39	22	17.9%	15.17	1.13
Total	123	100.0%	13.17	2.03	123	100.0%	13.17	2.03
				Boys				
	Average Stage excluding Spermarche				Average Stage including Spermarche			
1	45	22.2%	11.00	1.40	40	19.7%	10.73	1.22
2	56	27.6%	13.21	1.48	53	26.1%	12.99	1.50
3	61	30.0%	14.91	1.47	65	32.0%	14.76	1.40
4	41	20.2%	16.38	1.12	45	22.2%	16.38	1.08
Total	203	100.0%	13.87	2.34	203	100.0%	13.87	2.34

Thus, the evidence suggests that the measurement of average pubertal stage was not compromised by the decision to code only those adolescents who had experienced menarche or spermarche into Stages 3 and above. However, as highlighted above, this computation of an average stage based on the five 'whole' stages resulted in a restricted range of measurement for an average pubertal stage composite variable. Therefore, subsequent analyses were undertaken to compute a composite variable that is represented by pubertal half-stages as detailed in the next section.

Half-Stage. Because of the large variability of age between stages within individuals, averaging the pubertal indices across five stages resulted in a substantially lower average stage in comparison to some individual indices. Therefore, a composite pubertal half-stage variable was computed to allow identification of participants who placed at a comparatively higher stage than others (e.g. Half-Stage of 4.5 compared to Whole Stage 4.0). A composite half-stage variable also provides more refined measurement of participants' progression through pubertal stages by distributing measurement across eight pubertal half-stages (i.e. Stage 1.0 to Stage 4.5) in comparison to four whole-stages (i.e. Stage 1.0 to 4.0)

Table 5.8 displays the number and mean age of girls and boys by average half-stage calculated with and without the inclusion of the menarche and spermarche variables. On average the expected systematic progression through pubertal half-stages was observed. As with the composite average whole-stage variable, when menarche or spermarche was included in the analyses of average pubertal half-stage, no large fluctuations in the average age or the proportion of participants in a particular stage were observed.

Participants were also distributed fairly equally across the half-stages from approximately 12 to 20% in each half-stage, with the exception of Stage 1.5 and 4.5. For both girls and boys, less than 8% were placed in Stage 1.5 and less than 5% were placed in Stage 4.5. As discussed previously, the lack of participants in the highest stages (Stage 4.5 and Stage 5) is accounted for by the large variability in reported ages across indices within individual responses, and the lack of older-aged participants. The low proportion of participants placed in Stage 1.5 is probably best explained by the fact that children have either started (i.e. Stage 2.0), or not started (i.e. Stage 1.0) pubertal development. That is, children who report being in Stage 1 on one indice, most likely report being in Stage 1 on all other indices, whereas more advanced children may place themselves on Stage 2 on some indices, but Stage 3 on others, for example.

Summary of Operationalizing Pubertal Stage

Measurement reliability for pubertal development stage was improved by excluding the redundant and comparatively less reliable body hair and acne items. Participants were fairly equally distributed across the composite pubertal stages and these distributions were unaffected by the decision to code only those adolescents who had experienced menarche or spermarche into Stages 3 and above. The observed incremental progression through stages suggests that average pubertal stage

Table 5.8. Distribution and mean age by Average (Half) Stage for girls and boys.

	Distribution by Average (Whole) Stage							
Stage	*n*	%	*M*	*SD*	*n*	%	*M*	*SD*
	Girls							
	Average Stage excluding Menarche[5]				Average Stage including Menarche[6]			
1.0	20	16.3%	10.1	0.76	18	14.6%	10.1	0.80
1.5	9	7.3%	11.7	1.19	9	7.3%	11.0	0.74
2.0	16	13.0%	12.8	1.15	12	9.8%	13.0	1.20
2.5	20	16.3%	13.0	0.99	25	20.3%	12.9	1.07
3.0	23	18.7%	14.2	1.52	17	13.8%	13.9	1.64
3.5	16	13.0%	14.8	0.86	20	16.3%	14.6	1.01
4.0	18	14.6%	15.0	1.43	16	13.0%	15.0	1.28
4.5	1	0.8%	14.9	-	6	4.9%	15.5	0.47
Total	123	100.0%	13.2	2.03	123	100.0%	13.2	2.03
	Boys							
	Average Stage excluding Spermarche[7]				Average Stage including			
1.0	29	14.3%	10.7	1.46	24	11.8%	10.0	1.03
1.5	16	7.9%	11.6	1.14	16	7.9%	11.5	1.13
2.0	26	12.8%	12.7	1.74	26	12.8%	12.3	1.60
2.5	30	14.8%	13.7	1.05	27	13.3%	13.6	1.09
3.0	29	14.3%	14.2	1.51	34	16.7%	14.1	1.25
3.5	32	15.8%	15.5	1.13	31	15.3%	15.5	1.15
4.0	32	15.8%	16.3	1.23	36	17.7%	16.3	1.17
4.5	9	4.4%	16.8	0.47	9	4.4%	16.8	0.47
Total	203	100%	13.9	2.34	203	100.0%	13.9	2.34

[5] Calculated on 5 variables (Growth, Skin Changes, Acne, Breast, Pubic Hair)

[6] Calculated on 6 variables (Menarche, Growth, Skin Changes, Acne, Breast, Pubic Hair)

[7] Calculated on 6 variables (Growth, Skin Changes, Acne, Voice Changes, Genital, Pubic Hair)

[8] Calculated on 7 variables (Spermarche, Growth, Skin Changes, Acne, Voice Changes, Genital, Pubic Hair)

measurement across indices is reliable and valid. By computing a composite pubertal half-stage, rather than whole-stage variable, the measurement of average stage across pubertal indices was refined and improved. Thus, for all future reference to pubertal development stage in the current study, average stage refers to average half-stage and is computed as including menarche and spermarche.

Construct Validity and Measurement Reliability

The best method of determining construct validity for adolescent self-reports of pubertal development status is comparisons with physician ratings. This was not possible in the current study, therefore a test of external validity was obtained by comparing adolescents' self-reports with published normative data, and is discussed later in a following section of this chapter (see Pubertal Onset Age). The majority of reviewed studies relied on tests of internal consistency to test validity of the measured pubertal development construct (e.g. Canals et al., 2005; Petersen et al., 1988). Thus, the current section focuses on the measurement validity and reliability of the construct of pubertal development.

Great care was taken to ensure the validity of pubertal development measurement by reviewing the previously published literature to ensure that the construct was operationalized correctly and that the appropriate measures were obtained. Another key aspect of developing the pubertal development instrument was to include questions that were presented in various formats. For example, some questions asked for an age that a particular event occurred, whereas others provided a multiple choice format, both in descriptive wording, and in pictorial format. This multiple-method approach to measurement increases construct validity (see Cook & Campbell, 1979).

Participant-Response Reliability (Construct Validity)

Thus, evidence for construct validity of pubertal development is provided by the consistency of stage between participants' self-reports on descriptive and pictorial items, and the computed historical items. For example, a child who reported that a growth spurt occurred 15 months previously (growth spurt Stage 3), also placed herself in Stage 3 breast changes, and reported menarche as having occurred less than 12 months previous (Stage 3). Undoubtedly, this was not the case in all instances, and most participants placed themselves in more than one stage when reporting across all indices. However, placement variability was usually dispersed between adjacent stages; this type of variability is to be expected, as a large amount of within-individual differences exist in the progression through stages to physical maturity.

Correlations (Spearman's rho, one-tailed) between adolescent ratings on each pubertal development variable were performed to test participant-response reliability (Table 5.9). Correlations were performed separately for boys and girls. For girls, self-ratings on each of the five variables were significantly correlated with each other (all p-values $< .001$, $r =$ between .319 and .748). For boys, self-ratings on six pubertal development variables were also significantly correlated with each other (all p-values $< .001$, r between .264 and .707). The relatively large correlations between variables suggests that girls and boys demonstrated internal consistency when making their self-ratings, with girls reporting slightly, but not significantly more consistently than boys.

For girls, comparatively higher correlations were found between the three indices, skin changes, and breast, and body hair growth. Similarly, for boys, comparatively higher correlations were found between the three indices, skin changes, and genital, and body hair growth. Comparatively lower correlations for girls were found between growth spurt and all other indices, and for boys, between spermarche and voice change, and genital growth. A possible explanation for these comparatively lower correlations may be that the historical computation values for growth spurt and for spermarche were not adequately defined, resulting in increased measurement error. However, the low correlations on these items may also result from the high number of missing values on these indices. For example, Stage 1 and 2 boys were not coded on spermarche, and older participants were less able to recall an age of growth spurt (see Pubertal Onset section). Regardless, it appears that, overall, the pubertal development measures used in this study demonstrate good construct validity.

Table 5.9. Correlations between pubertal indices for girls and boys.

	Pubertal Stage Indice				
Girls		*Pubic Hair Stage (n = 119)*	*Growth Spurt Stage (n = 119)*	*Skin Changes Stage (n = 119)*	*Menarche Stage (n = 75)*
Breast Stage		.748**	.319**	.646**	.406**
Pubic Hair Stage			.353**	.641**	.470**
Growth Spurt Stage				.401**	.343**
Skin Changes Stage					.538**
Boys	*Genital Stage (n = 192)*	*Pubic Hair Stage (n = 184)*	*Growth Spurt Stage (n = 188)*	*Skin Changes Stage (n = 188)*	*Spermarche Stage (n = 125)*
Voice Change Stage	.621**	.680**	.517**	.569**	.394**
Genital Stage		.667**	.436**	.580**	.264**
Pubic Hair Stage			.558**	.707**	.454**
Growth Spurt Stage				.650**	.498**
Skin Changes Stage					.574**

** Correlation is significant at the 0.001 level (1-tailed).

Internal Reliability

The internal consistency of the pubertal development measures was assessed by computing Cronbach's coefficient alpha. Item-total and inter-item correlations, as well as alpha coefficients, were computed for girls and boys separately on pubertal items (Table 5.10). Item-total correlations for girls ranged from .34 to .60, with an alpha of .755 and for boys, ranged from .47 to .69, with an alpha of .817. For girls, the inter-item correlations ranged from .099 to .555 with a mean of .359, and a median of .370 (Table 5.11). For boys, the inter-item correlations range from .253 to .620 with a mean of .427, and a median of .387 (Table 5.11).

Table 5.10. Pubertal Development Measure item-total correlations, Cronbach's alpha, and scale characteristics for girls and boys.

Girls

	*Cronbach's Alpha**	*Mean*	*Variance*	*Std. Deviation*	*N of Items*
Total Scale	.755	18.00	15.913	3.99	5

Scale Items	*Scale Mean if Item Deleted*	*Scale Variance if Item Deleted*	*Corrected Item-Total Correlation*	*Squared Multiple Correlation*	*Cronbach's Alpha if Item Deleted*
Breast Stage	14.27	11.45	.455	.352	.695
Body Hair Stage	14.51	10.89	.569	.387	.655
Growth Spurt Stage	14.96	10.48	.340	.177	.767
Skin Changes Stage	14.44	9.87	.600	.403	.635
Menarche Stage	13.81	11.69	.596	.388	.660

Boys

	*Cronbach's Alpha**	*Mean*	*Variance*	*Std. Deviation*	*N of Items*
Total Scale	.817	22.11	20.036	4.48	6

Scale Items	*Scale Mean if Item Deleted*	*Scale Variance if Item Deleted*	*Corrected Item-Total Correlation*	*Squared Multiple Correlation*	*Cronbach's Alpha if Item Deleted*
Voice Change Stage	18.73	15.64	.467	.274	.795
Genital Stage	18.46	16.15	.474	.333	.794
Body Hair Stage	18.33	15.64	.584	.389	.775
Growth Spurt Stage	18.62	12.35	.615	.472	.768
Skin Changes Stage	18.64	11.75	.686	.529	.747
Spermarche Stage	17.78	15.21	.668	.490	.761

*Cronbach's Alpha Based on Standardized Items

Table 5.11. Pubertal Development Measure inter-item correlations for girls and boys.

Girls	Breast Stage	Body Hair Stage	Growth Spurt Stage	Skin Changes Stage	Menarche Stage
Breast Stage		.531	.099	.429	.370
Body Hair Stage			.277	.412	.464
Growth Spurt Stage				.351	.326
Skin Changes Stage					.555

Boys	Genital Stage	Body Hair Stage	Growth Spurt Stage	Skin Changes Stage	Spermarche Stage
Voice Change Stage	.437	.372	.343	.313	.359
Genital Stage		.483	.253	.387	.286
Body Hair Stage			.369	.495	.473
Growth Spurt Stage				.620	.598
Skin Changes Stage					.612

These alpha values indicate that participants were consistent in their reports of pubertal change across indices. However, the low inter-item correlations indicate that some variables were highly correlated with some, but not the majority, of the other items (e.g. breast and body hair growth with growth spurt for girls). However, no one item was found to be particularly poor in this case, as no improvement was found by deleting any of the items from the total scale. Therefore, the items used to measure the level of attainment of pubertal development have reasonable internal reliability.

Pubertal Onset Age

The primary objective of this section is to describe how a pubertal onset age was computed for the purposes of investigating the relationship between pubertal onset and first participation in ASB. This section begins by examining the validity of 'pubertal onset' measurement by means of comparisons with other adolescent samples before describing how pubertal onset age was computed for the purposes of the current study.

As mentioned previously (see Typical Progression of Events section), the published literature states that pubertal development measurement typically contain variations of at least one year in either direction on any indice; this measurement variation is particularly influenced by nationality, socioeconomic status, and race differences (see Ellis, 2004). The majority of the pubertal development literature reviewed was conducted with American and British adolescents. It was expected that Australian adolescents would follow the same typical progression of events, at approximately the same ages, as reported in the reviewed literature.

Sample Comparisons

Several studies investigating the measurement of pubertal stage and pubertal timing have been published (see Coleman & Coleman, 2002 for a review). However, very few of these studies have published normative age data by pubertal *stage*. A standard method used by physicians to classify adolescents by pubertal stage is by a physical examination comparison to Tanner's photos of breast and genital growth stage (see Dorn et al., 1990). However, the majority of these studies report only on the mean age of onset (i.e. age at entry into Stage 2) on a few selected indices (see Coleman & Coleman, 2002 for example). An exception to this practice is a study by Dorn and colleagues (1990), and a separate, subsequent study by Dorn and colleagues (1999). Dorn et al. (1990) published data from physician ratings of girls and boys (breast and genital growth) for mean age by pubertal stage, and Dorn and colleagues (1999) reported the distribution of girls by menarcheal status according to Tanner's (breast growth) stages.

The mean age (including standard deviations) by pubertal stage for three indices (menarche, breast growth, genital growth), for the current study and from the above-noted two published studies are displayed in Table 5.12. The most noteworthy difference between the samples is the older ages of menarcheal girls in the current study in comparison to the Dorn et al., (1999) sample. However, a principal difference exists between these two samples in that the girls in the current study were classified into menarche stage based on how many months had passed since the first presence of menses, whereas, in the Dorn et al. (1999) study, menarcheal girls were classified into pubertal stage by Tanner's breast stage. This difference in classification procedure may explain the fact that (across all three stages) girls in the current study reported mean ages that were between 1 and 1.5 years older than in Dorn et al. 1999.

Table 5.12. Comparison of mean age on menarche, breast, and genital growth by pubertal stage for current study.

Stage	*n*	*M*	*SD*	*n*	*M*	*SD*
	Current Study			Dorn et al, 1999 (physician ratings)		
			Menarche (girls only)			
3	24	13.17	1.34	11	12.12	1.08
4	18	14.18	1.47	8	12.88	0.71
5	34	14.98	1.32	9	13.87	0.68
Total	76	14.23	1.55	28	12.00	1.60
	Current Study			Dorn et al, 1990 (physician ratings)		
			Breast Growth (girls only)			
1	24	10.30	0.84	9	10.04	0.70
2	26	12.45	1.13	14	12.75	1.04
3	28	13.97	1.55	8	11.15	1.17
4	20	14.74	1.22	9	12.32	0.72
5	22	14.75	1.12	9	13.87	0.69
Total	120	13.18	2.05	49	-	-
	Current Study			Dorn et al, 1990 (physician ratings)		
			Genital Growth (boys only)			
1	24	10.27	1.07	9	10.96	0.93
2	21	12.29	1.61	14	12.75	0.98
3	65	14.39	1.76	6	12.79	0.85
4	61	14.82	1.72	5	13.32	1.04
5	21	16.08	1.48	12	13.39	0.91
Total	196	13.90	2.34	46	-	-

Another likely explanation for the reported older ages by girls in the current study is that the sample from the current study included girls from a wider (and older) age range. The oldest girls in Dorn et al.'s (1999) study were 14 years of age (compared to 16 years in the current study). Similarly, the sample in Dorn et al.'s (1990) study also included a younger age range (girls, 9 – 14 years; boys, 9 – 15 years) than the current sample (girls, 9 – 16 years; boys, 9 – 17 years). The younger age range in Dorn et al.'s 1990 study may explain why, similar to the menarche indice, a younger mean age is reported for girls and boys on the breast and genital growth indices (respectively) in the later pubertal stages (i.e. Stage 3 – 5) in comparison to the current study (refer to Table 5.12).

The younger age range in the Dorn et al. (1999; 1990) studies also accounts for the (slightly) smaller standard deviations from the mean in each indice-stage. Further evidence for the likelihood that the age-range differences account for the small discrepancies in mean age between the current study and previously reported studies is found by comparing the mean ages reported for the *earlier* (i.e. Stage 1 and 2) pubertal stages across both the breast and genital growth indices. As displayed in Table 5.12, the differences in girls' reported mean age are less than .3 of one year, and for boys, less than .5 of one year across Stage 1 and 2 for both indices.

It was concluded that the reported mean ages (and standard deviations) by pubertal stage for the three indices are broadly comparable between the current study and the published research. Thus, these findings provide good evidence for using reported age of first occurrence of an event as an 'onset age' for the pubertal event. The next section describes how pubertal onset age was computed from selected pubertal indices, including comparative descriptive data for onset age on these indices.

Operationalizing Pubertal Onset Age

Pubertal onset age was computed as the average age from self-reported age on growth spurt, skin changes, and menarche indices for girls, and growth spurt, skin changes, and spermarche indices for boys. For girls and boys separately, self-reports of mean age on each pubertal onset indice was compared to what the published literature reports as an average age of onset for the particular event. This section then concludes with an examination of the distributions for the computed composite pubertal onset age variable.

Pubertal Onset Indices

Girls. Previously published reports (for example, HermanGiddens et al., 1997; Kaiser & Gruzelier, 1999; Paikoff & Brooksgunn, 1991), indicate that girls typically experience a growth spurt anywhere between the approximate age of 9.5 and 12 years, skin changes at the approximate age of 10.5, and the onset of menses at an approximate age of 12.5 to 12.8 years. In comparison (see Table 5.13), the girls in the current sample reported skin changes and a growth spurt at a mean age of 11.7 years, and menarche at a mean age of 12.3 years. The girls in this sample, on average, reported an onset age for growth spurt and skin changes that was within one year of previously reported data, and a comparable (slightly younger) mean onset age for menarche. From these previously published studies it is evident that there is much variability in onset-age reports; thus, the reports for mean age of onset in the current study (on these three indices) can be considered consistent with previous reports.

Boys. The reported mean age of onset for growth spurt (12.4 years), skin changes (12.6 years), and spermarche (12.8 years) for boys in the current study is displayed in Table 5.13. Similar to the findings with girls, the presented data from published studies indicates that there is some variability in mean onset-age reports for the growth spurt and skin changes indices for boys (12 to 14 years); thus, the reported mean age in this study on these indices is comparable to the published research. The mean age of spermarche reported by boys in the current study is one year younger that the mean reported by Kaiser and Gruzelier (1999); however, it is within the average age reported generally for this indice (12 – 14 years; Paikoff & Brooksgunn, 1991).

Table 5.13. Mean age comparisons for onset of growth spurt, skin changes, and menarche/spermarche.

	Pubertal Indice Mean Ages for Current and Published Research			
Pubertal Indice	Current Study	Paikoff & Brooks-Gunn, 1991	Kaiser & Gruzelier, 1999	Herman-Giddens et al, 1997
		Girls		
Growth Spurt	11.7	9.6	12.2	10.0
Skin Changes	11.7	10.5	-	-
Menarche	12.3	12.5	12.8	12.8
		Boys		
Growth Spurt	12.4	11.7	14.0	-
Skin Changes	12.6	12 - 14	-	-
Spermarche	12.8	12 - 14	13.7	-

Composite Pubertal Onset Variable

Figures 5.3a and 5.3b display the distribution of the average (composite) pubertal onset age computed from the three indices discussed above for girls and boys respectively. Because only high school participants were provided the menarche and spermarche items, and because not all respondents provided a response on all three indices, only 49 girls and 72 boys were included in the computation of this variable. Although over 40% of girl respondents (n = 20) reported a composite pubertal onset age of 12 years, girls reported pubertal onset as occurring anywhere between the ages of 9 and 14 years. Likewise, although almost 70% of boy respondents (n = 49) reported a composite pubertal onset age of either 12 or 13 years, boys reported pubertal onset as occurring anywhere between the ages of 10 and 15 years.

Summary of Pubertal Onset Age

The mean age for pubertal onset for girls was 12.1 years (SD = 1.24), and for boys was 12.5 years (SD = 1.10). This composite pubertal onset age variable will be used in future analyses investigating the relationship between age of pubertal onset and age of peak antisocial behaviour participation. One final pubertal development variable was operationalized for the purposes of examining the possible effects of pubertal timing on executive functioning and, consequently, antisocial behaviour participation. The next section describes how early- developers and late-developers were differentiated from those adolescents who matured on- time.

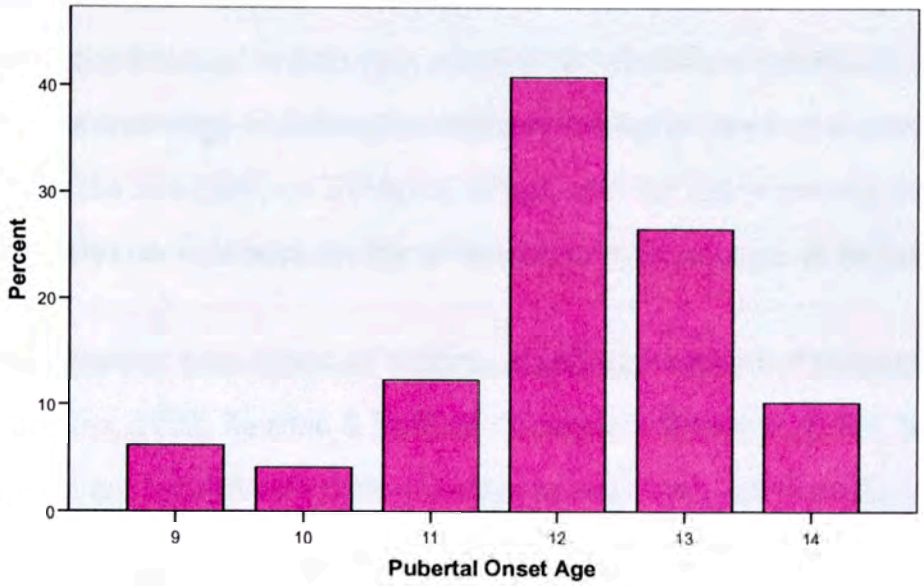


Figure 5.3a. Percent of girls by self-reported age of pubertal onset.

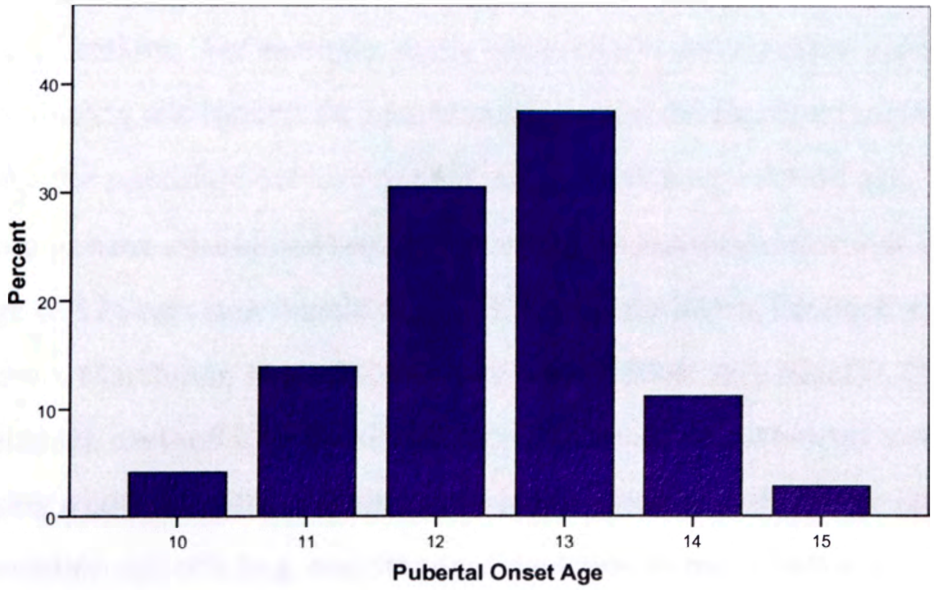


Figure 5.3b. Percent of boys by self-reported age of pubertal onset.

Pubertal Timing

Pubertal stage is an absolute measure of the level of physical maturity that an individual has reached, whereas pubertal timing is a relative measure, measuring individual differences in the physical maturity level reached compared to one's same-age peers (Dubas, Graber, & Petersen, 1991). Outside of genetic differences, there are many psychosocial factors that account for why these individual differences exist in physical maturity, including the delaying effects of stress, the accelerating effects of stress, the absence of a biological father, and the presence of a non-biological father figure (for an extensive review of these potential sources of variation see Ellis, 2004).

Many studies have relied on reports of self-perceptions of pubertal timing (e.g. Piquero & Brezina, 2001; Rierdan & Koff, 1984; Sanders & Soares, 1986), however, these self-reports are less reliable than objective assessments, particularly in the younger ages where there is a lack of comparison criteria (Dubas et al., 1991). The current study allows for comparisons within and across age groups on a number of pubertal indices to classify participants into one of three pubertal timing categories: 'early', 'on-time', or 'late'.

A number of methods have been used to place adolescents into these three distinct classifications. For example, many researchers have assessed pubertal timing by comparing self-reports on a particular pubertal development marker, (e.g. menarche) with the published normative data, and establishing a cut-off age. For example, some studies have operationalized 'early-timing' as pubertal onset that occurs prior to the age of 12 years (see Angold et al., 1998; Kaltiala-Heino, Kosunen et al., 2003; Kaltiala-Heino, Marttunen et al., 2003). However, another very popular, (and arguably more reliable), method is to classify participants based on within-sex sample distributions using a cut-off method of either the top and bottom 20% of the sample, or standard deviation cut-offs (e.g. one standard deviation or more below the mean is 'early'). The 20% cut-off method allocates 20% of the sample to the early and 20% to the late classifications respectively, and 60% of the sample is classified as on-time (Brooksgunn, Petersen, & Eichorn, 1985; Brooksgunn & Warren, 1985; Caspi & Moffitt, 1991; Obeidallah, Brennan, Brooks-Gunn, & Earls, 2004). The 'standard deviation' method allocates approximately the bottom one-sixth of the sample to the 'early' classification, the top one-sixth to the 'late' classification, and the middle two-thirds (e.g.~66%) to the 'on-time' classification (see Dubas et al., 1991; Romans et al., 2003; Williams & Dunlop, 1999).

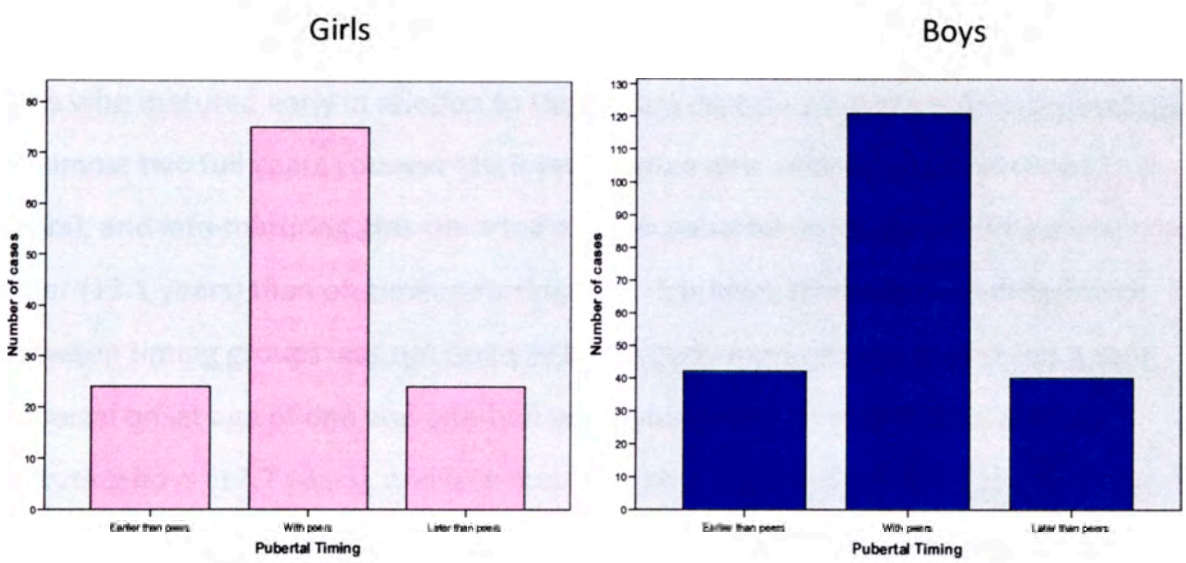
Operationalizing Pubertal Timing

'Early' Pubertal Timing Classification

Applying the standard deviation method of classification, early-timers in the current study were identified through a series of steps. First, any child who reported an age that was below one standard deviation from the mean on any one or more of the pubertal development indices was identified. This resulted in over 41% of both girls and boys identified as early on at least one pubertal development indice. The pubertal indices included were the computed composite of average stage, as well as growth spurt, skin changes, and body hair growth for both, girls and boys, plus menarche and breast growth for girls, and spermarche, voice change, and genital growth for boys. This classification resulted in an identification of over 40% of the sample as early, which suggested that classification according to identification on only one indice was too inclusive. Thus, to remain consistent with the previous literature and to obtain more representative classification, a decision was made to indentify as early only those children who were classified as early according to the following rules: 1) early on the computed average stage indice, or 2) early on three or more indices *or* early on two or more indices in which menarche/spermarche is one of the indices. On this basis, 19.5% of the girls (n = 24), and 20.7% of the boys (n = 42) were classified as early-timers.

'Late' Pubertal Timing Classification

As with early-timers, a large percentage of girls and boys were identified as late on at least one pubertal development indice (girls = 45.5%; boys = 39.9%). Therefore, late-timers were identified and categorised in the same manner as early-timers (see above). As a result, late-timers in this sample are comprised of 19.5% of the girls (n = 24), and 19.7% of the boys (n = 40). Thus, this sample has an equal proportion of early to late-developing girls (19.5%), and an approximately equal proportion of early (20.7%; Figure 5.4a) to late-developing boys (19.7%; Figure 5.4b). Furthermore, although these proportions are somewhat higher than 1/6 of the sample (i.e. 16.7%), the numbers are consistent with the method of selecting the most extreme 20% at either end of the distribution for timing classifications.



Figures 5.4a and 5.4b. Number of cases by pubertal timing group for girls and for boys.

Sample Distribution

Cross-validation of both the pubertal timing and the pubertal onset age measures were established by examining the mean pubertal onset age by pubertal timing classification. For those adolescents who were included in the computation of a pubertal onset age, Table 5.14 displays the distribution of number and percent of girls and boys by pubertal timing classification, as well as the mean age of pubertal onset for each group. The pubertal timing distributions for pubertal onset age are almost identical to the above computations based on pubertal stage. For both girls and boys, approximately 20% of adolescents were identified as early or late-maturing in relation to their peers. The small standard deviations indicate that the majority of adolescents within pubertal timing groups reported a pubertal onset age that was within approximately one year of the reported mean age.

Table 5.14. Distribution by pubertal timing groups for girls and boys.

	Girls				Boys			
Pubertal Timing	*n*	%	*M*	*SD*	*n*	%	*M*	*SD*
Earlier than peers	10	20.4	10.5	1.27	16	22.2	11.3	0.77
With peers (on-time)	29	59.2	12.3	0.80	41	56.9	12.7	0.74
Later than peers	10	20.4	13.1	0.74	15	20.9	13.0	1.25
Total	49	100.0	12.1	1.24	72	100.0	12.5	1.08

Girls who matured early in relation to their peers reported a mean pubertal onset age of almost two full years younger (10.5 years) than girls who matured on-time (12.3 years), and late-maturing girls reported a mean pubertal onset age of almost one year older (13.1 years) than on-time maturing girls. For boys, the mean age-differences between timing groups was not quite as large; early-maturing boys reported a mean pubertal onset age of one and one-half years younger (11.3 years) than on-time maturing boys (12.7 years), and late-maturing boys reported a mean pubertal onset age that was little more than one-quarter of a year older (13.0 years) than on-time maturing boys.

Summary of Pubertal Timing

The identification of "early" developers is particularly salient to the current study as in addition to finding a relationship between the onset of puberty and age of peak participation in antisocial behaviour, it has also been hypothesized that an additional relationship exists in which those adolescents who mature early, participate in antisocial behaviour at a higher rate, and for a longer length of time, than those who mature "on-time" or "late". Thus, it is expected that the girls and boys identified here as "early" will begin participation in antisocial behaviour significantly earlier, participate in a significantly larger proportion of antisocial behaviours, and continue participating in antisocial behaviours for significantly longer than their "on-time" or "late" peers. Before investigating these hypotheses, the next two chapters describe how the other constructs under investigation (antisocial behaviour/attitudes and executive function) were operationalized. The next chapter in this section will examine the characteristics of the sample in regards to antisocial attitudes and antisocial behaviour participation, including age and sex differences.

Chapter 6: Antisocial Behaviour and Antisocial Attitude Variables

Antisocial behaviour (ASB), and antisocial attitudes (ASA) were measured via self-report on two separate questionnaires (Appendices 3.3 and 3.2). To protect the validity of responses, participants were reminded that their responses were completely confidential and anonymous, and that they did not have to answer any part of the questionnaires if uncomfortable with reporting on aspects of their own antisocial activity. This chapter will examine the measurement validity and reliability of these two constructs and describe how they were operationalized for the purposes of the current study. Similar to the previous chapter, this chapter will also describe the data set in terms of how it was distributed within the various operationalized measures of ASB and ASA, along with group differences.

The ASB and ASA questionnaires were described briefly in Chapters 3 and 4 (Materials section). This chapter will describe the two types of questionnaires in further detail with particular attention to item-selection and scale construction to accommodate sex and age differences. As with the pubertal development measure, the younger participants (i.e. primary school, approximate ages 9 – 12 years) in the sample were not asked to respond to the full range of items on ASB/ASA measures. Therefore, this chapter will distinguish measures which were included in all age groups and measures which were not recorded for primary-school participants.

To facilitate hypothesis testing, several ASB/ASA measures were computed from participants' responses, and will be described in detail in the first section of this chapter. A total ASB score (Cumulative ASB) was computed from all participant responses and was used to investigate hypothesized relationships between pubertal timing and 'persistent' ASB participation. To investigate the hypothesized relationship between current pubertal stage and current ASB, a Current ASB score was computed from high-school participants' responses. High-school participants' responses were also analyzed to compute an age of peak-ASB participation and the first-age of any ASB participation. These ASB variables were computed primarily for the purposes of investigating whether executive functioning mediates a relationship between pubertal development and antisocial behaviour. In conjunction with examining sex and age distributions, additional hypotheses investigated the relationships between the ASB measures. These tests provide further evidence for the validity of ASB measurement, and replicate previous research findings regarding trends and patterns in antisocial behaviour (e.g. Baker, 1998; Blumstein et al., 1985; Farrington, 1986; Freeman, 1996; Smart et al., 2004).

Additional hypothesis testing includes (but is not limited to) investigations of relationships between adolescents' self-reported antisocial behaviour and reports on their own antisocial attitudes. Although ASB and ASA are two distinct constructs, it is expected that participants' scores on these measures will be positively correlated, and that both ASB and ASA will be associated with pubertal development stage and timing. The second part of this chapter will examine the construct validity of ASA and the reliability of measurement across age and gender.

Antisocial Behaviour

The ASB questionnaires developed for use with participants were modified from Mak's 40-item Self-Reported Behaviour Scale (SRBS, 1993; Appendix 6.1). The SBRS contains four lie-scale items (e.g. "Have you ever…Lied to a friend?") and two construct validity items (e.g. …"Been warned by the police…") in addition to 34 items relating to a range of antisocial behaviour (e.g. truancy, shoplifting, assault, and alcohol and drug use). For each item, in the SRBS, respondents indicated whether they had participated in the behaviour in the past 12 months. Mak's SRBS was validated on a delinquent, and a non-delinquent, sample of adolescents. The non-delinquent sample comprised 63 boys (61%) and 43 girls (39%), between the ages of 13 and 18 (n = 103), selected from Canberra high schools.

Measurement Validity and Reliability

The need to design valid, and consistent, measures of antisocial behaviour (ASB) for both boys and girls across an age span of 9 to 17 years necessitated the development of three versions of the questionnaires (see Appendices 4.4a and 4.4b for high-school boys, high-school girls, and primary-school ASB questionnaires). For each ASB item, high-school girls and boys reported whether they had ever participated in the behaviour, and if they had, whether they had participated in this behaviour in the past 12 months, and the age they were the first time they participated. Primary-school girls and boys only reported on whether they had every participated in the behaviour.

Scale Construction and Validity

Scale Construction. The questionnaires developed for use with high-school girls and high-school boys were almost identical, and differed only in that six additional items were included in the girls' questionnaire (girls = 60 items; boys = 54 items). To meet ethics committee approval for administration to primary-school participants, some items were removed or reworded because they were deemed inappropriate for the younger-aged group of participants. Thus, primary-school girls and boys completed a substantially shorter version (40 items) than high-school boys (54 items) and girls (60 items). Although high-school participants responded to approximately 50% more items than the primary-school participants, the two forms of the questionnaire were designed so that relative to the total number of items in each questionnaire, both contained approximately the same proportion of items that were similar in behaviour type (e.g. assault vs graffiti) and seriousness level (e.g. shoplifting vs motor vehicle theft). This was achieved by slightly modifying some items to contain more age-appropriate content for the younger-aged participants in primary school. For example, the item, "Bought beer, wine, spirits or other kinds of liquor?" was replaced with "Drank alcohol without parent's permission?", "Used LSD?" was replaced with "Smoked cigarettes?", and "Forced someone to do sexual things?" was replaced with "Intentionally hurt an animal?".

ASB Severity-Level. Like Mak's SRBS, the ASB questionnaires included a wide variety of ASB items to the full range of types and severity of antisocial behaviour. For analyses investigating the age of first participation and age of peak participation in ASB, an ASB measure that reflects differences in the severity-level of ASB (Total ASB) was critical. Thus, consistent with previous studies investigating relationships between pubertal development and antisocial behaviour (see for example Caspi et al., 1993 ; Caspi & Moffitt, 1991) for comparative purposes in the current study, ASB items were categorized into four ASB levels, which were weighted for the severity of the behaviour. In this four-level categorization, Level 1 items comprised minor delinquent acts, such as "Not attended classes or jigged school?" and "Smoked cigarettes?". Level 2 items comprised comparatively more serious delinquent acts (e.g. status offences), minor theft, and drug use, such as "Purchased alcohol", "Stolen under $10", and "Used marijuana". Level 3 items comprised behaviours that may be considered 'serious antisocial and illegal behaviour', such as theft, property damage, and aggressive acts. Examples of these items include "Taken someone's wallet or purse?", "Purposely damaged property by setting a fire?", and "Used or threatened to use force to get money/things from another person?". Level 4 items include those behaviours which are considered serious criminal activity. Examples of these items include "Used a weapon in a fight?" and "Taken and driven a car without the owner's consent?".

Content and Construct Validity. For the most part, content and construct validity for the ASB questionnaires was established by Mak's 1993 study with the Self-Reported Behaviour Scale. Content validity was obtained for the SRBS by the inclusion of four lie-scale items (e.g. "Have you ever done something that your parents did not want you to do?"). Content validity was further assessed by selecting items from a list of common types of juvenile offences provided by police officers and other legal authorities responsible for young offenders, and thirdly, construct validity of the SRBS was tested by correlating individual's scores with self-reported police contacts ("Appeared in Children's Court for something you did" and "Been warned by the police?"). Mak found that total delinquency scores were positively associated with self-reported contacts with the police for boys ($r = .49$, $p < .0001$), and girls ($r = .46$, $p < .0001$). In addition, Mak observed a coefficient alpha of .88 indicating that the scale had satisfactory internal reliability. The inclusion of additional items for the current study required that similar tests be performed with the modified versions of Mak's SRBS to establish validity and reliability of ASB measurement for the current study.

Correlational Analysis. Similar to Mak's (1993) study, construct validity was tested by correlating participant's total scores with self-reported police contacts. In addition to police-contact items mentioned above, participants were also asked if they had been convicted of a crime. None of the participants reported having been convicted, and no high school participants reported appearing before Children's Court (endorsements on this item by two primary school participants were excluded as they were considered unreliable). However, 10.8% of high school girls ($n = 9$), 12.6% of high school boys ($n = 18$), and 8.9% of primary school girls and boys ($n = 8$) reported that they had been warned by the police; point biserial correlation revealed a significant relationship between self-reports of police warnings and total ASB score (rho = .407; $p < .0001$), indicating that participants reporting police warnings had higher scale scores than those who reported no police warnings, providing support for scale construct validity.

Item-frequency Analysis. Although the majority of additional items were derived from scales used in previous studies (Elliott, Dunford, & Huizanga, 1987; Kazdin & Esveldt-Dawson, 1986; Kulik, Stein, & Sarbin, 1968; Leblanc & Frechette, 1989), some items were included at the suggestion of school principals. Thus, following removal of the four lie-scale and three police-contact items, content validity was tested further with item-frequency analysis. Table 6.1 displays, for each level, the ASB items retained for analysis, and the participation rate in each behaviour for high school girls ($n = 83$), high school boys ($n = 143$), and primary girls and boys ($n = 90$), and the total sample ($N = 316$). The symbol N/A indicates that the item was not included on the questionnaire for a particular school sample. Thus, of the 51 items seen by high school girls, 47 were also seen by high school boys and 37 were seen by primary school girls and boys. Only the common 47 items for high-school girls and boys were retained for analyses; however, three of these items were not endorsed by any high-school girls ("Gone to school drunk or high?", "Broken into a house with the intention of stealing something?", and "Grown/sold marijuana or other drugs?"), and one item was not endorsed by any high-school boys ("Been expelled from school?"). With the exception of these four items, all other items were endorsed at least once within each school type sample.

Frequency analysis revealed that approximately half of the items (~26 items across groups) were endorsed by fewer than 10% of the sample in Severity-level categories 2, 3 and 4, suggesting that participation in these behaviours was not very common among adolescents in this sample. Examples of these uncommonly endorsed items include Severity-level 2 items (e.g. 'used marijuana', and 'run away from home', Severity-level 3 offences (e.g. 'threatened someone to get money' and 'taken purse or wallet', and Severity-level 4 offences (e.g. 'car racing' and 'broke into a house or building' [theft]. Approximately one-third of items (~17 items) were endorsed by between 10 and 30% of the sample, and less than one-quarter of the items (~8 items) were endorsed by over 30% of the sample. Two items were endorsed by more than 60% of the sample and were therefore dropped from analyses as they were considered to be a somewhat 'normative' behaviour. Both of these items were from the girl's version of the ASB questionnaire; "Pretend to talk about someone and laugh at them?" was endorsed by 65% of girls and "Say mean things to someone about them?" was endorsed by 72% of girls in the current sample.

As expected, on average, Severity-level 1 behaviours were endorsed substantially more often than behaviours from comparatively higher severity-levels (see Table 6.2). Overall, 27.1% of girls and boys between the ages of 9 and 17 had participated in a Severity-level 1 ASB; whereas, average participation rates in other severity-levels of ASB was much lower, (approximately 10%). High-school girls and boys averaged a 30% higher participation-rate than primary-school girls and boys, which may in part be due to the older participants' greater number of years available for participation. Across all ASB levels, high-school boys had substantially higher average ASB participation (approximately 10 – 15%) than high-school girls. Tests of significant differences between sex and age groups are presented later in this chapter.

Table 6.1. Proportion of ASB items endorsed across sample-type by ASB Severity-level.

Severity Level	Item Description	% of H.S.Girls (*n* = 83)	% of H.S.Boys (*n* = 143)	% of H.S. Girls & Boys (*n* = 226)	% of Primary (*n* = 90)	% of Total Participants (*n* = 316)
Level 1	**Withheld Fee for Bus/Pool**	**59.0**	**69.9**	**65.9**	**13.3**	**50.9**
	Watched an R-rated Film	**43.4**	**15.4**	**25.7**	**15.6**	**22.8**
	Skipped School	**21.7**	**55.2**	**42.9**	**8.9**	**33.2**
	Made Prank Call	**39.8**	**32.2**	**35.0**	**14.4**	**29.1**
	Vandalized Public Property	**42.2**	**21.0**	**28.8**	**17.8**	**25.6**
	Not Paid for Coin-Operated	14.5	22.4	19.5	7.8	16.1
	Not Paid for Food - Dispensers	14.5	44.1	33.2	10.0	26.6
	Smoked Cigarettes	19.3	16.1	17.3	1.1	12.7
	Damaged Personal Property	**27.7**	N/A	N/A	N/A	N/A
	Intimidated Another	15.7	N/A	N/A	N/A	N/A
Level 2	**Stolen Under $10**	**37.3**	**35.0**	**35.8**	**23.3**	**32.3**
	Drank Alcohol	**33.7**	N/A	12.4	6.7	N/A
	Damaged School Property	**26.5**	**40.6**	**35.4**	**16.7**	**30.1**
	Vandalized Personal Property	16.9	23.8	21.3	12.2	18.7
	Made Abusive Phone Calls	16.9	17.5	17.3	5.6	13.9
	Purchased Alcohol	10.8	15.4	13.7	N/A	13.7
	Drinking in a Public Location	16.9	22.4	20.4	6.7	16.5
	Gone to School Drunk or High	-	1.4	0.9	N/A	0.9
	Had Sex with Someone	8.4	2.1	4.4	N/A	3.2
	Run Away From Home	8.4	4.9	6.2	8.9	7.0
	Solicited for Money in Public*	4.8	10.5	8.4	6.7	7.9
	Used Marijuana	4.8	8.4	7.1	1.1	5.4
	Abused Barbiturates	4.8	2.1	3.1	N/A	3.1
	Lived Away From Home	2.4	2.1	2.2	3.3	2.5
	Intentionally Hurt an Animal*	2.4	16.1	11.1	5.6	9.5
	Suspended From School	1.2	N/A	N/A	N/A	N/A
Level 3	**Shoplifted From Stores**	**33.7**	**28.0**	**30.1**	**15.6**	**25.9**
	Stolen Over $10 at One Time	**22.9**	**22.4**	**22.6**	6.7	18.0
	Sold or Bought Stolen Goods	12.0	21.0	17.7	6.7	14.6
	Driven Without License	12.0	19.6	16.8	N/A	16.8
	Damaged Things in Public	9.6	21.7	17.3	7.8	14.6
	Threatened Parent or Teacher	7.2	7.0	7.1	5.6	6.6
	Taken Purse or Wallet*	7.2	7.0	7.1	2.2	5.7
	Purposely Damage Property by	3.6	2.8	3.1	2.2	2.8
	Threatened to get Money	3.6	9.1	7.1	3.3	6.0
	Driven an Unregistered Car	3.6	0.7	1.8	N/A	1.8
	Stole Bicycle or Parts	1.2	4.9	3.5	6.7	4.4
	Expelled From School	1.2	-	0.4	3.3	1.3
	Stolen Parts from Car	1.2	4.2	3.1	2.2	2.8
	Used LSD (Acid)	1.2	0.7	0.9	N/A	0.9
Level 4	**Purposely Hurt or Beat Up**	**30.1**	**46.9**	**40.7**	**23.3**	**35.8**
	Taken Part in Group Fist	15.7	20.3	18.6	**23.3**	19.9
	Hit Parent or Teacher	9.6	12.6	11.5	7.8	10.4
	Used a Weapon in a Fight	3.6	4.2	4.0	13.3	6.6
	Driven Vehicle w/o Consent	4.8	3.5	4.0	N/A	4.0
	Bashed Someone for No	2.4	7.7	5.8	4.4	5.4
	Broke into House or Building	-	4.9	3.1	N/A	3.1
	Grown or Sold Drugs	0.0	0.7	0.4	N/A	0.4
	Driven While Intoxicated	1.2	1.4	1.3	N/A	1.3
	Car/Motorcycle Racing	1.2	1.4	1.3	N/A	1.3
	Forced Sexual Activity*	1.2	1.4	1.3	1.1	1.3
	Total Number of Items	(51)	(47)	(48)	(36)	(47)

N/A indicates an item that was not provided to respondents
Bold highlighting indicates an item that was frequently endorsed
*indicates that frequency loadings were so low the item could not be included in factor analysis

Table 6.2. Mean rate of endorsement of one or more ASB item by ASB Severity-level.

Severity Level	Mean rate of ASB participation				*Proportion Difference*	
	High School (HS)		*Primary*	*Total*	*HS boys >*	*High School >*
	Girls	*Boys*	*Boys & Girls*	*Average*	*HS girls*	*Primary School*
Level 1	29.8%	34.5%	11.1%	27.1%	11.6%	57.9%
Level 2	12.3%	14.4%	8.8%	11.8%	11.8%	30.4%
Level 3	8.6%	10.6%	5.7%	8.7%	12.4%	34.0%
Level 4	6.4%	9.5%	12.2%	8.1%	15.0%	13.0%

External Validity. External validity for the ASB measures was assessed by comparing the mean number of responses on each item with the normative data (non-delinquent sample) from Mak's (1993) study. To match Mak's non-delinquent sample of 13 – 18 year old adolescents (n = 103), only the data from participants between the ages of 13 and 17 (n = 190) in the current study were included (no 18 year olds participated in the current study). The samples were also comparable in the proportion of participating boys (Mak 61%; current = 66%) to girls (Mak = 39%; current = 34%). Items on the current study's ASB questionnaire were grouped according to Mak's factor-analyzed subscales to enable detailed comparisons. Table 6.3 displays the means and standard deviations for each of Mak's subscales and the 34-item total scale (total scale excludes all validity items) for Mak's Canberra high school students and the Sydney high school students from the current study. The means and standard deviations were very similar in the two samples, and the means on the total scale were almost identical (i.e. Current study, M = 6.15; Mak, M = 6.19). Only small differences were found on a few select offences; Mak's sample reported a comparatively higher mean response rate for status and driving offences, and the current sample reported a higher rate of theft and aggression, and minor offences such as cheating and disturbing the peace (refer to Table 6.3).

Table 6.3. Means and standard deviations for the current sample (Sydney high schools), and Mak's sample (Canberra high schools) of students ages 13 – 17 on Mak's (1993) Self-Reported Delinquency subscales.

	Sydney High Schools (*n* = 190)		Canberra High Schools (*n* = 103)	
Mak's Subscales	*M*	*SD*	*M*	*SD*
Lie	3.74	0.53	3.29	0.75
Factor 1: Cheat	1.23	0.96	1.00	0.96
Factor 2: Status	1.04	1.30	1.40	1.19
Factor 3: Fight	0.24	0.49	0.14	0.37
Factor 4: Vehicle	0.07	0.32	0.08	0.33
Factor 5: Drugs	0.05	0.21	0.02	0.14
Factor 6: Theft	0.91	1.08	0.47	0.71
Factor 7: Harm	0.47	0.58	0.21	0.45
Factor 8: Driving	0.28	0.65	0.63	0.89
Factor 9: Disturb	1.34	1.52	1.15	1.28
No Factor	0.58	0.78	-	-
Mak's Total Scale (excludes Lie items)	6.15	5.40	6.19	4.47

Factor Analysis. As described by Fabrigar, Wegener, MacCallum, and Strahan, (1999), the selection of variables to include in factor analysis is very important because this can influence the amount of variance a variable shares with all the other variables being considered. The amount of shared variance and the proportion of variance explained by the common factors are referred to as communalities; low communalities threaten the validity of the factor analysis results. Thus, to ensure a valid solution with factor analysis, it is necessary to have an adequate number of carefully-selected items and a large enough sample size (Cattell, 1978). Fabriger et al. state that if "...communalities are high (i.e. an average of .70 or higher), accurate estimates of population parameters can be obtained with samples as small as 100." (p 274). Because primary-school participants responded to substantially fewer items (22%) than high-school participants, and comprised only a small proportion of the entire sample (28%) they were excluded from factor analysis procedures.

Having established that the number of high-school participants in each group was large enough (girls = 83; boys = 143) factor analysis was conducted on the sample of high-school girls and boys *only* (by excluding primary school participants the number of items that could be included in the analysis was increased). Because boys traditionally participate in higher levels of ASB than girls (see for example Blumstein et al., 1985; Hua et al., 2006; Prime et al., 2001), analyses were performed separately for high-school girls and boys. Of the total 34 items, five items were dropped from the factor analysis procedure because low response rates prevented adequate loading values; these items have been identified and noted in Table 6.4. Thus, 29 items were included in analyses.

Two tests were performed to test the adequacy of the sample for analysis and the strength of the relationships between variables. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy is an index for comparing the magnitudes of the observed correlation coefficients to the magnitudes of the partial correlation coefficients (Tabachnick & Fidell, 2001). The KMO measure should be greater than 0.5 for a satisfactory factor analysis to proceed. Bartlett's test of sphericity is used to test the null hypothesis that the variables in the population correlation matrix are uncorrelated. If the observed significance level is $p < .05$ it can be concluded that the strength of the relationship among variables is strong. Results indicated that data from the remaining 29 ASB items for both high-school girls and boys were suitable for analysis. The KMO measure was .652 for girls and .718 for boys, and Bartlett's test of sphericity was $p < .001$ for both girls ($\chi^2 = 1033.5_{406}$) and boys ($\chi^2 = 934.6_{406}$).

Mak's (1993) exploratory factor analysis procedure revealed eight underlying constructs when analyses were conducted on the 29 ASB variables in her study. Exploratory factor analysis (principal axis factoring) was performed in the current study to identify underlying latent constructs on a similar, (but not identical), set of 29 ASB items. The eigenvalue method indicated an eight- factor solution for girls, and 11-factor solution for boys; however, Fabriger et al. (1999) recommends that inspection of the scree test is the most reliable method of identifying factors (rather than relying on the computed eigenvalues). The scree plot indicated that a one-factor solution was the best fit for the data for both girls (Figure 6.1a) and boys (Figure 6.1b).

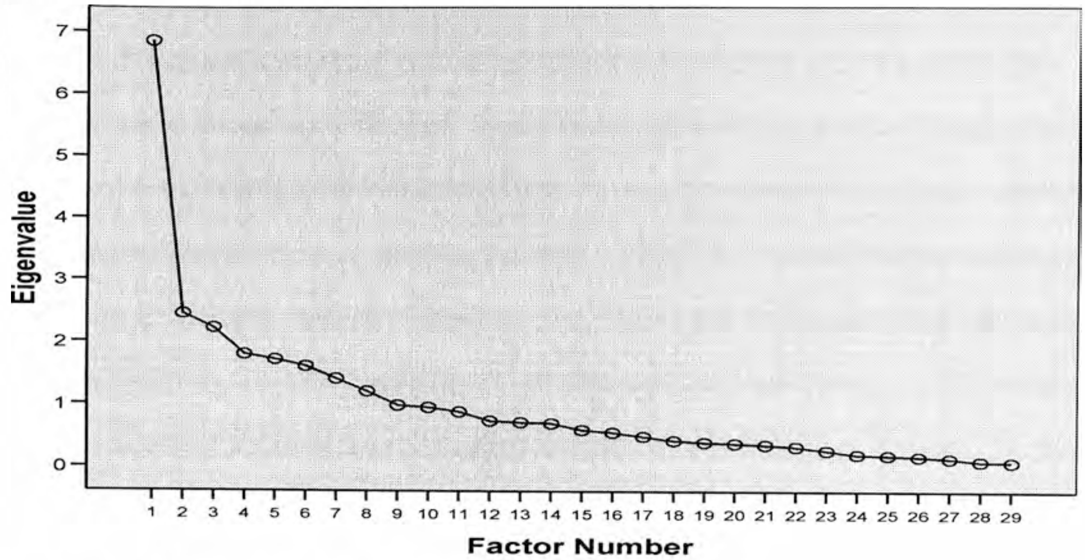


Figure 6.1a. Scree plot for girls on 29 ASB items.

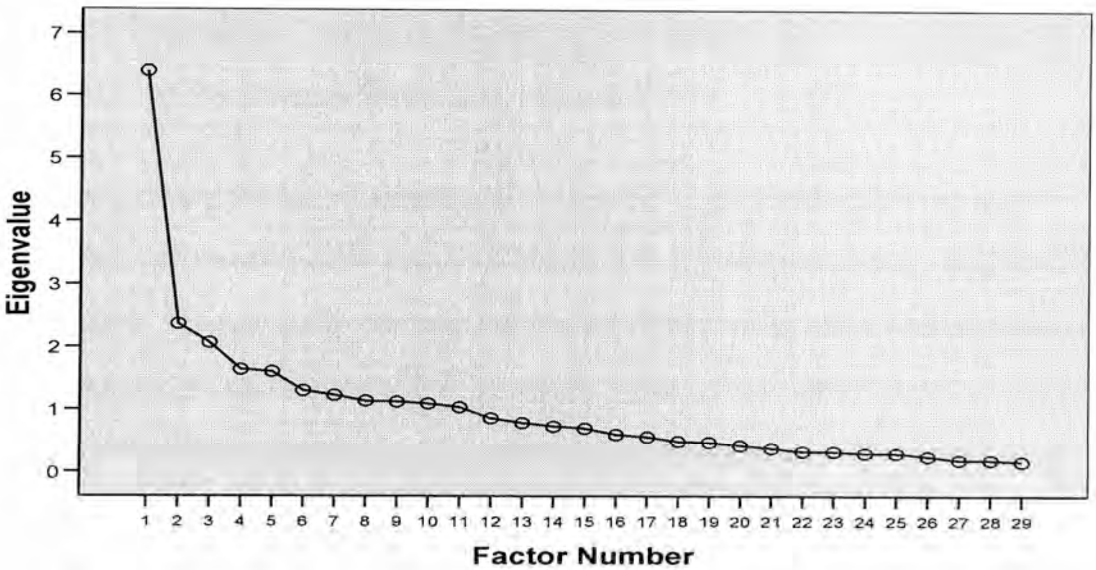


Figure 6.1b. Scree plot for boys on 29 ASB items.

The purpose of conducting factor analysis in the current study was to identify a small number of factors to represent the ASB construct, and to identify whether there were different types of ASB participation. For example, previous research has found that whilst a large number of adolescents may participate in a wide range of fairly minor ASB, only a small proportion of these will also participate in more serious forms of ASB (REF). It was determined that the 8-factor (girls) and 11-factor (boys) solutions were too cumbersome for the type of analyses to be conducted in the current study, and that a one-factor solution did not provide enough differentiation on ASB participation. Thus, a two factor model was tested to determine whether two types of ASB participation, ('minor' and 'major'), could be identified. A principal factor analysis was conducted prescribing a two-factor extraction and 25 iterations oblimin rotation (delta = 0). (Oblimin rotation is an oblique rotation, which is a recommended method of rotation as an orthogonal rotation does not allow for the possibility of correlations between factors). Factor loadings are simple correlations between the variables and the factors, and are generally considered meaningful when they exceed .30; cross-loadings are items that load .30 or higher on two or more factors. For girls, three items did not load on any either factor; five items loaded on both factors, and the remaining items loaded on only one factor. For boys, three of six items that did not load on any factor were not included in the solution, but three of the items (15, 34, and 35) loaded on the primary-loading factor with correlations slightly below .30, and were thus included on that factor. Six items loaded on both factors, and the remaining items loaded only on the primary factor (see Table 6.4).

Table 6.4 displays the factor scores (i.e. composite scores estimated for each respondent on the derived factors) for the two-factor ASB measure, along with item descriptions. Theoretically, the two factors represent what can be referred to as *minor* (ASB-Minor) and *major* (ASB-Major) antisocial behaviours. Items were included on *one or both* factors if the correlation was .30 or higher. There was one exception to this rule; although correlation coefficients for three of the items did not quite reach .30 for boys, these items were included on the ASB-Minor factor to be consistent with the factor solution for girls, (see Table 6.4). As displayed in Table 6.4, the majority of ASB-Major items also loaded on the ASB-Minor factor. Thus, it appears that although these items may be relatively common among adolescents, they also contribute to differentiating those adolescents who also participate in relatively major ASB. All

Table 6.4. Factor loadings for Cumulative ASB.

Girls Items	Factor loading	Boys Items	Factor loading
	Factor 1: Minor ASB		
Skipped School	.71	Made Abusive Phone Calls	.70
Shoplifted from Stores	.71	Damaged Things in Public Places	.66
Damaged Things in Public Places	.66	Vandalized Public Property	.61
Smoked Cigarettes	.65	Taken Part in Group Fist Fight	.59
Stolen Over $10 at One Time	.62	Made Prank Call	.57
Made Prank Call	.56	Stolen Under $10^	.56
Vandalized Public Property	.54	Watched a Cinema Film Underage	.53
Watched a Cinema Film Underage	.53	Shoplifted from Stores	.50
Made Abusive Phone Calls	.52	Damaged School Property	.50
Not Paid for Food from Dispensers^	.51	Sold or Bought Stolen Goods	.49
Drinking in a Public Location	.50	Purposely Hurt or Beat Up Someone	.46
Withheld Fee for Bus/Pool	.49	Stolen Over $10 at One Time	.45
Solicited for Money in Public	.48	Used a Weapon in a Fight	.45
Purposely Hurt or Beat Up Someone	.45	Taken Purse or Wallet	.45
Vandalized Personal Property	.44	Not Paid for Food from Dispensers	.43
Damaged School Property	.37	Vandalized Personal Property	.42
Bashed Someone for No Reason	.36	Skipped School^	.40
Used a Weapon in a Fight	.35	Withheld Fee for Bus/Pool	.38
Sold or Bought Stolen Goods	.34	Not Paid for Coin-Operated Games	.31
Stolen Under $10	.38	Smoked Cigarettes^	.46
Taken Part in Group Fist Fight	.32	Drinking in a Public Location^	.33
Threatened Parent or Teacher^	.60	Threatened to Get Money^	.37
Hit Parent or Teacher^	.34		
Forced Sex^	.34		
	Factor 2: Major ASB		
Not Paid for Food from Dispensers^	-.31	Stolen Under $10^	.33
Threatened Parent or Teacher^	-.60	Skipped School^	-.39
Hit Parent or Teacher^	-.59	Smoked Cigarettes^	-.49
Purposely Damage Property by Fire	.35	Bashed Someone for No Reason	.48
Forced Sex^	-.34	Drinking in a Public Location^	-.46
Threatened to get Money	.30	Threatened to Get Money^	.41
		Purposely Damage Property by Fire*	.29
		Threatened Parent or Teacher*	.28
		Hit Parent or Teacher*	.26

Did not load on any factor

Girls Items	Factor: 1	Factor: 2	Boys Items	Factor: 1	Factor: 2
Not Paid for Coin-Operated Games	.24	-.12	Solicited for Money in Public	.19	.23
Taken Purse or Wallet	.16	.21	Intentionally Hurt an Animal	.16	.22
Intentionally Hurt an Animal	.10	.20	Forced Sex	.09	-.09

^ Cross-loading items
*Factor loading less than .30

items included on either the ASB-Minor (girls, n = 24 items; boys n = 22 items) or ASB-Major (girls, n = 5 items; boys, n =4 items) factor were also included in a composite (ASB-Total) factor (girls, 26 items; boys, 24 items). Thus, although some items were included on both the ASB-Minor and the ASB-Major scale, the ASB-Total scale is a sum of all items, not of the two scales combined.

The results from factor analysis provide good evidence of construct validity for ASB measurement in the current study. The three ASB factor-scales (ASB-Major, ASB-Minor, and ASB-Total) represent a more parsimonious representation of the original set of items. These three factor-scales represent the measures (Major, Minor, Total) of all reported ASB by high-school and primary-school participants (Cumulative ASB) and the measure of ASB participated in the past 12 months (Current ASB) for high-school participants. These ASB measures will be used for discussing the distributions of the sample by sex and age in participant-reported ASB participation, and for testing hypothesized relationships with pubertal development and executive functioning (in Section 4: Results).

Internal Reliability

Item analysis was performed to test the reliability of the two derived factor-scales (ASB-Major, ASB-Minor) and the total scale (ASB-Total). The assessment of scale reliability is based on the correlations between the individual items that make up the scale, relative to the variances of the items. Item-total correlations represent a measure of how well each individual item is correlated with the overall scale; a low item-total correlation means the item has little correlation with the overall scale and the researcher should consider dropping it. The literature reviewing assessments of internal reliability generally consider a Cronbach's alpha coefficient above .70 to be an 'acceptable' value, and above .80 a 'good' value, for a research instrument (Cronbach et al., 1972).

Item-total correlations as well as alpha coefficients were computed for the three Cumulative ASB scales (Major, Minor, Total) for high school girls and boys separately (see Table 6.5). For both girls and boys, 'good' alpha coefficients were obtained for both the ASB-Minor and ASB-Total scales (.88). Inspection of the individual item-total correlations revealed that some item-correlations were not consistent with the rest of the ASB-Total scale (girls = 4 items; boys = 3 items). Most of these items were items that loaded on the ASB-Major scale and thus provide further evidence for the construction of this separate factor. The alpha coefficients computed on the ASB-Major scale were much lower for both girls (.45) and boys (.53).

Table 6.5. Alpha coefficients for (Cumulative and Current) ASB factors (Major, Minor, Total) by sex.

Girls (n = 82)			*Boys (n =145)*		
Factors	*Cronbach's alpha*	*No. of[9] items*	Factors	*Cronbach's alpha*	*No. of items*
Factor 1: Minor ASB	.88	24	Factor 1: Minor ASB	.88	25
Factor 2: Major ASB	.45	5	Factor 2: Major ASB	.53	5
Factors 1 & 2: Total ASB	.88	26	Factors 1 & 2: Total ASB	.88	26

These low coefficients were most likely due to the very low number of items (see Cronbach et al., 1972) on the ASB-Major scale (5 items each for girls and boys), and only one item, (i.e. "Used or threatened to use force") was poorly correlated with the other items. It was concluded that the two-factor solution remained valid, and that the low internal reliability on the ASB-Major scale was due to low levels of endorsement, the low number of items in the scale, and that the ASB-Major scale represents a more heterogeneous measure of ASB than the Minor and Total scales.

Summary: Validity and Measurement Reliability

The three ASB questionnaires used in the current study were based on findings from previous studies including an instrument validated on an Australian adolescent sample (SBRS; Mak, 1993). The modified versions of Mak's SBRS used in this study were rigorously assessed for validity and reliability. The questionnaires passed tests of

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[9] See Peterson (1994) and Kopalle & Lehmann (1997) for a review of how the number of items in a scale impacts the magnitude of coefficient alpha.

content and construct validity, and results from factor-analysis indicted two subscales (Major and Minor) in addition to a total scale. A final test of internal reliability confirmed that the two-factor solution was an acceptable parsimonious measurement of ASB for the current study. Thus, the ASB subscales (ASB-Major and ASB-Minor) and total scale (ASB-Total) represent valid and reliable measurement of (Cumulative and Current) antisocial behaviour for the current sample of adolescents.

Operationalizing ASB

For each ASB item, primary-school participants only responded to whether they had 'ever participated' in the behaviour, whereas, high-school girls and boys also reported 'age of first participation' in the behaviour, and whether they had 'participated in the past 12 months'. Thus, the ASB data have been operationalized into four measures of ASB. (1) For high-school and primary-school participants, all ASB 'ever-participated in' (Cumulative ASB), and, for high-school participants only, (2) ASB participated in the past 12 months (Current ASB), (3) the age of peak ASB participation (Peak-ASB) and, (4) the first age of participation in ASB (First-Age ASB). The measure of first age of ASB participation was computed for the purposes of testing relationships between ASB variables. It is hypothesized that a negative correlation will exist between first age of antisocial behaviour and level of ASB participation (i.e. children who start early report higher levels of ASB participation). In addition to testing hypotheses of relationships among ASB variables, the remaining three measures of ASB will be used to investigate whether executive functioning mediates relationships between pubertal development and antisocial behaviour (presented in Section 4: Results).

Primary-school participants were only included in analyses for the Cumulative measures of ASBb this age-group was not asked to respond to any questions regarding current, or first age of, ASB. Additionally, individual participants were excluded from analyses if it was suspected that the information provided was unreliable. Participants were excluded if the following conditions were met: 1) at least three of the four lie scale items were not endorsed, *and* 2) no other item was endorsed. (This means that participants were retained if only one or two of the four lie-scale items was endorsed, but other items were also endorsed). A total of nine participants (2.8% of the entire sample) met the above exclusion-criteria; thus, 3.4% of boys (n = 7, ages 12 to 16) and 1.6% of girls (n = 2, ages 11 and 14) were excluded from all further analyses in the current study.

Total Participation across ASB items (High-school and primary-school)

All items. Table 6.6 displays means, standard deviations, and tests of significant differences between groups for girls and boys by school type (i.e. primary schools, high schools, and all schools). The distribution for total participation in ASB by sex and school type is displayed in Figures 6.2a and 6.2b respectively. To adjust for the different number of items provided to each group, the mean number of ASB items endorsed was presented as a percentage of the total number of items provided to that group. As expected, across the entire sample (Figure 6.2a), boys (M = 14.77) reported participation in a significantly higher percentage of ASB items ($t = 2.421_{314}$, $p < .01$, one-tailed) than girls (M = 10.89). However, this gender difference is largely attributable to the very low level of ASB participation reported by girls in primary schools. Primary-school boys (M = 11.88) reported participation in a significantly higher percentage of ASB items ($t = 2.919_{68}$, $p < .01$, one-tailed) than primary-school girls (M = 4.75). Although high-school boys (M = 15.85) reported participation in a higher percentage of ASB items than high-school girls (M = 13.63), this difference was not significant (Figure 6.2b).

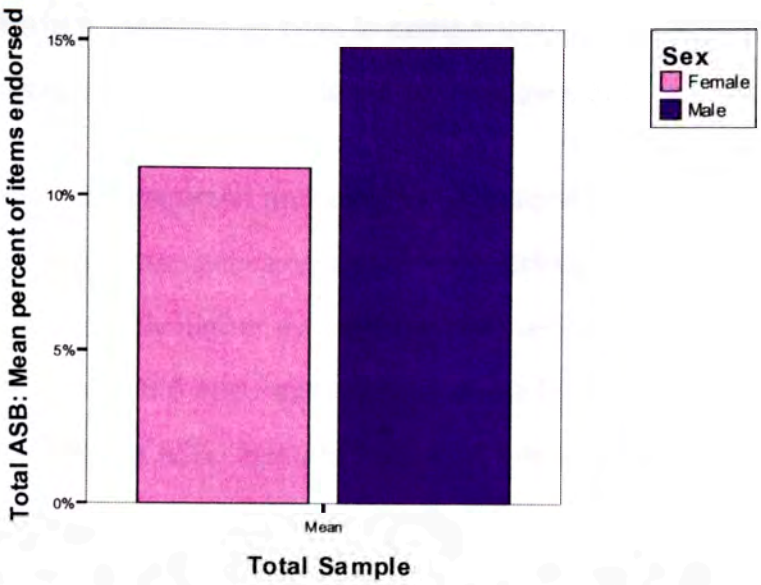

Figure 6.2a. Mean percent of Total ASB by sex for all schools.

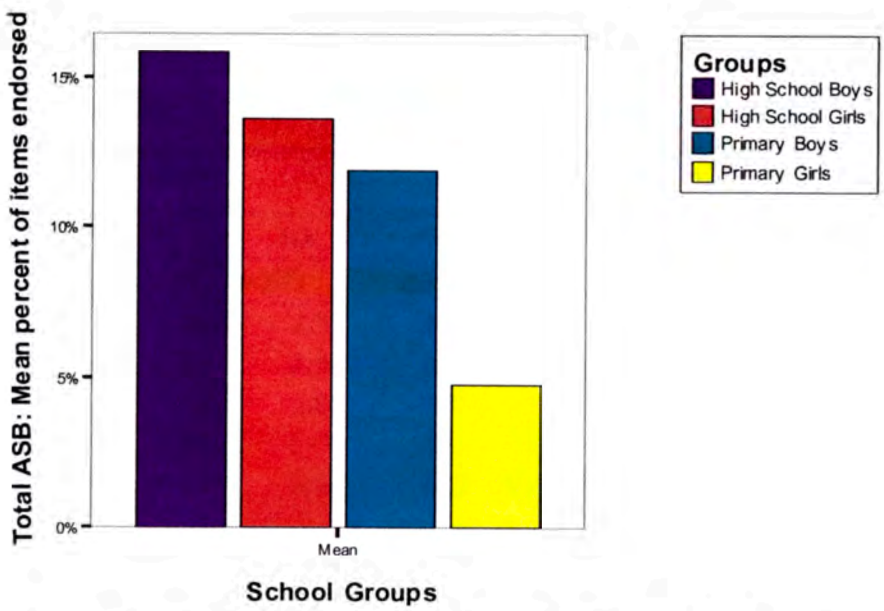

Figure 6.2b. Mean percent of Total ASB by school type

Items by severity-level. In comparison to primary-school girls, primary-school boys also reported participation in a significantly higher percentage of ASB items for each of the four severity-levels of ASB (see Table 6.6 and Figure 6.3a). Whereas, in comparison to high-school girls (M = 1.37), high-school boys (M = 2.23) reported participation in a significantly higher percentage of ASB items for only severity-level 4 ASB ($t = 2.539_{224}$, $p < .01$, one-tailed), and for the other three (i.e. 1 to 3) ASB severity-levels, this difference was in the same direction, but non-significant (see Figure 6.3b). The overall sex difference in participation across school-type (i.e. all schools) indicates that the higher ASB participation reported by boys in comparison to girls did not reach significance for Severity-level 1 (see Table 6.6 and Figure 6.3c).

Although high-school girls reported participation in a significantly higher percentage of severity-level 1 ASB items than primary-school boys, primary-school boys reported participation in a significantly higher percentage of severity-level 3, and 4, items than high-school girls (see Table 6.6 and Figure 6.3c). These findings suggest that both *sex* and *age* are associated with ASB. Results from multiple regression revealed that although *sex and age* combined produce a significant model for each of Severity-levels 1 to 4 and all Severity-levels combined, *sex* is a better predictor than *age* for severity-level 4 ASB ($F_{2,313} = 5.942$, $p < .01$), and *age* is a better predictor than *sex* for the total of all ASB items, and for Severity-levels 1, 2, and 3 (see Table 6.7).

Table 6.6. Mean % of Total ASB and statistical tests of significant differences for girls and boys by ASB severity-levels.

	Primary Schools						
	M	*SD*	*M*	*SD*	Statistical test results		
ASB Severity	Girls (n = 37)		Boys (n = 53)		*t*	*df*	*p*
Level 1	1.46	2.35	3.06	4.37	2.239	83	.01
Level 2	1.68	2.50	3.26	5.34	1.885	78	< .05
Level 3	.44	1.01	2.96	5.17	3.452	57	< .01
Level 4	1.17	1.97	2.60	3.27	2.589	86	< .01
Total ASB Level	4.75	5.64	11.88	16.46	2.919	68	< .01
	High Schools						
	Girls (n = 83)		Boys (n = 143)				
Level 1	5.84	5.02	5.88	4.37	.066	224	.43
Level 2	3.85	4.42	4.30	4.31	.748	224	.28
Level 3	2.58	3.46	3.44	4.66	1.465	224	.07
Level 4	1.37	2.00	2.23	2.69	2.539	224	< .01
Total ASB Level	13.63	13.44	15.85	13.89	1.169	224	.12
	All Schools						
	Girls (n = 120)		Boys (n = 196)				
Level 1	4.49	4.81	5.12	4.53	1.169	314	.12
Level 2	3.18	4.05	4.02	4.62	1.640	314	< .05
Level 3	1.92	3.09	3.31	4.80	3.134	313	< .01
Level 4	1.31	1.99	2.33	2.85	3.754	308	< .01
Total ASB Level	10.89	12.29	14.77	14.69	2.421	314	< .01

Table 6.7. Multiple regression results for sex and age by ASB severity-levels.

	Predictor variable						
	Age		*Sex*		Statistical Model		
	Beta	*p*	*Beta*	*p*	*F*	*df*	*p*
Level 1	.415	< .0005	.006	.915	32.723	2, 313	< .0005
Level 2	.248	< .0005	.056	.310	11.543	2, 313	< .0005
Level 3	.141	< .05	.138	.014	7.285	2, 313	< .0010
Level 4	-.005	.929	.192	.001	5.942	2, 313	< .0050
Total ASB Level	.259	< .0005	.098	.075	14.383	2, 313	< .0005

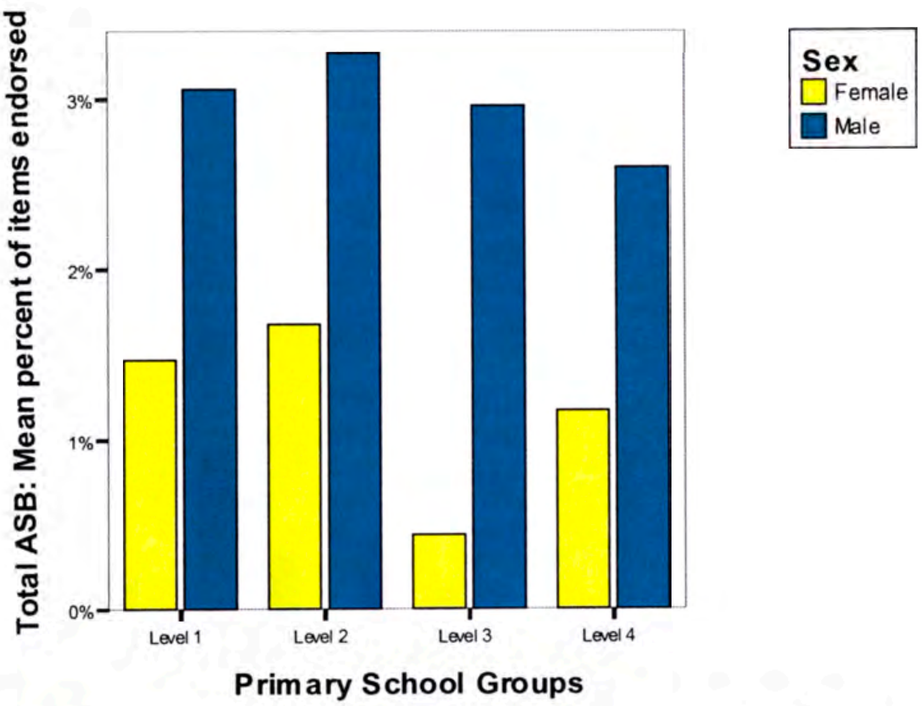

Figure 6.3a. Mean percent of Total ASB by severity-level and sex for primary-school participants.

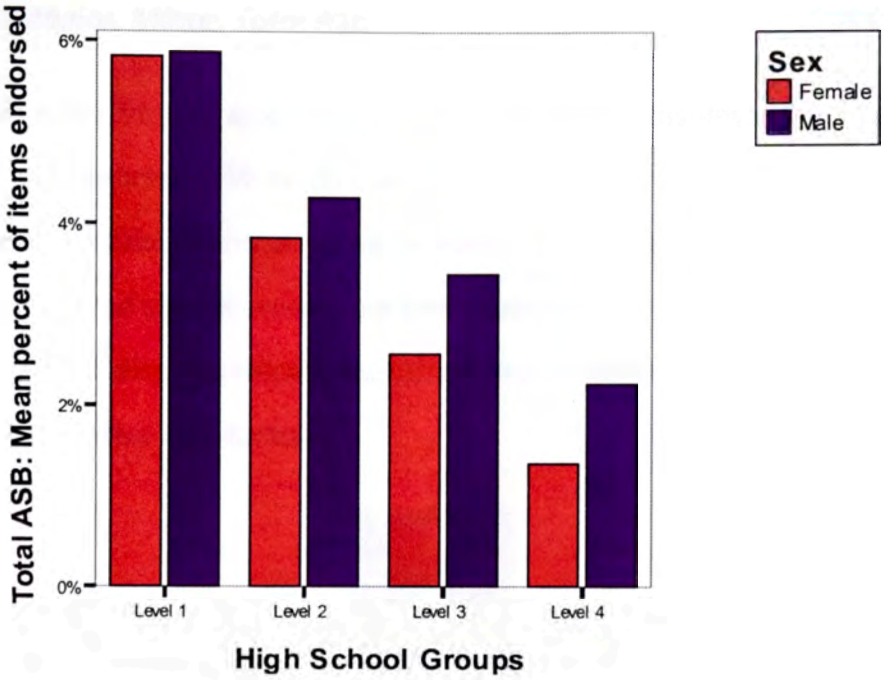

Figure 6.3b. Mean percent of Total ASB by severity level and sex for high-school participants.

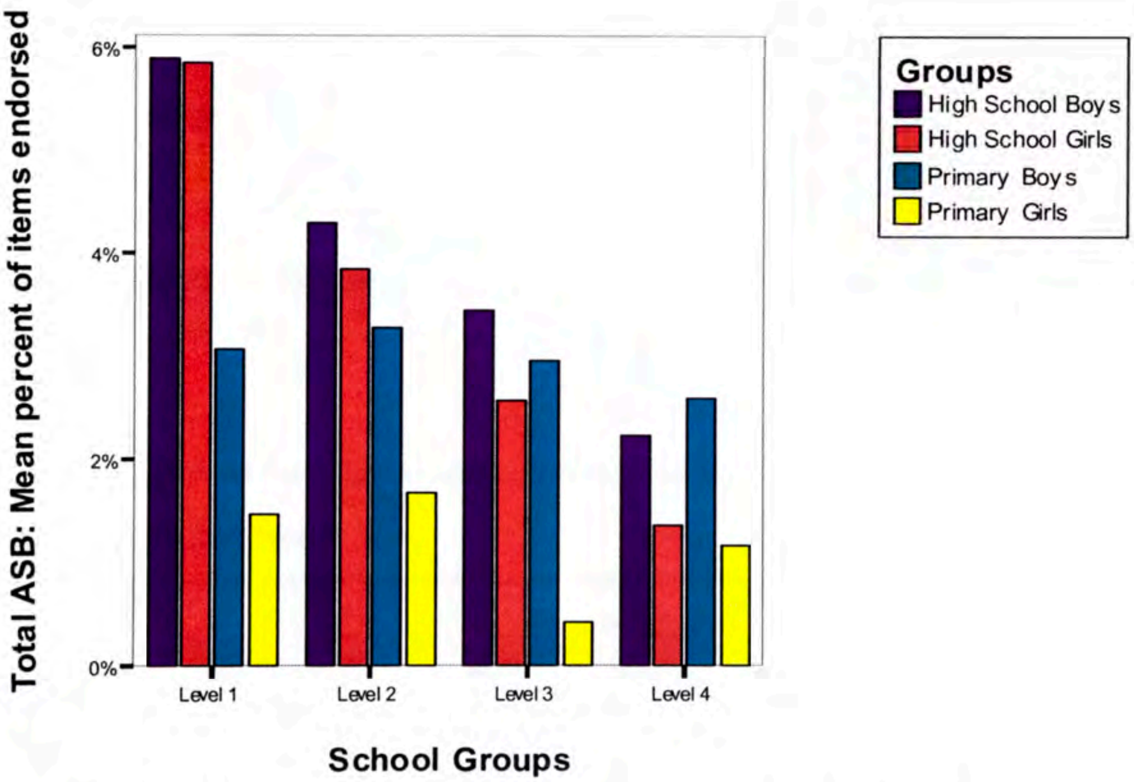

Figure 6.3c. Mean percent of Total ASB by severity level and sex for all school participants.

ASB Factors – Major, Minor, Total ASB

(1) Cumulative ASB (Primary and High-school). Figure 6.4 displays the distribution for mean number of reported ASB items ever participated in by boys and girls for primary and high-schools combined on all three factors of Cumulative ASB (i.e. Major, Minor, Total). Boys reported significantly more participation in all Cumulative ASB measures than girls. Table 6.8 displays means, standard deviations and significance tests results for all three Cumulative ASB factors.

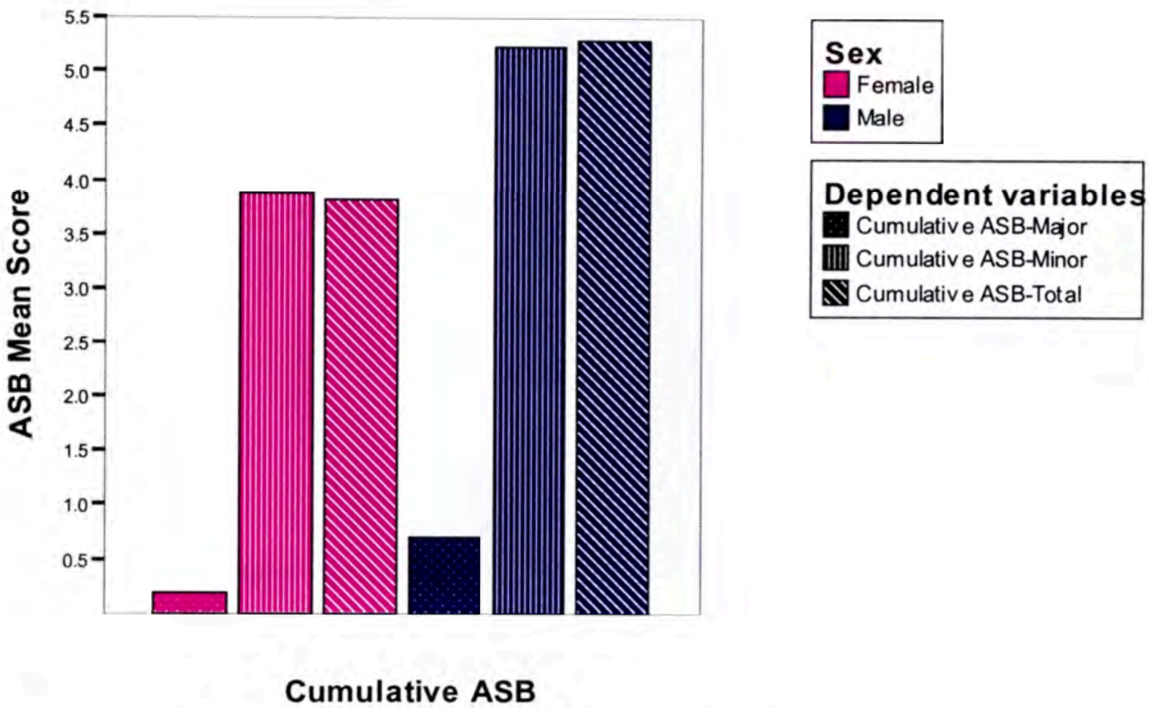

Figure 6.4. Mean Cumulative ASB scores by sex and ASB factor (Major, Minor, Total).

Table 6.8. Mean % of Cumulative ASB and statistical tests of significant differences for girls and boys by ASB factor.

Cumulative ASB Factor	*All Schools*						
	Girls (n = 118)		Boys (n = 196)		Statistical test results		
	M	*SD*	*M*	*SD*	*t*	*df*	*p*
ASB-Major	0.19	0.49	0.71	0.82	6.915	311	< .0005
ASB-Minor	3.87	4.23	5.23	4.89	2.503	311	< .0100
ASB-Total	3.81	4.15	5.30	4.96	2.720	310	< .0050

(2) Current ASB (High-school only). Figure 6.5 displays the distribution for mean number of ASB items high-school boys and girls reported participating in within the past 12 months. High-school boys reported significantly more participation in all Current ASB (i.e. Major, Minor, Total) measures than high-school girls. Table 6.9 displays means, standard deviations and significance-tests results for all three Current ASB factors.

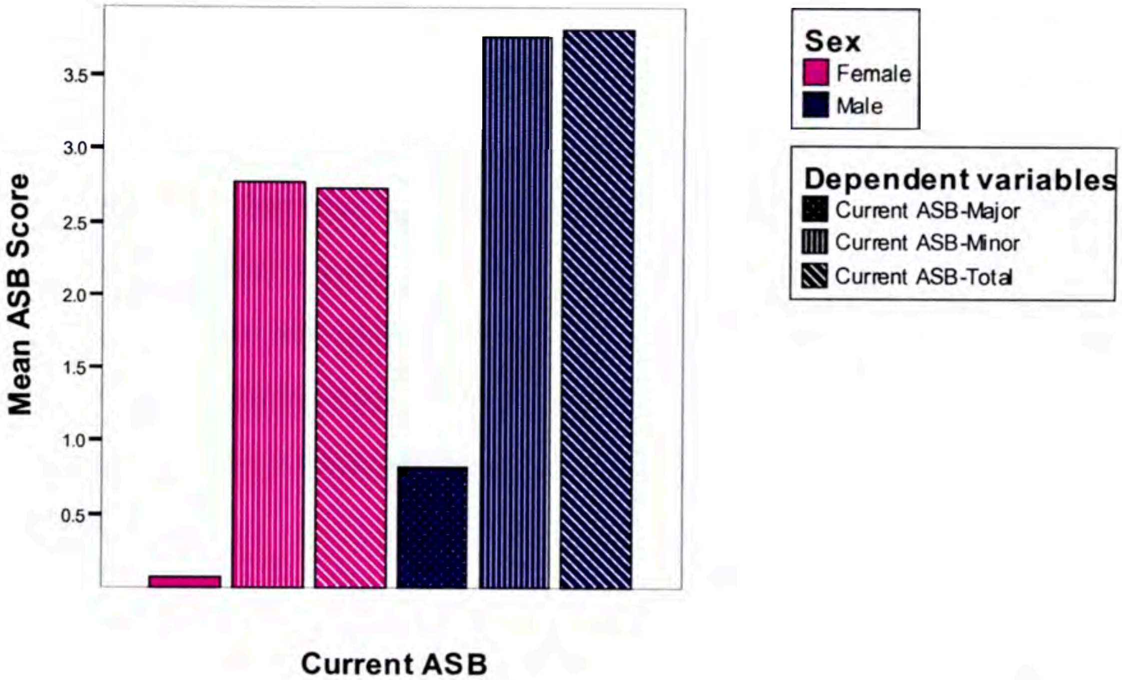

Figure 6.5. Mean Current ASB scores by sex and ASB factor (Major, Minor, Total).

Table 6.9. Mean % of Current ASB and statistical tests of significant differences for girls and boys by ASB factor.

Current ASB Factor	*High Schools (only)*						
	Girls (n = 80)		Boys (n = 139)		Statistical test results		
	M	*SD*	*M*	*SD*	*t*	*df*	*p*
ASB-Major	0.07	0.31	0.82	0.99	8.307	185	< .0005
ASB-Minor	2.77	3.28	3.76	3.85	1.925	216	< .0500
ASB-Total	2.73	3.31	3.82	3.91	2.077	215	< .0500

(3) Age of Peak-ASB Participation (High-school only). An examination of group means (girls, Figure 6.6a; boys, Figure 6.6b) indicates that in comparison to other ages participants reported engaging in the highest mean number of ASB at the approximate age of 14 (girls) or 16 (boys). Consistent with the literature (e.g. Moffitt, 1993), this mean age of first-participation peaks at approximately the age of 14 (girls; M = 24) or 16 (boys; M = 35), and then begins to decrease (age 15 for girls, age 16 for boys). To compute an age of peak-ASB, however, it was necessary to identify the age at which an adolescent reported the greatest amount of first-participation. Across the individual ASB items endorsed, there was extreme variability within adolescents' age-reports of first participation. For example, an adolescent may report first participation on one ASB item at the age of 8, but then not report any other participation until age 14, when reports of first participation are made across several ASB items. Clearly, the age of peak-ASB participation for this adolescent is age 14, rather than age 8. Age of peak-ASB participation is, therefore, operationalized as the age at which there is a substantial increase in the number of an adolescent's reports of first participation across ASB items.

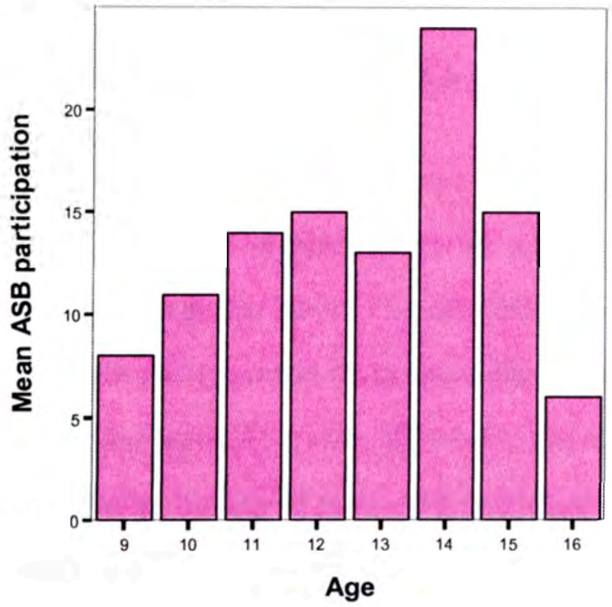

Figure 6.6a.

Mean ASB participation by age for girls.

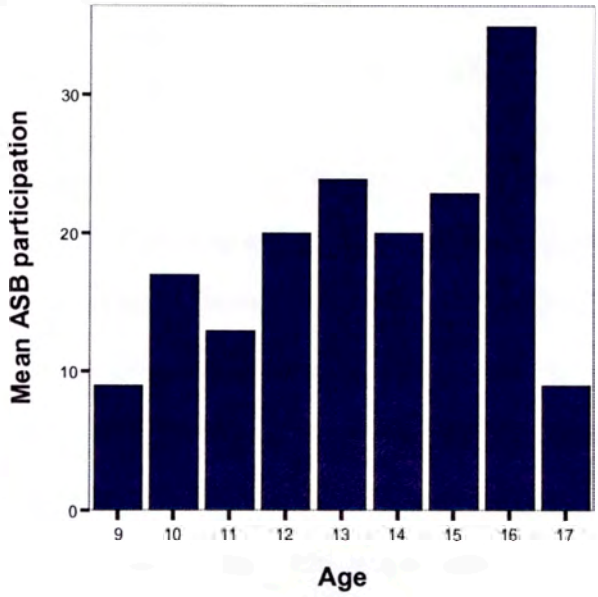

Figure 6.6b.

Mean ASB participation by age for boys.

Because of the wide range of behaviours included in the questionnaire, ASB items differ in their level of severity. Thus, age of peak-ASB was analyzed on the total severity-level (Total ASB) of participants' ASB rather than a simple sum of total ASB. Figure 6.7a illustrates how age of peak-ASB participation was derived by displaying 'age of first participation' data for two 14-year old girls in which age of peak-ASB participation for both participants is computed as age 12. Both girls report a relatively moderate increase in ASB participation from age 8 to 11, followed by a relatively large increase from age 11 to 12, and returning to a moderate increase in reported Total ASB from age 12 to 14. Although this pattern was very distinct in the majority of cases, for some participants, it was not possible to unequivocally compute a value (38.5% of girls, n =32; 26.6% of boys, n = 38). In a number of cases, minimal participation, or small increments of participation over the years were reported, or both (see Figure 6.7b for example). The fact that little or no participation was reported in these cases is most likely explained by the fact that a substantial percentage of adolescents in this sample would possess characteristics (e.g. relatively high SES) that protect them from engaging in ASB. For example, Duyme (1990), found that among adopted children, the higher the adoptive parental social class, the lower the antisocial behaviour rates in the adoptees. Thus, although a large percentage of adolescents engage in ASB, not all adolescents do so (e.g. Moffitt & Caspi, 2001; Piquero, Brezina, & Turner, 2005).

Thus, age of peak-ASB involvement was identified in 43 girls and 96 boys in the high-school sample. The distribution for age of peak-ASB is displayed in Figure 6.8a for girls and Figure 6.8b for boys. The distributions are markedly similar, displaying a mode of peak-ASB participation at 13 years for both groups, and similar means and standard deviations (girls, M = 12.6, SD = 1.43; boys (M = 12.3, SD = 1.78). A small percentage of boys display an age of peak-ASB participation as young as 8 or 9 years, whereas girls report peak participation in ASB no earlier than 10 years of age. Although there are no girls older than 16 years of age in the sample, the fact that no 17-year old boys reported an age of peak-ASB of 17, combined with the low percentage of both girls and boys reporting the age of 16 as an age of peak-ASB, suggests that it is a rare occurrence for peak-ASB participation to occur at the age of 17 years or older.

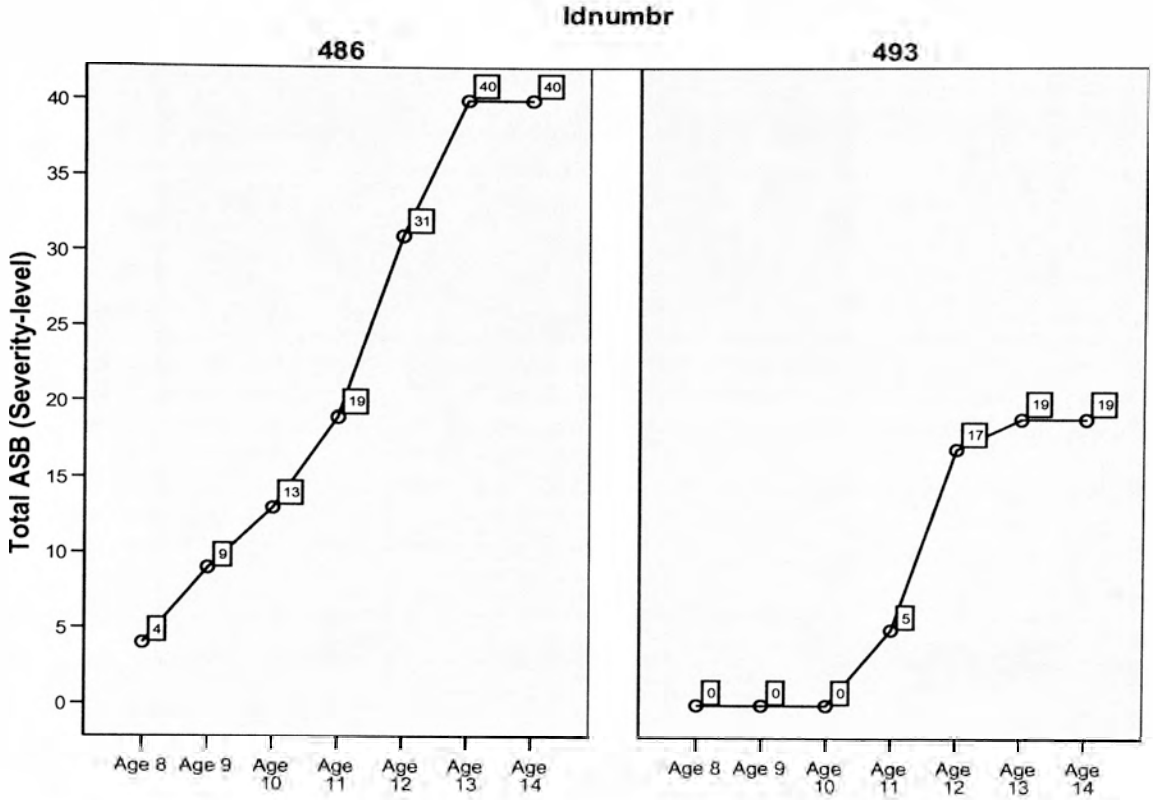

Figure 6.7a. Example to illustrate age of first participation data: Age of peak-ASB computed as *age 12*.

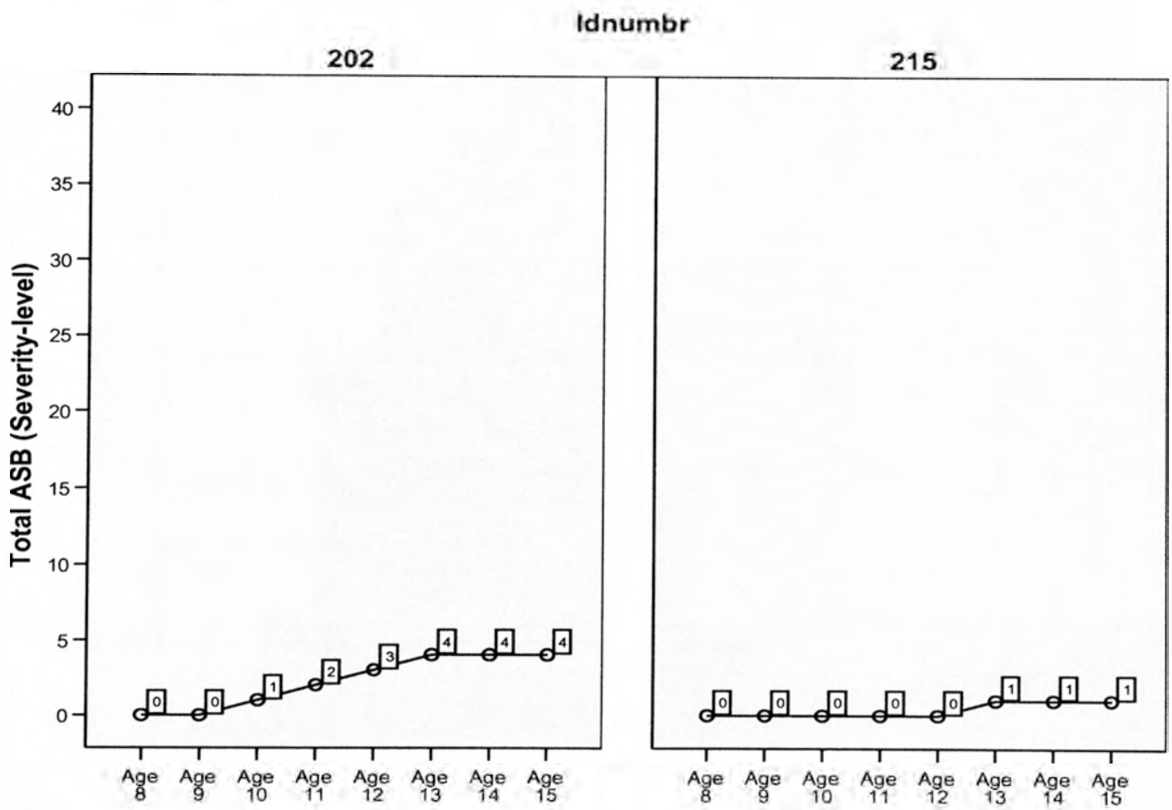

Figure 6.7b. Example to illustrate Age of first participation data: *No age* of peak-ASB computed.

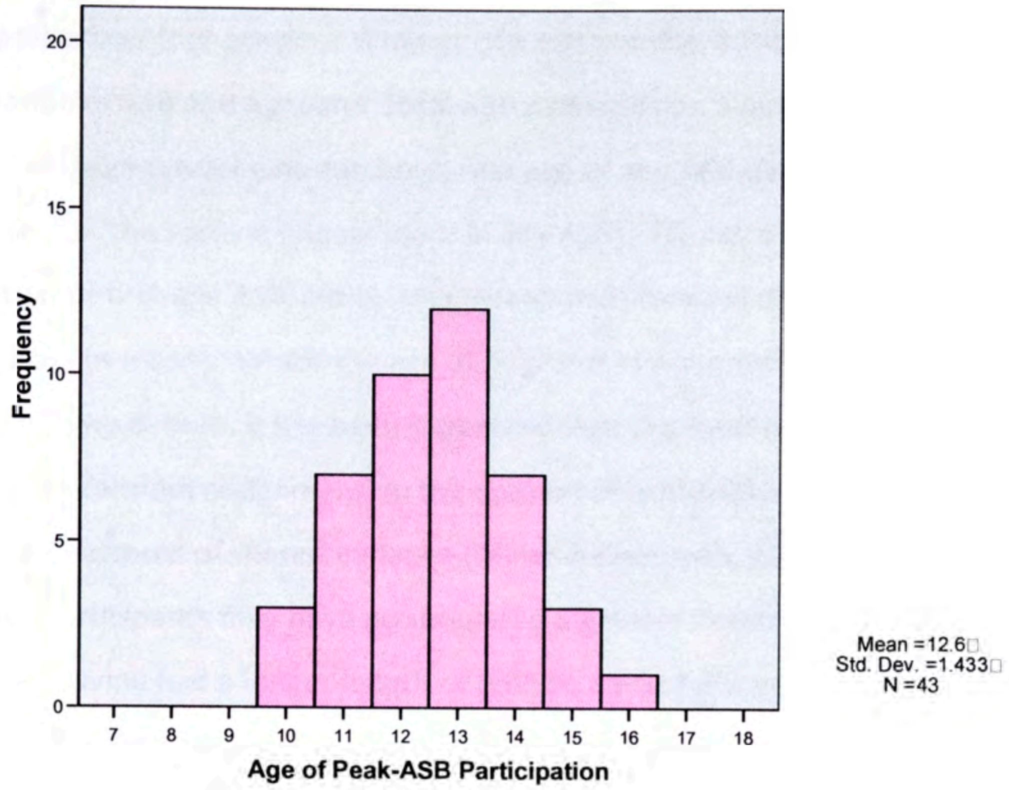

Figure 6.8a. Mean Age of Peak-ASB participation for girls.

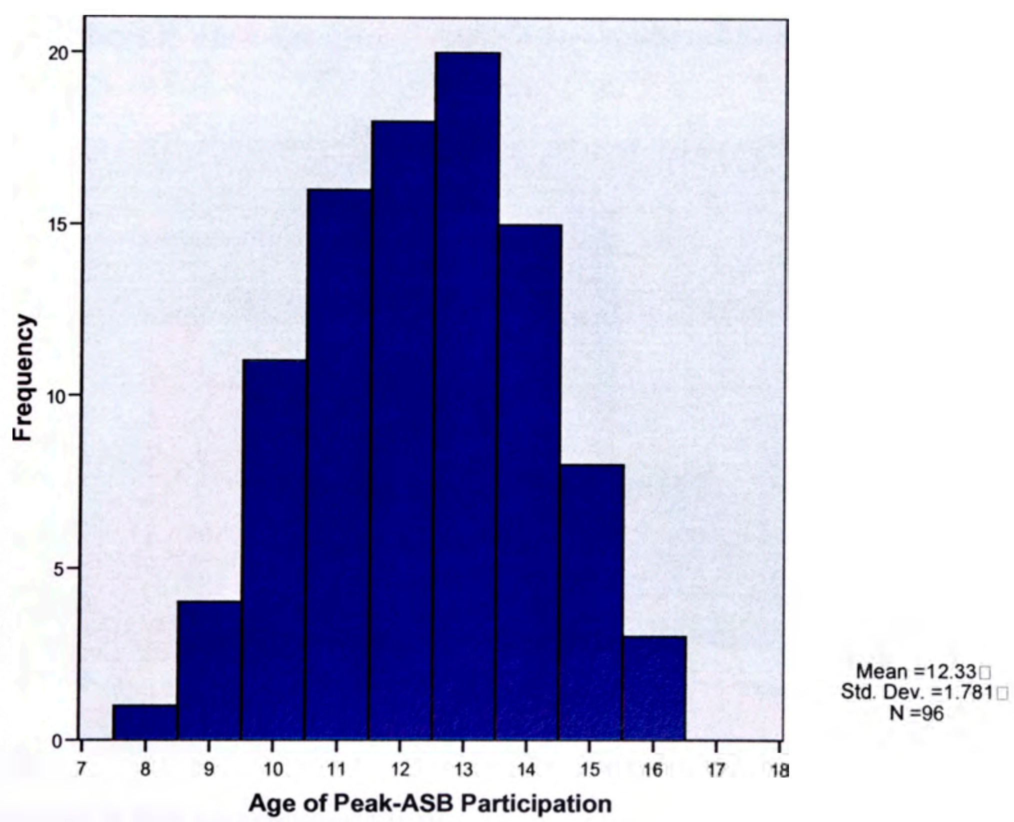

Figure 6.8b. Mean Age of Peak-ASB participation for boys.

(4) First-Age ASB (High-school only). As an additional test of measurement validity, it was hypothesized that previous findings of a relationship between 'early' first participation in ASB and a greater Total ASB participation would be replicated in this sample. For high-school girls and boys, first age of any ASB (first-age ASB) was computed (i.e. the earliest engagement in any ASB). Figures 6.9a and 6.9b display the distribution of first-age ASB, along with means and standard deviations for girls (n = 75) and boys (n = 134). Whilst the use of ANCOVA in nonrandomized designs has been subject to some debate, it has been suggested that this methodology may be useful (despite non-random assignment) in the context of exploration of a dataset to understand patterns of shared variance (Miller & Chapman, 2001). It was expected that older participants may have accumulated a greater Total ASB participation because of having had a longer length of time to participate in behaviours. Thus, the current age of the participant (i.e. age at interview) was entered into the equation. Analysis of Covariance (ANCOVA) revealed that for boys an earlier age of ASB participation was significantly associated with higher Total ASB ($F_{8,124}$ = 2.612, p = .011; Figure 6.10a). For girls, ANCOVA results only approached significance, ($F_{7,66}$ = 2.009, p = .067; Figure 6.10b), however, a polynomial planned contrast (adjusting for the unequal numbers in each age group) revealed a significant linear trend (p = .035).

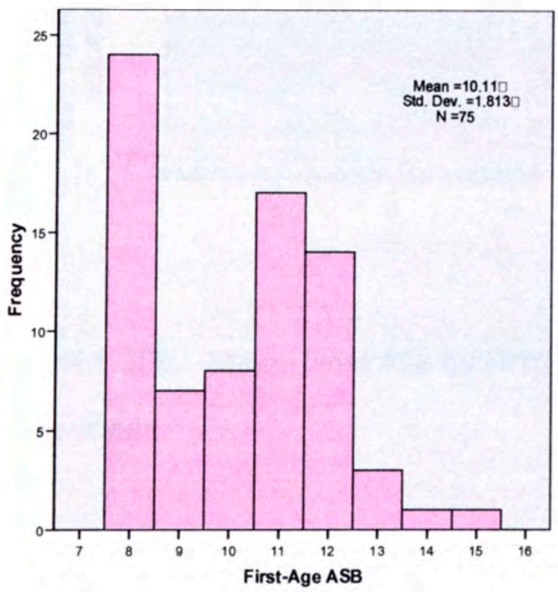

Figure 6.9a.

Mean First-Age of ASB participation for girls.

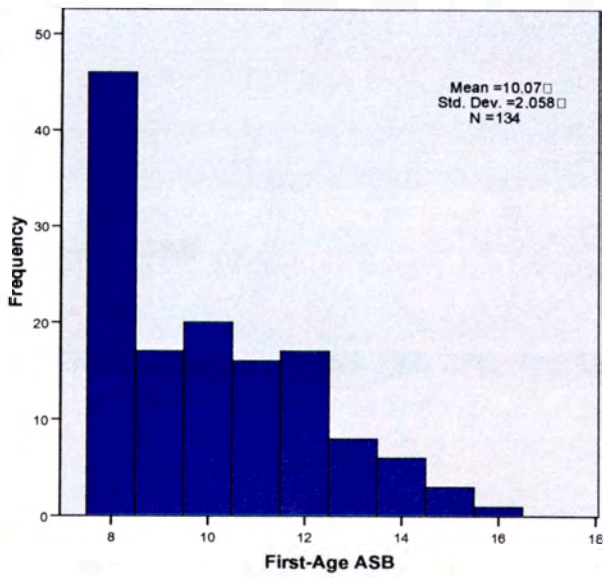

Figure 6.9b.

Mean First-Age ASB participation for boys.

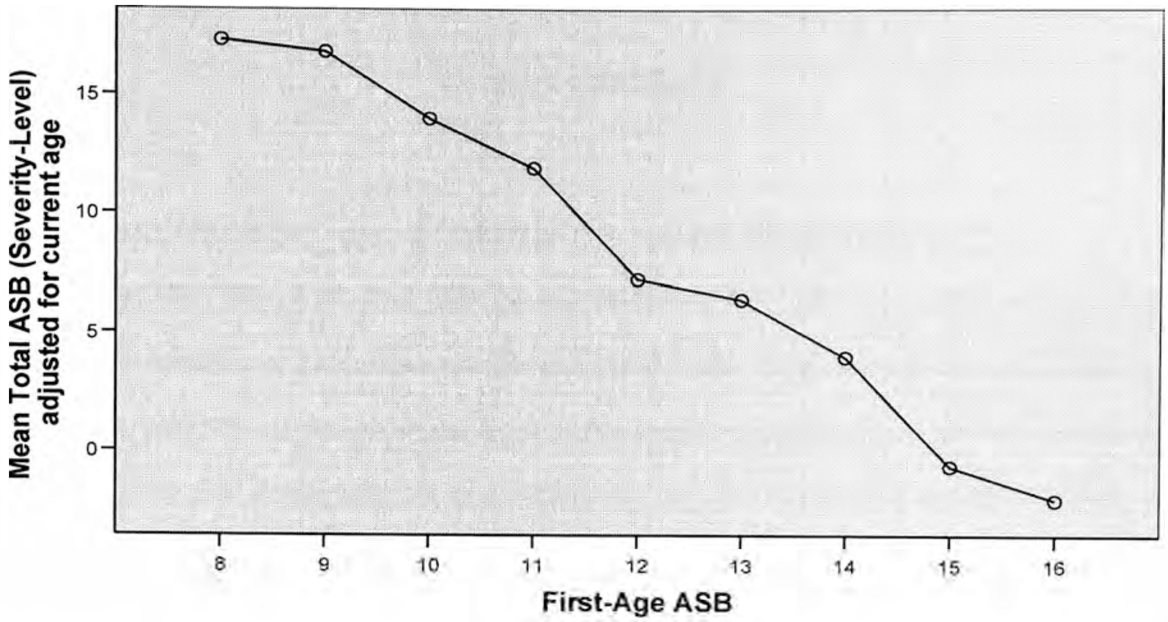

Figure 6.10a. Mean Total ASB by First-Age of ASB participation for boys adjusted for current age.

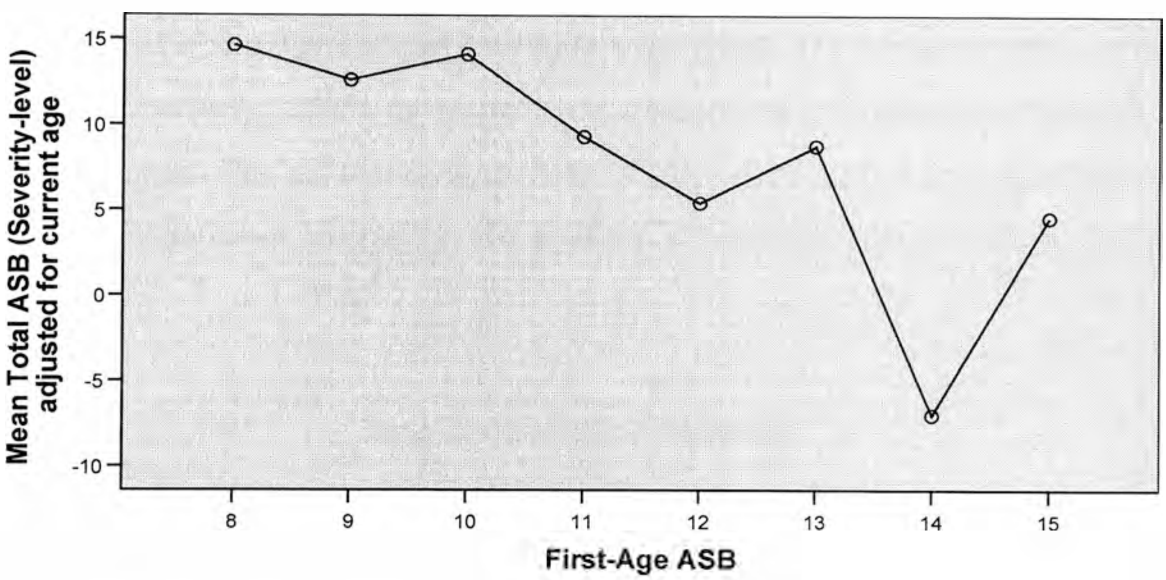

Figure 6.10b. Mean Total ASB by First-Age of ASB participation for girls adjusted for current age.

Summary: Operationalising ASB Participation

Examination and significance testing between group means provided evidence of the validity of the ASB measures used in the current study.

Antisocial Attitudes

Antisocial attitudes (ASA) were included in the current study because it was hypothesized that, like ASB, ASA will show a relationship with pubertal development. Although personality constructs remain relatively stable over time (Caspi & Roberts, 2001; Lewis, 2001b), some variation in an individual's attitudes may occur during the adolescent phase of development (e.g. Canals et al., 2005; Choudhury et al., 2006; Kuhn, 2006; Paikoff & Brooksgunn, 1991). Clearly, only *current* antisocial attitudes can be measured reliably, therefore, hypothesis testing (Section 4: Results) will be limited to associations between pubertal stage and timing and current ASA. As described in Chapter 3 (Materials section), the Antisocial Attitudes Scale (ASAS; Appendix 3.2) consists of 32 items that were designed to measure attitudes regarding affective and interpersonal style (Factor 1), behavioural style (Factor 2), and items that relate specifically to romantic and sexual interactions (Factor 3). This section of the chapter will present evidence relating to the measurement validity and reliability of the ASA Scale and factors. The distributions on these factors will be provided along with tests of differences between sex and age (i.e. primary-school versus high-school) group means.

Internal Validity and Reliability

The Antisocial Attitudes Scale was based on other self-report scales that have been used with adolescent samples to test the two-factor structure of the Psychopathy Checklist: Youth Version (PCL:YV; Forth, Kosson, & Hare, 2003a). The ASA Scale was designed as a *current measure only* of attitudes that were categorized on three dimensions: Factor 1: Affective (e.g. lack of guilt, empathy, or remorse); Factor 2: Behavioural (e.g. impulsive, irresponsible, thrill seeking); and Factor 3: Relationship Behaviour (promiscuous, self-serving; high school girls and boys only).

It was considered inappropriate to ask younger children to respond to items relating to sexual and romantic relationships, so primary-school children responded to only 28 items rather than 32. As only the high-school students completed the additional four items measuring sexual and romantic relationship functioning, these items were analyzed separately; the 4-item Relationship Behaviour scale was found to be unreliable and has been excluded from analyses. Previous research has found that males score higher than females on measures of antisocial attitudes (Hubbard & Pratt, 2002; Marsee, Silverthorn, & Frick, 2005), thus, the majority of analyses were performed for boys and girls separately. External validity was tested by examining sex and age (primary-school and high-school) group differences and by correlating antisocial attitudes scores with antisocial behaviour scores.

Affective and Behavioural Factors (28-item scale): Content and Construct Validity

Content and construct validity of the two-factor structure is examined by performing inter-item correlations among scale items and conducting factor analysis to test the theoretical factor structure. The internal reliability of the scale is then examined by conducting item-analysis.

Inter-item Correlations. Each factor is comprised of seven sub-constructs, (referred to hereafter as constructs), with two items measuring each construct (14 items per factor) (see Table 6.10). Thus, in addition to correlating with the factor-total score, each item within the construct should correlate with the corresponding item for that construct. Although the majority of constructs produced inter-item correlations that were significant at $p = .01$ for both boys (Factor 1: $r = .215$ to .268; Factor 2: $r = .157$ to .319; Appendix 6.2) and girls (Factor 1: $r = .220$ to .502; Factor 2: $r = .163$ to .434; Appendix 6.3), the three constructs contained items that did not correlate with each other: Shallow Affect, Liar and Lacks Goals, and the following two constructs contained items that were negatively correlated with each other: Irresponsible and Parasitic Behaviour. The lack of positive correlation within these constructs is most likely explained by poor item construction as some of these items were endorsed by a large proportion of the sample (i.e. 'often applies' was chosen by 30 - 40% of the sample in comparison to other items endorsed by only approximately 10 – 15% of the sample).

Table 6.10. Original Antisocial Attitudes by Factor, Constructs, and Items.

Factor 1: Affective	**Factor 2: Behavioural**
Narcissistic • I like to spend a lot of time talking about myself. • What I want is more important that what others want.	**Stimulation Seeking** • I am bored with most things that I have to do. • I like doing risky things or things I shouldn't do.
Manipulative • I can usually get other people to give me what I want. • I like talking people into giving me things or doing things they really don't want to do.	**Lacks Responsibility** • People are often telling me to act more responsibly. • I feel like I am always being blamed for things that are not my fault.
Lacks Remorse • I don't feel really bothered if I do something wrong. • I do what I want to [even if some don't] like it.	**Poor Anger Control** • I yell or get angry when [told] I did something wrong. • I can get so angry that I throw things.
Lacks Empathy • I don't really worry about hurting other people's feelings • ... people are bothered by things I do, but can't worry ...	**Impulsive** • I do what I feel like doing in the moment...... • Sometimes, even though I know something is not a good idea, I can't stop myself from doing it.
Impression Management • I think I am better than most people. • I would say things about myself that are not true so other people would know how important I am.	**Parasitic Behaviour** • If I want something .. I keep asking for it even if ...... • I usually let other people do what needs to be done.
Liar • It doesn't matter to me if someone finds out I told a lie. • *I am not very good at fooling others or telling lies.*	**Irresponsible** • *I really care about doing chores and returning things.* • I am often late for school or don't do my homework.
Shallow Affect • People tell me to talk about how I feel/describe feelings • *I am able to describe my feelings easily .... how I feel*	**Lacks Goals** • *I spend time in a hobby, sport, or some type of activity* • I live day to day and don't think about the future.
Factor 3: Relationship	
Promiscuous • Most of my relationships last less than 3 months, and include a number of 'one-time hook-ups'. • I like to maintain more than one romantic/sexual relationship at a time..	**Self-serving** • My romantic relationships can be described as unstable; my partners are often angry at me. • If a relationship breaks up, I don't worry about the other person, I just get on with my life.

Italicized items are reverse-coded
Shaded items were not positively correlated

Some poorly correlated items were (reverse-coded) items, which had required frequent explanation (particularly to younger participants) during the administration procedure (e.g. "I really care about doing chores and returning things"). Thus, a number of participants may have been confused by the reversed wording in the items, possibly resulting in unreliable responses.

Factor Analysis. The Blom method of testing the Normal P-P Plot indicated that each of the ASA items was normally distributed and therefore suitable for factor analysis. Principal factor analysis of the 28 items revealed a nine-factor structure as the "best fit", which explained 44% of the variance. However, the scree plot (Figure 6.11) indicated that the first factor accounted for the majority of the variance. The majority of the 28 items loaded on one principal factor, and eight items were scattered across the other factors. Thus, within a particular construct, factor analysis was able to identify which of the (above-noted) uncorrelated items were not valid items (see Table 6.10 for item descriptions and Appendix 6.4 for factor loadings). The removal of these eight items produced a seven-factor eigenvalue model (47% of the variance), and a single-factor scree plot model. Similar to the treatment of ASB factors, it was determined that a seven-factor model was unsuitable of the type of analyses being performed in the current study, and that a single factor model would not differentiate between types of ASA. Therefore, consistent with what has been generally accepted as the factor structure for the PCL:YV, a two-factor structure was examined. The initial component matrix revealed that all of the remaining 20 items loaded on one factor, with some items cross-loading on the second factor (KMO = .80, $p < .0001$), and oblimin rotation resulted in the items loading on the theoretically derived two-factor structure (Table 6.11). Therefore, the two-factor structure of the Antisocial Attitudes Scale was determined to be valid, and has been operationalized as being comprised of 10 items (two items for each of five constructs) per factor, rather than the original 14 items.

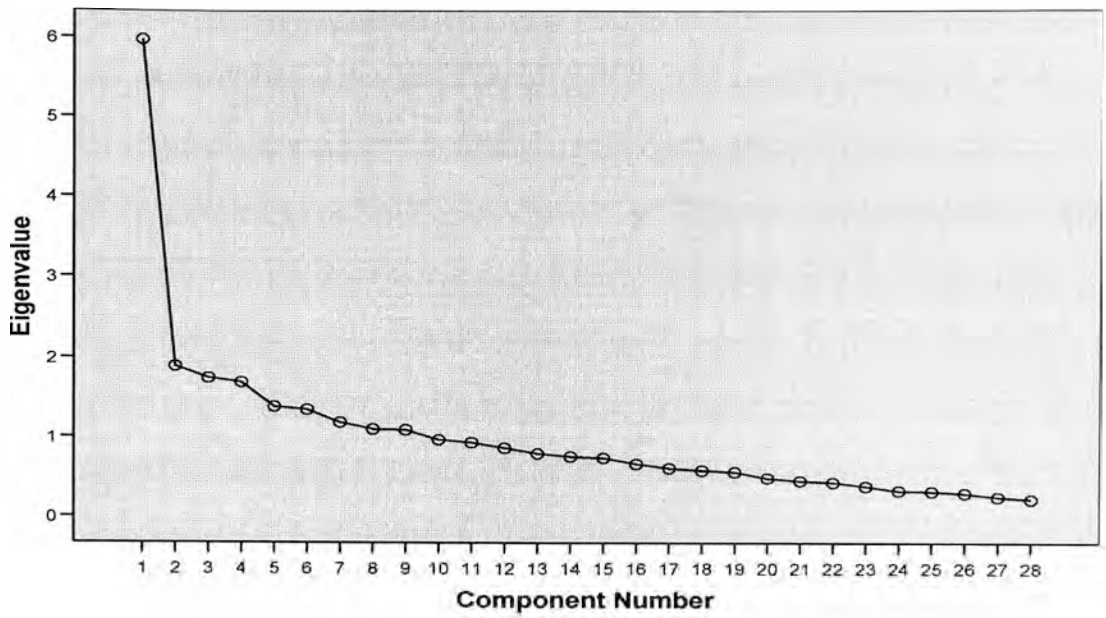

Figure 6.11. Scree plot on 28 ASA items.

Table 6.11. Two-factor structure of the Antisocial Attitudes Scale.

	Initial Rotation		Varimax Rotation[a]	
ASA Construct	Factor 1	Factor 2	Factor 1	Factor 2
Narcissistic	**.697**	-.467	**.826**	.145
Manipulative	**.787**	-.173	**.688**	.419
Lacks Remorse	**.745**	-.180	**.662**	.385
Lacks Empathy	**.649**	.014	**.459**	.459
Impression Management	**.658**	-.538	**.847**	.066
Stimulation Seeking	**.729**	.377	.266	**.776**
Lacks Responsibility	**.654**	.377	.212	**.725**
Poor Anger Control	**.641**	.159	.353	**.559**
Impulsive	**.610**	.133	.348	**.518**
Parasitic Behaviour 1	**.614**	.015	.434	**.436**
Irresponsible 2	**.467**	**.486**	.001	**.674**

Extraction Method: Principal Factor Analysis.
Rotation Method: Oblimin with Kaiser Normalization.
a Rotation converged in 3 iterations.

Affective and Behavioural Factors (28-item scale): Reliability Analysis

Cronbach's alpha. The original two 14-item factor structures were analyzed separately for internal reliability. The initial (standardized) alpha coefficient for Factor 1 of .740 (14 items) was improved to .772 (10 items) by dropping both items from each of the

Liar and Shallow Affect constructs. The results of the scale reliability analysis revealed that scale reliability could not be meaningfully improved by removal of any other items (i.e. all remaining items contributed to the overall reliability of the scale). The initial (standardized) alpha coefficient for Factor 2 of .699 (14 items) was improved to a coefficient of .749 (10 items) by dropping the first item of the Irresponsible construct, the second item from the Parasitic Behaviour construct, and both items from the Lacks Goals construct. As alpha usually increases in relation to the number of the items in the scale (Cronbach, 1951; Cronbach et al., 1972)[10], it is evident that these (now excluded) items were not measuring the same construct as the majority of items.

Factor 3 Relationship Behaviour (4-item scale): Validity and Reliability Analysis

For high-school girls (n = 78), all relationship variables were significantly correlated at p = .01 or p = .05 (r = .207 to .393). However, for high-school boys (n = 137), the only significant inter-correlations identified were between the first sexual relationship item and the two romantic relationship items (r = .300 and .304, p = .01; see Appendices 6.2 and 6.3). Correlations between each of the items and their corresponding (two-item) constructs were also significant at p = .01 for both girls (r = .616 to .907) and boys (r = .492 to .888), and between individual items and the total Factor 3 subscale (girls, r = .602 to .792; boys, r = .457 to .726). Scale reliability analysis revealed that all four items contribute to the Factor 3 scale (alpha = .514).

Summary: ASA Internal Validity & Reliability

After detailed analysis, the overall basic factor structure of the ASA Scale was retained; however, some items were dropped from the scale as they compromised the validity and reliability of the scale, and did not contribute to a parsimonious factor structure. The eight excluded items were identified by concurrent examination of results from 1) the initial factor structure analysis, 2) scale reliability analysis (alpha and split-half), and

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[10] See Peterson (1994) and Kopalle & Lehmann (1997) for a review of how the number of items in a scale impacts the magnitude of coefficient alpha.

3) inter-item correlations analysis. The ASA Scale thus maintained a two-factor structure (Factor 1: Affective and Factor 2: Behavioural) with 10 items per factor. The additional 4-item Relationship subscale (Factor 3) was not reliable. Therefore, Current ASA is operationalized as the total score on Factors 1 and 2. However, the Factor 3 subscale was included in the remainder of analyses in this chapter for the purposes of fully exploring the validity of all items. Thus, in the next section of this chapter, external validity of the ASA Scale is assessed by examining the distributions and significance testing of (age and sex) group differences, as well as associations between ASA and ASB measures.

External Validity

Affective and Behavioural Factors (28-item scale): Distributions & Group Differences

Items on the ASA Scale were scored on a likert scale of zero to 3. Following the removal of items found to be unreliable measures of Current ASA, the possible score ranges from zero to 30 for each of Factors 1 and 2, with a maximum total of 60 for the two factors combined. Table 6.12 displays the means and standard deviations for each factor and combined factor-totals for girls and boys for primary and high schools. As expected, across all schools, boys (M = 20.35) reported significantly higher antisocial attitudes than girls (M = 17.19) on Factors 1 and 2 combined ($t = 3.067_{278}$, $p = .001$, one-tailed). Boys' scores were significantly higher than girls' on both Factor 1 (M = 8.94, 7.47 respectively; $t = 2.554_{296}$, $p = .006$, one-tailed) and Factor 2 (M = 11.55, 10.13 respectively; $t = 2.454_{295}$, $p < .01$, one-tailed; see Figure 6.12a). Most of the difference in ASA scores between boys and girls is accounted for within the primary-school samples. Primary-school boys reported significantly higher antisocial attitudes than primary-school girls on Factor 1 ($t = 2.630_{83}$, $p = .005$, one-tailed (M = 8.92; 6.11), on Factor 2 ($t = 2.237_{79}$, $p = .014$, one-tailed (M = 11.48; 8.97), and on Factors 1 and 2 combined ($t = 3.001_{74}$, $p = .002$, one-tailed (M = 20.26; 14.30); Figure 6.12b). However, high-school boys' scores were only slightly higher than girls (approaching significance at $p < .10$) for Factors 1 and 2 and the combined factor-total (Figure 6.12c).

Table 6.12. ASA means, standard deviations and significance test results for girls and boys by factor.

Sex Differences									
Antisocial Attitudes Scale Factor	Girls			Boys			Statistical test results		
	n	*M*	*SD*	*n*	*M*	*SD*	*t*	*df*	*p*
				Primary Schools					
Factor 1: Interpersonal	35	6.11	4.21	50	8.92	5.24	-2.630	83	.005
Factor 2: Behaviour	35	8.97	5.00	46	11.48	4.99	-2.237	79	< .05
Factor 1 & 2 ASA Total	33	14.30	7.83	43	20.26	9.09	-3.001	74	.002
				High Schools					
Factor 1: Interpersonal	75	8.11	4.94	138	8.95	4.64	-1.237	211	.109
Factor 2: Behaviour	74	10.68	4.51	142	11.58	4.87	-1.325	214	.094
Factor 1 & 2 ASA Total	67	18.61	8.97	137	20.62	8.61	-1.543	202	.062
Factor 3: Relationship	79	1.85	2.18	140	1.75	1.79	.360	217	.358
				All Schools					
Factor 1: Interpersonal	110	7.47	4.79	188	8.94	4.79	-2.554	296	.010
Factor 2: Behaviour	109	10.13	4.72	188	11.55	4.88	-2.454	295	.010
Factor 1 & 2 ASA Total	100	17.19	8.81	180	20.53	8.70	-3.067	278	.001

School-type Differences									
Antisocial Attitudes Scale Factor	High School			Primary School			Statistical test results		
	n	*M*	*SD*	*n*	*M*	*SD*	*t*	*df*	*p*
				Girls					
Factor 1: Interpersonal	75	8.11	4.94	35	6.11	4.21	2.061	108	< .05
Factor 2: Behaviour	74	10.68	4.51	35	8.97	5.00	1.779	107	< .05
Factor 1 & 2 ASA Total	67	18.61	8.97	33	14.30	7.83	2.351	98	.011
				Boys					
Factor 1: Interpersonal	138	8.95	4.64	50	8.92	5.24	.037	186	.481
Factor 2: Behaviour	142	11.58	4.87	46	11.48	4.99	.119	186	.453
Factor 1 & 2 ASA Total	137	20.62	8.61	43	20.26	9.09	.239	178	.406

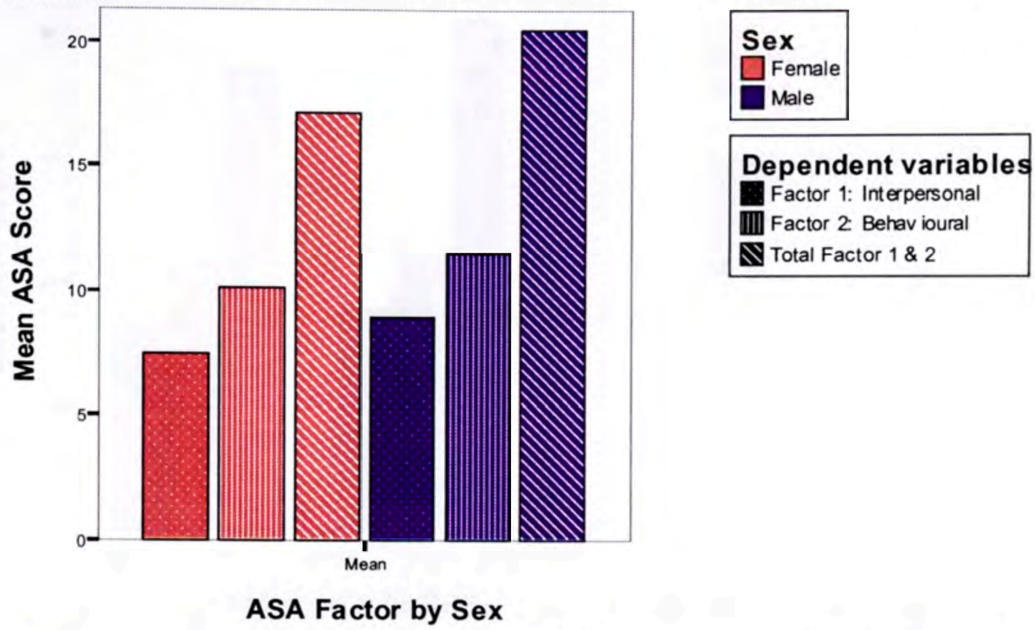

Figure 6.12a. Mean ASA Score by factor for all schools girls and boys.

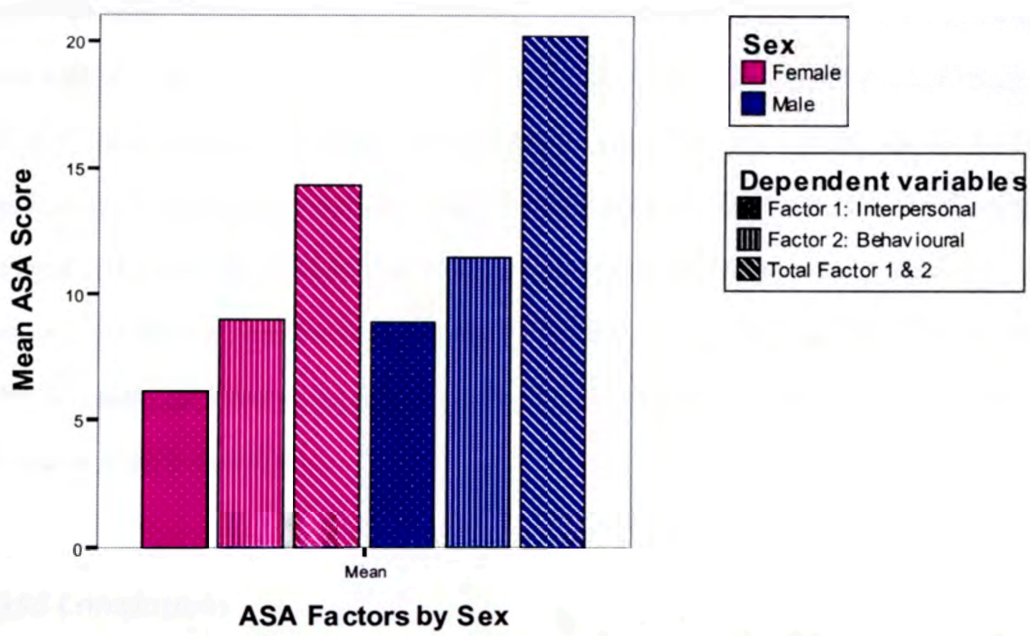

Figure 6.12b. Mean ASA Score by factor for primary-school girls and boys.

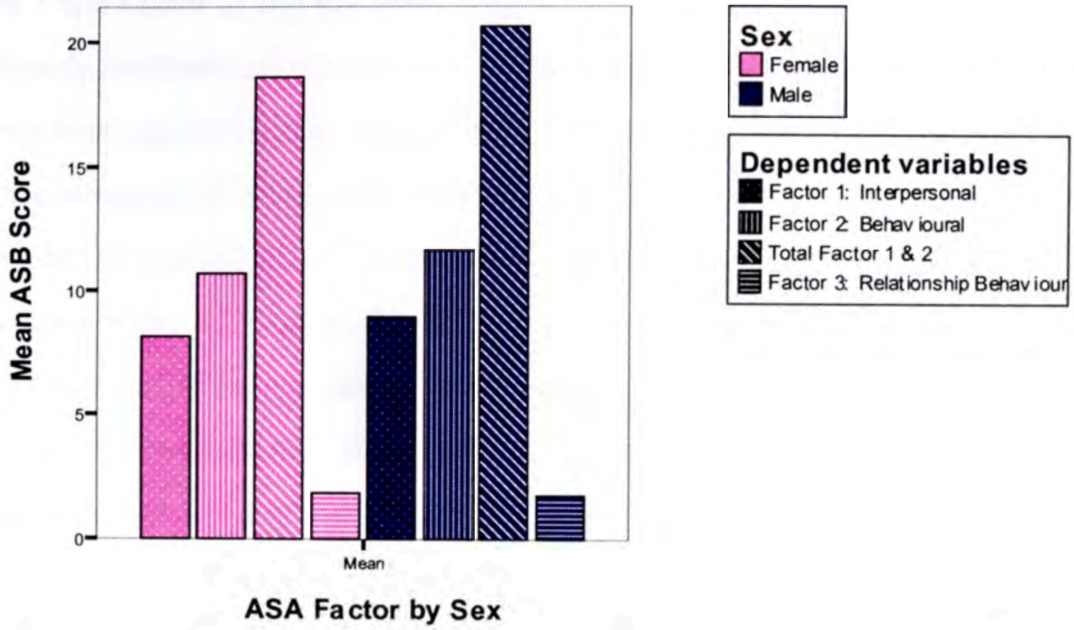

Figure 6.12c. Mean ASA Score by factor for high-school girls and boys.

As expected, high-school girls reported higher antisocial attitude scores than primary-school girls on ASA Total and the two factors separately (Factor 1 & 2: $t = 2.351_{98}$, $p = .011$, one-tailed; Factor 1: $t = 2.061_{108}$, $p < .05$, one-tailed; Factor 2: $t = 1.779_{107}$, $p < .05$, one-tailed; Figure 6.13a). However, high-school boys did not report higher antisocial attitude scores than primary-school boys (Figure 6.13b). This may be a reflection of the fact that the high school sample of boys were drawn from a 'selective' (i.e. high-performing) school (i.e. hold more *pro*-social attitudes than the general population of high-school boys), or it may suggest that for boys, antisocial attitudes are found earlier and are more stable over time.

ASA & ASB Correlations

External validity was tested further by measuring the correlation between antisocial attitude scores with cumulative antisocial behaviour scores (Cumulative ASB), and (for high-school samples only) with current antisocial behaviour scores (Current ASB). It was expected that reports on these constructs would be positively correlated; that is, those participants reporting relatively higher antisocial attitudes should report relatively higher ASB participation. Overall, across all ages, both of the ASA factors

(Factor 1 and Factor 2) and the total score for these factors (Total ASA) were significantly positively correlated ($p < .01$, one-tailed) with Cumulative ASB for both girls and boys separately and combined ($r = .348$ to $.585$; Table 6.13). Because the ASA Scale is a measure of *current* antisocial attitudes, the correlations between ASA factor scores and Current ASB scores were also tested for high-school girls and boys (Table 6.14). Examination of Table 6.13 and 6.14 reveals that the correlations between ASA factors and Total ASB were small, but consistently, larger than those between ASA factors and Current ASB ($r = .342$ to $.587$; $p < .01$, one-tailed). This finding indicates that antisocial attitudes are more strongly related to persistent or enduring ASB participation patterns, than to transient (i.e. in the past 12 months) ASB participation. Across sexes, the Behavioural Factor (Factor 2) consistently produced higher correlations with the ASB measures than did the Affective Factor (Factor 1), indicating that Factor 2 is measuring attitudes that support participation in ASB.

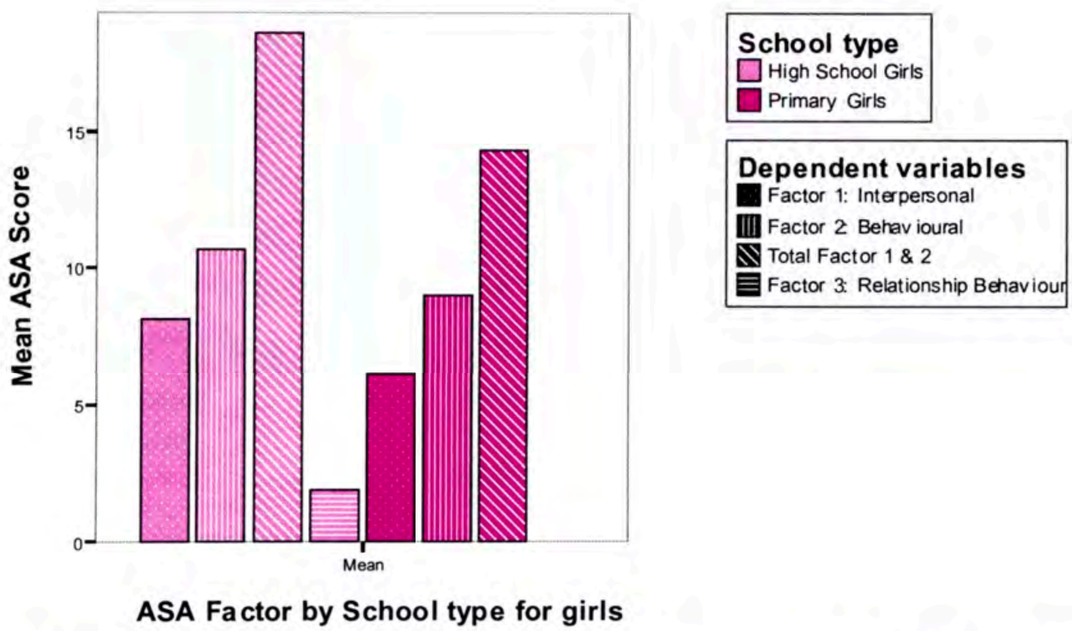

Figure 6.13a. Mean ASA Score by factor for high-school and primary-school girls.

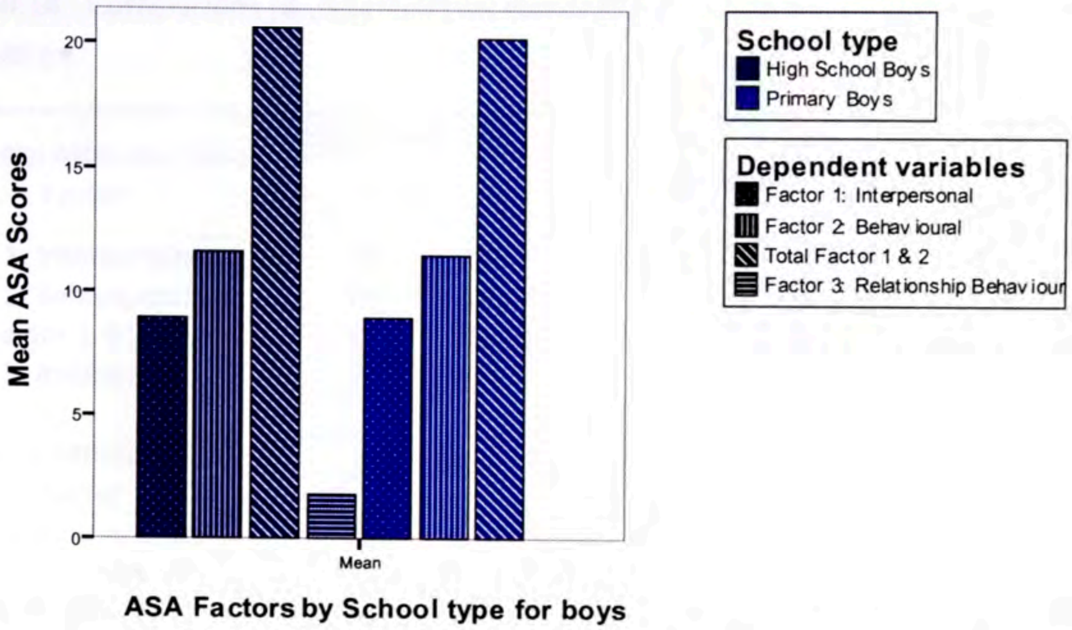

Figure 6.13b. Mean ASA Score by factor for high-school and primary-school boys.

Table 6.13. Correlations for ASA factor scores with Cumulative ASB scores.

Antisocial Attitudes Scale Factor	Cumulative ASB (Severity-level)					
	Girls		*Boys*		*Girls & Boys*	
	n	*r*	*n*	*r*	*n*	*r*
			Primary Schools			
Factor 1: Interpersonal	35	.348*	50	.424**	85	.433**
Factor 2: Behavioural	35	.458**	46	.493**	81	.487**
Total Factor 1 & 2	33	.482**	43	.493**	76	.512**
			High Schools			
Factor 1: Interpersonal	73	.410**	137	.356**	210	.379**
Factor 2: Behavioural	71	.562**	141	.470**	212	.503**
Total Factor 1 & 2	65	.585**	136	.466**	201	.508**
			All Schools			
Factor 1: Interpersonal	108	.427**	187	.362**	295	.396**
Factor 2: Behavioural	106	.526**	187	.468**	293	.497**
Total Factor 1 & 2	98	.584**	179	.465**	277	.515**

** Correlation is significant at the 0.01 level (1-tailed).
* Correlation is significant at the 0.05 level (1-tailed).

Table 6.14. Correlations (and partial correlations) for ASA factor scores with Current ASB scores.

Antisocial Attitudes Scale Factor	High-School Girls		High-School Boys		Girls & Boys	
	Current ASB					
	n	*r*	*n*	*r*	*n*	*r*
Factor 1: Interpersonal	70	.455**	134	.342**	204	.382**
Factor 2: Behavioural	69	.525**	138	.460**	207	.484**
Total Factor 1 & 2	62	.587**	133	.447**	195	.492**
Factor 3: Relationship	74	.395**	136	.415**	210	.398**

Antisocial Attitudes Scale Factor	*Current ASB with Non-current ASB partialled out*					
	df	*r*	*df*	*r*	*df*	*r*
Factor 1: Interpersonal	49	.430***	110	.328***	162	.372***
Factor 2: Behavioural	49	.471***	110	.447***	162	.461***
Total Factor 1 & 2	49	.499***	110	.440***	162	.468***
Factor 3: Relationship	49	.247*	110	.313***	162	.291***

* Correlation is significant at the 0.05 level (1-tailed).
** Correlation is significant at the 0.01 level (1-tailed).
*** Correlation is significant at the 0.001 level (1-tailed).

We might expect a measure of current antisocial attitudes to be tapping into a relatively stable personality construct, and this in turn might lead to a higher participation in antisocial behaviour across the life span. The aim of the current study is to investigate whether individuals experience a temporary increase in antisocial attitudes and antisocial behaviour during pubertal development onset. Therefore, partial correlation analysis was performed to identify the separate role of Cumulative ASB (which includes Current ASB) in our measure of Current ASB. The number of participants included in analyses decreased substantially because of missing data. Despite this, when non-current participation in ASB (Total Cumulative ASB - Current ASB) was partialled out, the majority of correlations between ASA and Current ASB remained significant, ($r = .313$ to $.499$; $p < .001$, girls' Factor 3 scores, $r = .247$; $p < .05$ Table 6.14).

Summary: External Validity

Consistent with theoretical predictions, external validity analyses revealed that overall, boys reported higher antisocial attitudes than girls, although the high-school boys in this sample reported comparatively lower antisocial attitudes than would be expected. Likewise, statistically significant medium to large positive correlations were found between antisocial atttitude factors and Current Antisocial Behaviour, both before and after controlling for he probable confounding influences of the non-current portion of Cumulative ASB participation.

Summary: Operationalizing Antisocial Behaviour & Antisocial Attitudes

In summary, the variables operationalized above (i.e. ASA Factor 1: Interpersonal, ASA Factor 2: Behavioural, and Total ASA; Cumulative and Current ASB with Minor, Major, and Total factor subscales; and Age of Peak ASB Participation) were determined to be suitable for measuring the constructs of antisocial behaviour and antisocial attitudes with this sample of children and adolescents. A weighted severity-level of ASB (Total ASB) was computed only for the purposes of operationalizing age of peak-ASB participation and first age of ASB participation. For the purposes of investigating the primary aim of the current study examining whether executive functioning mediates a relationship between pubertal development and antisocial behaviour, three ASB measures were operationalized. For high-school participants, the age of peak-ASB participation measure will be used to examine whether the age of ASB participation is positively correlated with the age of pubertal onset. The relationship between pubertal onset and ASB participation will be further investigated with the Current ASB measure to test whether there is a relationship between current pubertal development stage and current ASB participation, and between current executive functioning (as a possible mediator) and current ASB participation. For primary-school and high-school participants, the Cumulative ASB measure will be used to investigate the relationship between pubertal timing (early, on-time, late) and persistent (continuing) participation in ASB, and secondly to investigate the relationship between reduced (current) executive functioning and ASB participation. The antisocial attitudes measure was operationalized as a current measure only. The theoretically-derived two-factor structure (Factor 1: Affective, Factor 2: Behavioural) was confirmed, but four items on each factor were found to be unreliable and were dropped from the scale. The results from validity and reliability tests on Factor 3: Relationship Behaviour were mixed; due to these inconclusive results, and because only high-school students completed this factor, it was decided not to include this factor in operationalization of ASA. Thus, ASA was operationalized as the total of Factor 1 and Factor 2.

The primary relationships being investigated in the current study include associations between pubertal development and ASB, pubertal development and executive function, and executive function and ASB. No theoretical relationship exists between ASA and executive function, therefore only associations between pubertal development and Current ASA will be investigated. However, both Cumulative ASB and Current ASB will be included in analyses examining associations between pubertal development, executive function and ASB. The next chapter operationalizes executive functioning, and presents the associated sex and age distributions for this construct.

Chapter 7: Executive Functioning Variables

In addition to the robust findings that participation in antisocial behaviour is related to reduced executive functioning (e.g. Bergeron & Valliant, 2001; Blair, 2001; Deckel, Hesselbrock, & Bauer, 1996; Dolan & Park, 2002; Lueger & Gill, 1990; Moffitt & Henry, 1989; Seguin & Zelazo, 2005), recent research has found evidence to suggest that a temporary 'dip' in executive functioning may occur during adolescence (Blakemore & Choudhury, 2006; McGivern et al., 2002), which is a developmental period of 'peak' antisocial behaviour participation (Caspi et al., 1993; Caspi & Moffitt, 1991; Felson & Haynie, 2002; Markey et al., 2003; Sonis et al., 1985; Williams & Dunlop, 1999). Although there have been no conclusive findings that this temporary decline in executive functioning is linked to the onset of pubertal development, a number of researchers have suggested that these deficits have an aetiology that is linked to hormones released during pubertal development (Buchanan et al., 1992; Susman et al., 1987; Udry & Talbert, 1988). Therefore, a primary aim of this research is to explore whether a temporary reduction in executive functioning mediates a relationship between pubertal development onset and antisocial attitudes and behaviour. Prior to testing the hypotheses associated with this aim, this chapter describes how executive functioning was operationalized and presents evidence for measurement validity and reliability by examining group (i.e. age and intellectual) differences. The theoretical framework for operationalizing executive functioning was adapted from the analysis by Miyake et al. (2000). This chapter begins by briefly describing each of the cognitive tasks administered and how each imposes demands on executive cognitive control. The next section explains how the data collected from administration of several executive functioning tasks were transformed into a unified measure of executive function. Finally, the process of separating executive functioning measurement from the measurement of overall cognitive ability (i.e. general intellectual functioning) is described, and the validity of measurement for both of these constructs is examined.

Measuring Executive Function

As reviewed in Chapter 2, executive functioning may be broadly defined as the higher order functions of the brain, which are responsible for planning, attending to, and organizing behaviour. Miyake et al. (2000) tested the latent variable structure of three executive function measures frequently discussed in the literature: shifting between mental-sets, updating information in working memory, and response inhibition. Miyake et al. suggest that these three executive functions (shifting, updating, and inhibition) are fundamental executive processes, and are easier to operationalize than higher level concepts like 'planning'. By conducting confirmatory factor analysis and structural equation modeling, Miyake et al. found that these three constructs were independently measuring individual underlying latent variables, but that a combined three-factor model produced a significantly better fit than the individual constructs alone. From their results, Miyake and colleagues concluded "...that it is important to systematically administer multiple executive tasks... [g]iven that executive functions are separable and that different executive functions contribute differentially to various executive tasks..." (p 91).

Thus, Miyake et al. (2000) postulate that relying on any one of the commonly used tests of executive function is not a reliable method of measurement, particularly given that for some of these measures, the overall evidence for construct validity is rather limited. Expanding these findings, Henry and Phillips (2006) suggest that dependable results *have been found* when measuring executive function with tasks of verbal fluency. Verbal fluency tasks include phonemic, semantic and alternating fluency tests, which measure "...the higher-level processes that permit contextually sensitive, flexible responses" (p 529). As will be discussed, measures of verbal fluency may be conceptualized as tapping into all three latent constructs (updating, inhibition, and mental-set shifting) of executive function identified by Miyake et al. Thus, the current study included measures of verbal fluency in addition to tasks individually measuring each of these three executive function constructs (i.e. Letter-Number Sequencing subtest of the WISC-IV, Updating; Stroop, Inhibition; and Trail Making Test, Shifting). Although multiple measures of executive function are preferred as a means of identifying the differential contributions of various executive tasks, data analysis would be simplified by a unified measure of executive function. Thus, the data w examined to determine its suitability for developing a single measure of executive function.

Executive Function Tasks

Baddeley's (1996) model of cognitive functioning comprises a central control structure called the 'central executive', which is thought to be responsible for the control and regulation of (comparatively) more basic cognitive processes. Thus, measures designed to assess executive function typically involve testing an individual's ability to control their basic cognitive functioning. Tests of verbal fluency are a standard choice for this type of neurological assessment as these measures assess control of generative response (Henry & Phillips, 2006). Under time-restricted conditions, participant's are required to generate as many responses as possible given specific search criteria (typically phonemic or semantic categories), which involves engagement in associative recall and retrieval of words. This verbal-generation task is often accompanied by constraints on 'acceptable' responses (e.g. no proper nouns, no repetitions). A third type of verbal-fluency task requires the participant to switch between category-types (e.g. phonemic and semantic categories). As explained by Henry and Phillips (p 531), "[t]he capacity for mental flexibility or switching, and the ability to avoid repetitive, perseverative behaviour, are widely regarded as core to mainstream conceptualizations of executive functioning".

In addition to the three types of verbal fluency tests (phonemic, semantic, alternating) as outlined above, a task was chosen to represent each of the three latent constructs identified by Miyake et al. (2000) (shifting, updating, inhibition). The selected tasks were chosen because they were determined to be the best measures for each of the executive function measures. The Trail Making Test (TMT) required participants to shift between a 'letter set' and a 'number set' (Shifting). The Letter-Number

Sequencing Test (Wechsler, 2003) required participants to update information held in short-term memory (Updating), and the Stroop (1935)is a widely-recognized test of response inhibition requiring respondents to inhibit an automatic response and produce the desired response (Inhibition). Although briefly mentioned in the Method section of this thesis previously, each of these tasks, and how they purport to measure executive function, is reviewed below.

Shifting between tasks or mental sets ('Shifting')

In the cognitive literature, shifting is generally defined as the ability to shift back and forth between multiple tasks, operations, or mental sets (see Monsell, 1996). Thus, shifting measures an individual's "... ability to engage and disengage [in] appropriate task sets ... but may also (or even instead) involve the ability to perform a new operation in the face of proactive interference or negative priming" (Miyake et al., , p 56). The process of shifting between mental sets thus requires very complex and sophisticated cognitive function and control, making this a prime exemplar of executive function. The Trail Making Test (TMT) was chosen as a measure of shifting because participants are required to alternate between following a set of numbers in numerical order, and following a set of letters in alphabetical order.

Trail Making Test. In the control condition (TMT-A) participants were required to construct a pencil trail by connecting numbered circles in numerical order from 1 to 15 in as little time as possible. Part B (TMT-B) is more complex than Part A because it requires the subject to connect numbers and letters in an alternating pattern (1-A-2-B-3-C...) as quickly as possible. Participants were told to work as quickly as possible avoiding any errors on both the control and experimental condition of the Trail Making Test. Participants were also instructed to self-correct any errors made whilst completing the trail by tracing back to where the error occurred and continuing from that position (thus accumulating a higher time-score). The experimental condition of the TMT is substantially more difficult than the control condition, particularly for those individuals who experience difficulty in controlling and executing responses quickly and efficiently. Thus, completion time-scores should be significantly higher (i.e. longer in duration) for those participants whose executive functioning is still developing (younger children), and those who are experiencing any, (possibly temporary), shortfalls in executive function ability. The TMT task measuring 'shifting' (TMT Time), is therefore operationalized as the ratio of time to complete the control and experimental conditions (TMT-B minus completion time for TMT-A, divided by TMT-A).

Updating

The updating function of the central executive is very similar to what has been conceptualized as working memory (Jonides & Smith, 1997; Lehto, 1996a, 1996b; Miyake & Shah, 2003). However, updating is a more advanced function than basic working memory; as new information is received the updating function monitors the information for its relevance and codes it appropriately. Thus, rather than passively storing the information, updating is the function of manipulating information held in working memory. The Letter-Number Sequencing Task was chosen to measure updating because it tests the limits of an individual's ability to hold a set of random numbers and letters in short-term memory and put this information in a prescribed sequence before repeating it back to the interviewer.

Letter-Number Sequencing (Sequencing). The Letter-Number Sequencing task is a demanding task because the participant must continually update information held in short-term memory until the final solution can be resolved. The task becomes increasingly more difficult because successive trials contain longer strings of characters. The task is continued until the participant fails three consecutive trials. The task is a subtest of the fourth edition of the Weschler Intelligence Scale for Children (WISC-IV; Wechsler, 2003). The WISC-IV measures intellectual functioning by computing standardized scores from raw scores based on age-normative data. The purpose of the current study is to compare age-related changes in executive functioning; therefore, updating is operationally defined as the total of participant's *unstandardized* scores on the Letter-Number Sequencing task (Sequencing).

Response Inhibition (Inhibition)

Miyake et al. (2000) define the executive function of (response) inhibition as the "...ability to deliberately inhibit dominant, automatic, or prepotent responses when necessary" (p 57). The task chosen to measure inhibition in the current study is considered a classic inhibition task, and has been found to correlate with self-reports of impulsivity (Enticott, Ogloff, & Bradshaw, 2006). The Stroop (1935) task requires participants to suppress the natural inclination to provide an automatic (more dominant) response (i.e., read the name of the colour-word), whilst producing a required alternative response (i.e. say the colour of ink the word is printed in). Inhibition is considered an executive function because it involves a deliberate action of preventing oneself from performing a particular action.

Stroop. The interference condition of the Stroop required participants to name out loud the colour of the ink in which each of a list of words was printed, whilst inhibiting the automatic response of reading the name of the colour-word (e.g. the correct response for the word RED written in blue ink is 'Blue'). To control for individual differences in reading fluency or motivation, two control conditions were administered prior to the experiment condition: 1) participants were required to *read a list of colour names* which were printed in the same colour (e.g. BLUE written in blue ink and RED printed in red ink; Stroop 1); 2) participants were required to *name the colour of the ink* in which a short row of X's were printed (Stroop 2). The test was scored by summing the number of correct responses with a 2-minute time limit on both the experiment (Stroop 3) and control (Stroop 1 and Stroop 2) conditions. The net score was obtained by subtracting the control-condition scores from the experimental-condition scores. These two net scores were averaged to obtain the measure of inhibition (Stroop = [{Stroop3 – Stroop1} + {Stroop3 – Stroop2}/2])

Verbal Fluency

Fluency tasks characteristically tap into several executive function abilities. As described below, to avoid repetitions and other errors, participants must continually update memory for previously spoken words and inhibit particular responses whilst switching between different search strategies they employ. The alternating fluency tasks contain an additional requirement; in addition to the above functions, participants must also alternate between two sets of search criteria provided to them. Participants in the current study were assessed on these executive function abilities with the administration of *phonemic, semantic, and alternating*, verbal fluency tasks.

Fluency Tasks. For each verbal fluency task, participants were required to generate a list of words within a set time; they were provided with a search criteria (i.e. type of response required), a 60-second time constraint and a set of rules restricting the type of responses that could be included in the list (i.e. no proper nouns, no 'rude' words, and no word could be repeated). Participants were informed that any responses that did not follow the criteria or 'restrictions', were considered errors, and would be deducted from their score (i.e. score = total number of words produced – invalid responses). Three types of verbal fluency tasks were included in the battery of tasks. The *phonemic fluency* task required participants to generate words beginning with the letter 't'. The *semantic fluency* task required participants to generate words belonging to the category of 'fruits and vegetables'. Two *alternating* tasks were included: 1) the *semantic-phonemic alternating* task required participants to generate responses whilst switching between reciting words from the category 'animals' and words beginning with the letter 's', and 2) the *alpha-number alternating* task required participants to shift between reciting the alphabet and counting from the number one (i.e. 1-A-2-B-3-C...). The *semantic* task was dropped from the set of verbal fluency measures during the experimental phase of the study due to errors in administration, and thus was not included in analyses. For each of the fluency tasks, the measure was defined as the total number of responses, minus errors (e.g. number of repetitions and 'prohibited' responses made within the 60-second time limit). Thus, the verbal fluency measures comprise of the net scores on the phonemic fluency test (*Phonemic Fluency*) and two alternating fluency tests (*Semantic-Phonemic and Alpha-Number*).

Non-Executive Function

General Intellectual Functioning

To separate individual differences in executive function from general cognitive-functioning differences, a non-executive functioning test was included in the cognitive-task battery. A prime exemplar of non-executive function is crystallized knowledge (Gustafsson, 1984), and an example of crystallized knowledge is vocabulary. As vocabulary tests have been used extensively in tests measuring intelligence (e.g. Wechsler, 1997), it is feasible that in addition to testing crystallized knowledge, vocabulary tests can be conceptualized as a quick and approximate measure of general intellectual functioning (see below).

Peabody Picture Vocabulary Test (PPVT). The Peabody Picture Vocabulary Test (PPVT) has been standardized on a large age-referenced sample (Dunn & Dunn, 1997), and more pertinently, has been found to be a quick and easy to administer measure of general intelligence (Carvajal et al., 1993). Carvajal et al. found that the PPVT was significantly correlated (r = .60 to .76) with full scale IQ and the verbal and vocabulary subtests on the third edition of the Wechsler Intelligence Scale for Children (WISC-III). These findings suggest that the PPVT is a valid instrument for conditions when a rapid estimate of IQ is required. A full description of the PPVT is provided in the Materials section of this thesis, but of particular relevance is the fact that the PPVT has been validated for use on children from ages two to adult. This means that the age-standardized scores provide a measure of IQ, enabling the samples in the current study to be examined for individual differences in general cognitive ability as well as age. Thus, the non-executive functioning measure in the current study was operationalized as participants' standardized scores on the PPVT, referred to as standardized vocabulary score (SVS). Participant's raw vocabulary scores were also examined to facilitate measurement validity and reliability of other cognitive measures.

Participant's unstandardized vocabulary scores (UVS) will be discussed only (briefly) in this chapter. The SVS measure, however, will be referred to in subsequent results chapters, and represents the non-executive functioning control for data analysis, and occasionally may be referred to as general intellectual functioning.

Operationalizing Executive Function and Non-Executive Function

To operationally define executive functioning and general intellectual functioning, each of the above-noted measures was examined for construct validity and measurement reliability by examining (expected) group differences, and for the executive function measures, correlational analysis and scale reliability analysis were also performed. It is important to note that, consistent with Miyake and colleagues' (2000) findings that executive functions are both unified and diverse, some correlation between variables is expected, but strong associations are not anticipated. Thus, the results of associations between variables were closely examined for suitability to construct a unified measure of executive function.

Operationalizing Executive Function

Miyake et al. (2000) note that conceptualization of executive functioning as a unified construct is debatable. There is evidence from both clinical observations and individual differences studies that different cognitive tasks that purport to measure the same aspect of executive functioning yield highly inconsistent findings. For example, clinicians have described individuals who fail on one task, but perform adequately on others (e.g. Godefroy, Cabaret, Petit-Chenal, Pruvo, & Rousseaux, 1999; Shallice, 1988). Additionally, many studies examining individual differences in executive functioning consistently reveal low correlations between measures. Although the sample populations differ between studies (e.g. children or adults; forensic or clinical samples), and the details vary, the studies have consistently found low intercorrelations between executive functioning tasks (usually $r = .40$ or less) that usually fail to reach statistical significance (see Miyake et al., 2000). Thus, after examining group differences, correlational and reliability analysis findings were analyzed to explore the strength of the relationship between executive functioning measures.

Group Differences

Table 7.1 displays the results of comparisons (t-tests) of scores of boys and girls in high schools and primary schools for each of the six executive function measures: TMT Time, Sequencing, Stroop, Phonemic Fluency, Semantic-Phonemic, and Alpha-Number). Note that a low score on TMT Time or Stroop represents better performance (i.e. a small difference between control condition and experiment condition implies good executive functioning).

Table 7.1. Statistical difference tests by sex and school type for executive function tasks.

Executive Function Task	Girls (n = 37)		Boys (n = 50)				
	M	*SD*	*M*	*SD*	*t*	*df*	*p*
			Primary Schools				
TMT Time	1.41	0.83	1.64	1.98	-0.669	85	.253 ns
Sequencing	18.41	1.67	17.62	2.30	1.758	85	.041
Stroop	71.86	27.31	76.44	29.53	-0.726	82	.235 ns
Phonemic Fluency	10.08	3.36	9.06	3.36	1.401	85	.083 ns
Semantic-Phonemic	12.61	3.23	10.52	4.87	2.231	82	.014
Alpha-Number	31.54	8.39	29.41	11.89	0.930	84	.178 ns
			High Schools				
TMT Time	1.49	1.37	1.11	.75	2.309	108	.012
Sequencing	19.14	1.97	21.66	2.21	2.675	220	.084 ns
Stroop	35.34	26.84	16.19	20.60	5.486	134	.000
Phonemic Fluency	11.73	3.85	14.52	4.19	-4.929	220	.000
Semantic-Phonemic	14.54	3.25	15.20	3.25	-1.434	218	.078 ns
Alpha-Number	47.70	12.32	62.18	14.59	-7.824	185	.000

Tests for significant differences between girls and boys were performed separately for primary and high schools. Tests of significant differences between mean scores found that high-school boys outperformed high-school girls on all executive functioning tasks, and this difference was significant for all tasks (Stroop, Phonemic Fluency, and Alpha-Number Fluency, $p < .0001$; TMT Time, $p < .05$) except Sequencing and Semantic-

Phonemic Fluency ($p < .10$). Thus high-school boys outperformed girls even on the verbal tasks, which are more commonly associated with superior performance by females (see Halpern & LaMay, 2000 for a critical review). It is possible that boys outperformed girls because all of the high-school boys in this sample were recruited from a selective high school. In contrast, examination of the mean differences between girls and boys in the primary-school samples, reveals superior performance by girls, in comparison to boys, on all cognitive tasks, with the performance difference in Sequencing and Semantic-Phonemic Fluency tasks reaching significance at $p <.05$, and the Phonemic Fluency difference approaching significance ($p = .08$).

Inspection of the standard deviations for the individual tasks reveals relatively large standard deviations in Stroop scores, particularly for high-school girls and boys (standard deviation is approximately the same size as the mean), suggesting that wide variations in ability were observed on this executive functioning task (Table 7.1). These variations could be attributable to the wide range of ages (12 – 17) within the restricted sample of high-school students. Therefore, a separate analysis was performed to inspect means and standard deviations for girls and boys by age, on each executive function task. As displayed in Table 7.2, large standard deviations in Stroop scores remained for both girls and boys in the majority of age groups, and the variability in Stroop scores appears to increase with age. No similar, or any other, patterns emerged for any other executive functioning tasks. It is unclear what this increased variability in Stroop scores reflects. One possibility is that the measure is more sensitive to variations in executive functioning in this population. However, the greater variance might instead reflect increased measurement error (for instance, this test may be more susceptible to the influence of fatigue, background noise, or motivational difficulties). The next section of this chapter examines measurement validity and reliability by analyzing how well the individual scores on tasks were correlated. High correlations provide evidence that the cognitive tasks were measuring a similarly unified construct (i.e. executive function).

Correlation and Reliability Analysis

Prior to performing correlation and reliability analyses, scores on the Stroop and TMT Time tasks were reversed so that for all measures, higher scores represent better executive functioning performance.

Correlation Analysis. Correlations between all test scores were calculated (see Table 7.3). Consistent with previous research findings, the majority of significant correlations were moderate in size, (i.e. average $r = .40$, $p < .001$). The strongest intercorrelations were found between Stroop and Alpha-Number tasks ($r = .68$). All measures were significantly intercorrelated with the exception of TMT Time, which was significantly correlated with only one of the other five executive function tasks (Alpha-Number) at $r = .11$ ($p < .05$). The Alpha-Number alternating fluency task and the TMT Time task share an obvious similarity; both tasks require the participant to shift between the mental sets of reciting the alphabet and counting from the number '1'. An interesting effect was revealed when the same analysis was performed separately for girls and boys. Although the same pattern of correlations emerged for both groups, analysis of the data (using the Fisher r-to-z transformation) for girls and boys separately, revealed significant differences between the size of correlations for the two (Table 7.4). Boys produced significantly higher correlations between all executive function tasks than girls ($p < .05$ to $p < .001$). Inspecting the results separately for girls and boys, girls produced correlation coefficients ranging from $r = .18$ to $r = .57$ ($p < .05$ to $p < .001$). In contrast, for boys, with the exception of TMT Time, all executive function tasks were more highly correlated at a significance level of $p < .001$ ($r = .51$ to $.75$). The TMT Time task was positively correlated with both the Alpha-Number task ($r = .19$, $p < .01$), and the task ($r = .17$, $p < .05$) for boys; whereas for girls, no significant positive correlations were observed for this task. All tests correlated except TMT which did not show reliable correlations with most other measures.

Table 7.2. Descriptives and statistical difference tests by age for executive functioning tasks.

Age	TMT Time			Sequencing			Stroop			Phonemic Fluency			Semantic-Phonemic			Alpha-Number		
	n	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
								Girls										
9	9	1.33	.68	9	18.44	1.81	9	**81.67**	**22.01**	9	10.11	3.86	9	12.44	4.36	9	29.00	7.71
10	12	1.46	.65	12	17.83	1.47	12	**74.00**	**28.30**	12	9.42	2.11	12	12.00	2.83	12	30.92	9.29
11	16	1.32	1.01	16	19.06	2.08	15	**58.53**	**23.38**	16	10.50	3.12	15	12.93	2.71	16	33.81	7.99
12	17	1.88	1.34	17	18.59	2.18	17	**63.24**	**28.60**	17	10.12	4.08	16	14.38	4.46	17	42.35	11.10
13	15	1.54	2.20	15	18.27	2.28	15	**41.73**	**24.85**	15	11.33	3.35	15	13.93	2.22	15	46.47	10.08
14	27	1.18	.63	27	19.59	1.39	26	**27.85**	**26.33**	27	12.70	3.35	27	15.22	2.78	26	48.77	9.36
15	16	1.57	1.57	15	19.27	1.91	16	**22.63**	**18.69**	16	12.69	4.24	15	14.40	3.62	15	48.93	16.88
16	6	1.72	.41	6	19.83	1.47	6	**21.00**	**19.83**	6	10.50	6.16	6	14.50	3.27	6	57.17	16.51
Total	118	1.47	1.22	117	18.91	1.90	116	**46.67**	**31.78**	118	11.21	3.77	115	13.94	3.35	116	42.54	13.49
								Boys										
9	12	1.19	.83	12	17.17	1.59	11	**84.73**	**19.56**	12	8.33	2.10	12	12.00	2.52	12	27.83	9.81
10	16	1.67	.84	16	17.56	2.71	16	**73.06**	**39.87**	15	8.80	2.76	14	10.79	2.46	15	27.87	11.44
11	14	2.18	3.55	14	18.07	2.23	13	**71.08**	**31.31**	14	10.07	3.15	14	10.86	2.71	14	30.50	12.82
12	24	.97	.57	24	19.92	2.92	23	**46.52**	**32.39**	24	12.58	3.62	23	13.96	3.14	24	47.04	17.02
13	27	1.04	.72	27	21.04	2.64	25	**23.36**	**22.22**	27	13.07	4.29	27	14.04	3.83	27	57.63	13.92
14	25	1.39	.75	25	21.68	2.23	23	**15.22**	**20.21**	25	13.88	3.50	25	15.08	3.56	25	61.32	11.73
15	23	1.02	.64	23	22.48	2.29	23	**12.26**	**18.11**	23	14.83	3.93	23	15.61	3.10	23	68.52	17.07
16	38	1.23	.95	38	21.87	1.60	37	**11.41**	**18.37**	38	15.66	4.86	38	15.82	3.07	38	66.37	13.62
17	11	.90	.37	11	21.55	2.42	10	**9.00**	**15.58**	11	16.27	3.38	11	15.45	2.70	11	61.45	13.34
Total	190	1.25	1.22	190	20.59	2.86	181	**32.17**	**35.39**	189	13.17	4.50	187	14.19	3.55	189	53.81	20.03

Table 7.3. Executive function task correlations for girls and boys separately and combined for primary and high schools.

Executive Function Task	Phonemic Fluency		Semantic-Phonemic		Alpha-Number		Stroop		TMT Time	
	r	*n*	*r*	*n*	*r*	*n*	*r*	*n*	*r*	*n*
					Girls and Boys					
Sequencing	.41**	307	.38**	303	.57**	307	.47**	298	.07	309
Phonemic Fluency	1	308	.49**	303	.43**	306	.45**	297	.07	308
Semantic-Phonemic			1	303	.53**	302	.44**	293	.00	303
Alpha-Number					1	307	.68**	297	.11*	307
Stroop							1	299	.04	299
					Girls					
Sequencing	.25**	117	.19*	115	.32**	116	.21*	115	.05	117
Phonemic Fluency	1	118	.37**	115	.25**	116	.30**	116	-.09	118
Semantic-Phonemic			1	115	.45**	114	.33**	114	-.16*	115
Alpha-Number					1	116	.51**	115	-.02	116
Stroop							1	116	-.05	116
					Boys					
Sequencing	.51**	190	.52**	188	.71**	191	.62**	183	.10	192
Phonemic Fluency	1	190	.58**	188	.54**	190	.52**	181	.17*	190
Semantic-Phonemic			1	188	.60**	188	.54**	179	.12	188
Alpha-Number					1	191	.75**	182	.19**	191
Stroop							1	183	.10	183

* Correlation is significant at the 0.05 level (1-tailed).
** Correlation is significant at the 0.01 level (1-tailed).

Table 7.4. Significant difference tests between boys' and girls' executive task correlations.

Executive Function Task	Phonemic Fluency		Semantic-Phonemic		Alpha-Number		Stroop		TMT Time	
	r	*n*	*r*	*n*	*r*	*n*	*r*	*n*	*r*	*n*
					Girls					
Sequencing	.25**	117	.19*	115	.32**	116	.21*	115	.05	117
Phonemic Fluency			.37**	115	.25**	116	.30**	116	-.09	118
Semantic-Phonemic					.45**	114	.33**	114	-.16*	115
Alpha-Number							.51**	115	-.02	116
Stroop									-.05	116
					Boys					
Sequencing	.51**	190	.52**	188	.71**	191	.62**	183	.10	192
Phonemic Fluency			.58**	188	.54**	190	.52**	181	.17*	190
Semantic-Phonemic					.60**	188	.54**	179	.12	188
Alpha-Number							.75**	182	.19**	191
Stroop									.10	183
					*Significant Difference p-value**					
Sequencing	< .01		< .01		< .001		< .001		Not performed	
Phonemic Fluency			< .05		< .005		< .05			
Semantic-Phonemic					< .10		< .05			
Alpha-Number							< .001			

* Correlation is significant at the 0.05 level (1-tailed).
** Correlation is significant at the 0.01 level (1-tailed).
*** Correlation is significant at the 0.001 level (1-tailed).

Reliability Analysis. Scale reliability analysis on all six executive function variables revealed a Cronbach's alpha of .76. Separate analyses performed by sex revealed an alpha of .58 for girls and .82 for boys. Examination of the item-to-total statistics (Table 7.5) indicated that the relationship between TMT Time and the total scale was relatively poor in comparison to other executive function variables. The corrected-item correlation coefficient was much smaller (and in the case of girls' data was negative) for TMT Time in comparison to the other five executive function variables. Removal of the TMT Time variable from analyses resulted in a larger coefficient for girls (*alpha* = .70) and boys (*alpha* = .88) separately, and combined (*alpha* = .82).

Table 7.5. Alpha coefficients and corrected item-to-total statistics for executive function tasks by sex.

Executive Function Task	Item-to-total Statistics			
	Girls (n = 114)		*Boys (n =179)*	
	Including TMT Time	*Excluding TMT Time*	*Including TMT Time*	*Excluding TMT Time*
Sequencing	.312	.319	.679	.714
Phonemic Fluency	.370	.418	.628	.632
Semantic-Phonemic	.392	.464	.641	.668
Alpha-Number	.562	.584	.790	.804
Stroop	.480	.520	.689	.729
TMT Time	-.114		.166	
alpha	*.58*	*.70*	*.82*	*.88*

Composite Executive Function Variable

The methodology used to create a single executive functioning variable was adopted from Rosenthal's (1991) meta-analytic procedures for combining inter-correlated dependent variables. According to Rosenthal, a composite variable may be created if the variables in question share sufficient variance; Rosenthal's term 'supervariable' is used to describe this composite variable. It was determined that all executive function variables except TMT Time met the criteria for inclusion in a composite variable. Therefore, all other executive functioning tasks (Sequencing, Stroop, Fluency, Semantic Shift, and Alpha Shift) were first transformed to z-scores. The composite executive function variable was computed as the mean (rather than sum) of the various z-scores, to ensure that all variables were weighted equally (Rosenthal, 1991). Computing mean task scores also corrected for missing data; some participants provided complete data on some, but not all, executive function tasks. For example, a small number (e.g. < 1%) of participants could not complete the Stroop due to colour blindness, another small number of participants did not complete some tests as they became frustrated by the task (e.g. the Trail Making Test), or because they were not able to complete the interview because of time constraints. Thus, the composite executive function measure comprises of the scores on five executive function tasks, and is hereafter referred to as executive function score. Comparisons of executive function scores for girls and boys were conducted separately for high schools and primary schools. Analyses revealed that primary-school girls (mean z-score = -.52) scored significantly higher than primary-school boys (mean z-score = -1.00) on executive function (t_{82} = 4.458, $p < .001$). However, there was a non significant trend for high-school boys (mean z-score = .37) to achieve higher executive function scores than high-school girls (mean z-score = .23; t_{220} = -1.693, $p < .10$). The primary-school differences could be attributed to superior performance by females on verbal tasks (Halpern & LaMay, 2000); whereas the superior performance by high-school boys is likely to reflect the recruitment of these boys from a selective school.

Operationalizing Non-Executive Function

Convergent and discriminant validity between unstandardized (UVS) and standardized vocabulary scores (SVS) were tested to establish whether SVS can be used as a valid measure of a participants' general intellectual functioning. Convergent validity for standardized and unstandardized vocabulary scores was established by conducting correlational analysis. SVS and UVS were significantly correlated at $p < .001$ for primary-school (r = .92), and high-school (r = .74) participants. We would expect vocabulary knowledge to increase with age, but standardization (for age) should eliminate these differences. As expected (older) high-school girls (M = 157.3) and boys (M = 177.7) scored significantly higher on UVS than (younger) primary-school girls (M = 143.1) and boys (M = 135.1) (girls, t_{115} = 4.554; boys, t_{189} = 15.79; both $p < .001$). It was expected that no significant differences in SVS would be found; however, high-school boys scored significantly higher (M = 116.7) on SVS than primary-school boys (M = 100.1; t_{189} = 7.111, $p < .001$), and high-school girls scored significantly *lower* (M = 101.99) than primary-school girls (M = 106.7; t_{115} = 2.062; $p < .05$) on SVS. The findings that high-school boys obtained higher standardized vocabulary scores than primary-school boys is explained by the fact that the high-school boys in this sample were recruited from a selective school; the findings that high-school girls obtained significantly lower standardized vocabulary scores than the primary-school girls is not readily explained. Although not quite as expected, these findings provide support for the need for controlling for individual differences in intellectual functioning, that the standardized vocabulary scores (SVS) is a reliable measure to use as a proxy for general intellectual functioning.

Measurement Validity of Executive and Non-Executive Functioning

To determine if the general intellectual function (UVS and SVS) and the executive function variables represent valid indices of these two constructs, they were tested against two external criteria: First, executive function and SVS were examined for relationships with psychological disorders (e.g. learning disorder; ADHD) known to be correlated with low intellectual (particularly executive) functioning (McCandless & O'Laughlin, 2007). On the Demographic Sheet sent home to parents (see Appendix 4.8), four children had been identified as having either a learning disability or ADHD, and were thus excluded from the above analyses. The executive function and SVS (general intellectual function) scores of these children were used to further test the validity of these constructs by comparing these individual's scores to the mean score of a group of age and gender-matched children. As expected, analyses revealed that each participant identified as having a learning disability or ADHD scored significantly lower on executive function and general intellectual function than non-cognitively impaired children of the same sex and age (see Table 7.6 for means and *t*-scores).

Table 7.6. Statistical difference tests for cognitive disorders and matched controls.

	Test	Controls				
	M	*M*	*SD*	*t*	*df*	*p*
		Executive Function				
10-year old boy	-2.51	-1.30	.47	7.720	8	<.001
11-year old boy	-1.61	0.90	.34	6.532	9	<.001
12-year old boy	-1.69	-0.17	.65	8.636	13	<.001
12.5-year old girl	-1.48	-0.09	.68	7.030	11	<.001
		General Intellectual Function				
10-year old boy	-2.65	0.27	.50	18.43	9	<.001
11-year old boy	-1.65	-0.32	.97	4.328	9	<.005
12-year old boy	-2.40	-0.27	1.38	5.788	13	<.001
12.5-year old girl	-0.89	-0.34	.51	3.808	11	<.005

External validity was further investigated by plotting mean (z) scores for executive function (Figure 7.1a, girls; Figure 7.1b, boys) and general intellectual function (UVS, Figures 7.2a, girls and 7.2b, boys; SVS, Figures 7.3a, girls, and 7.3b boys), against age (age groups rounded down to nearest whole year). Analysis of variance was conducted separately for girls and boys. A significant linear trend ($p < .001$) across age was observed on both executive function ($F_{7,110} = 8.990$, girls; $F_{8,181} = 30.365$, boys) and UVS (i.e. general, non-executive) function ($F_{7,109} = 6.835$, girls; $F_{8,181} = 34.215$, boys). It was expected that when examining standardized vocabulary scores (SVS), no relationship with age would be observed.

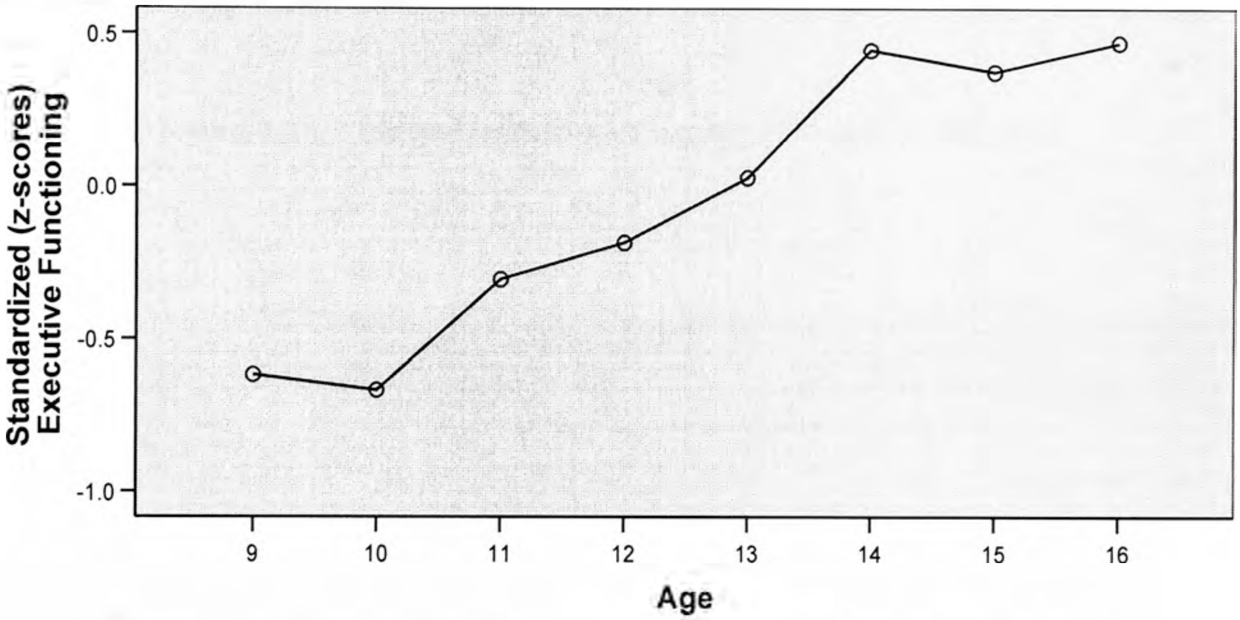

Figure 7.1a. Standardized (z-scores) executive function by age for girls.

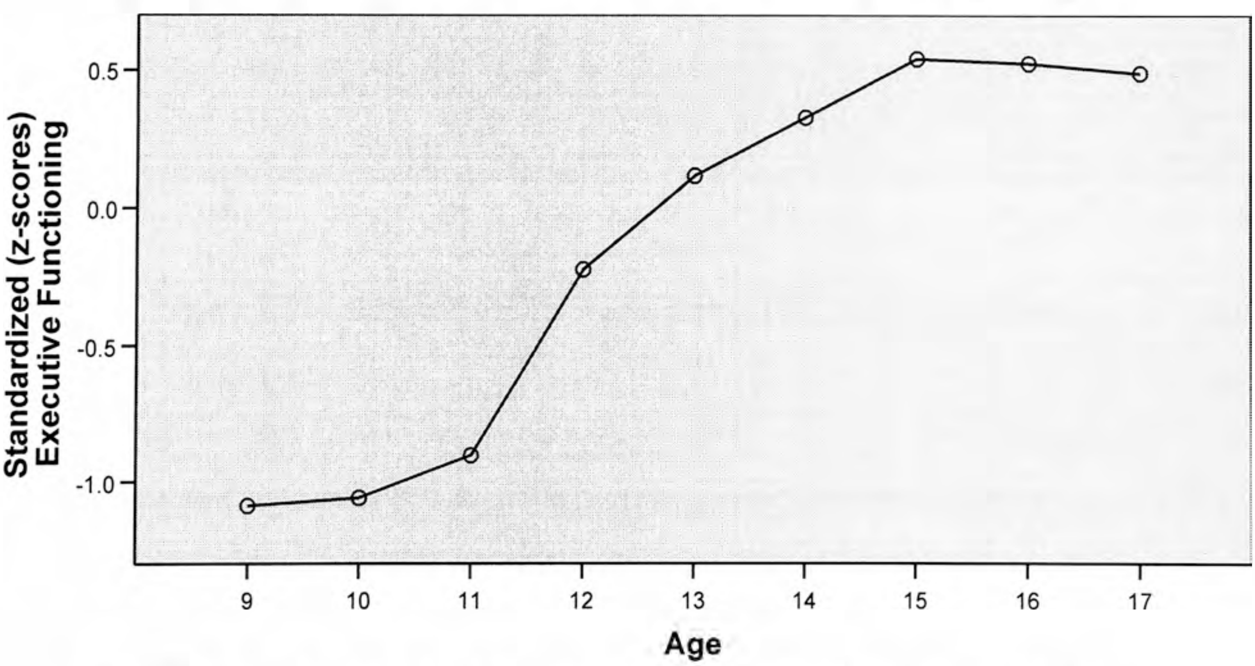

Figure 7.1b. Standardized (z-scores) executive function by age for boys.

Figure 7.2a. Unstandardized vocabulary (UVS) z-scores for girls.

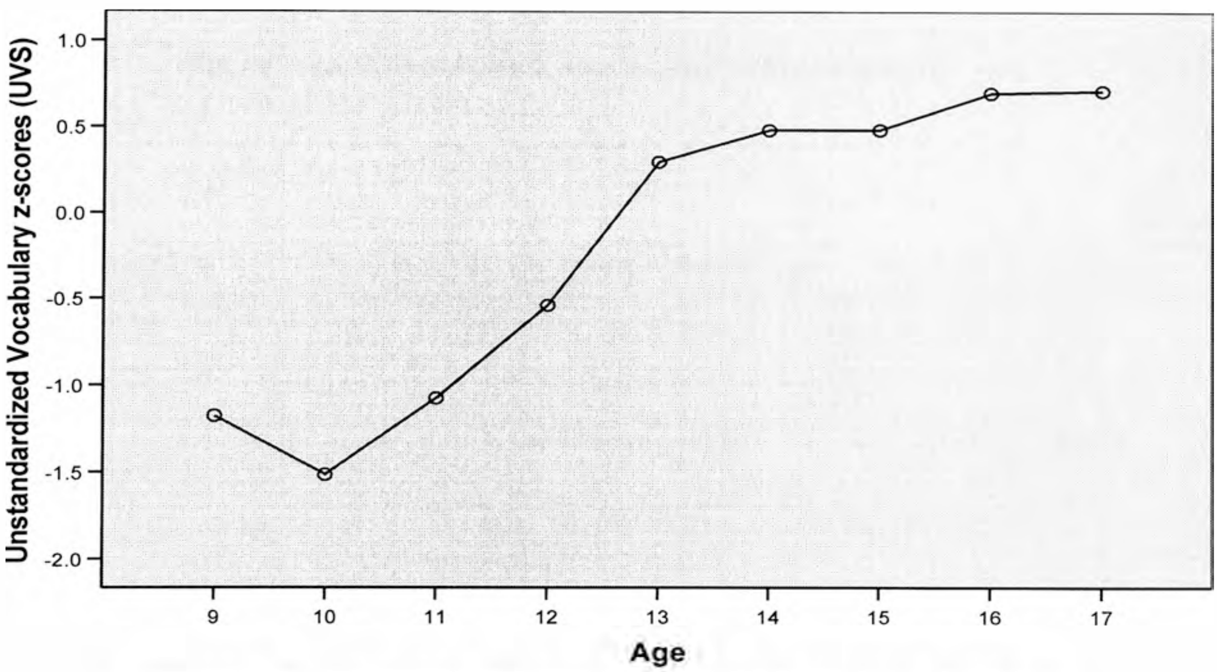

Figure 7.2b. Unstandardized vocabulary (UVS) z-scores for boys.

ANOVA revealed an overall significant effect of age on SVS for both girls ($F_{7,109}$ = 2.411, p < .05) and boys $F_{8,181}$ = 4.069, p < .001). However, the effect for girls results from a significant *decrease* in SVS at age 15 compared to all previous age groups (p = .001; see

Figure 7.3a). The effect for boys (Figure 7.3b) may reflect the fact that all older boys in this sample were recruited from a high-performing school.

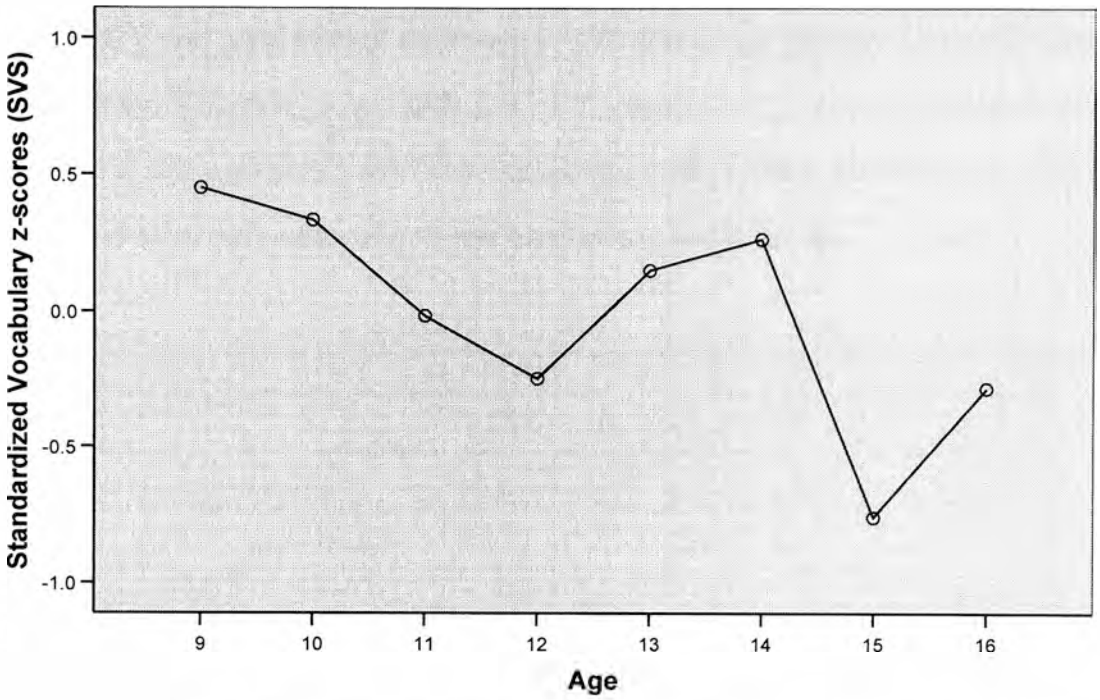

Figure 7.3a. Standardized vocabulary (SVS) z-scores for girls.

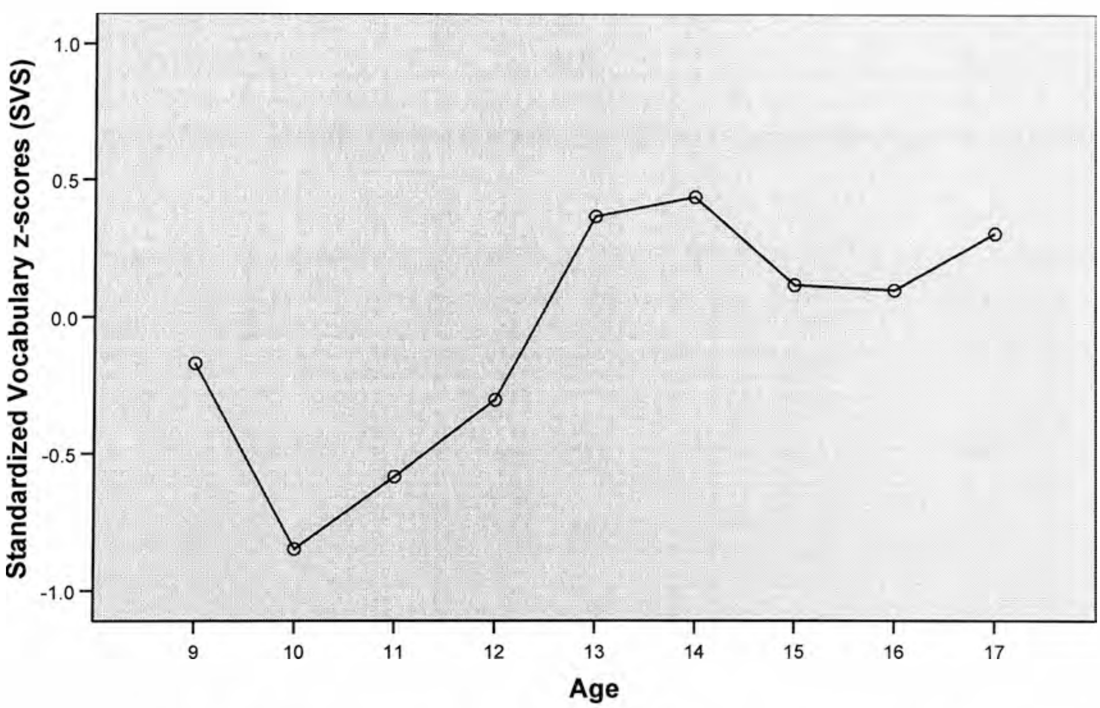

Figure 7.3b. Standardized vocabulary (SVS) z-scores for boys.

When analyses were run separately for primary-school and high-school boys, no significant effect for age was observed for high-school boys ($F_{6,133}$ = 1.271, p = .26; Figure 7.3c), and a significant decrease in SVS across age groups was observed for primary-school boys ($F_{3,46}$ = 5.488, p < . 005; Figure 7.3d). Thus, as no increase in SVS scores with age was observed, these results provide further discriminant validity for this operational definition of general intellectual functioning.

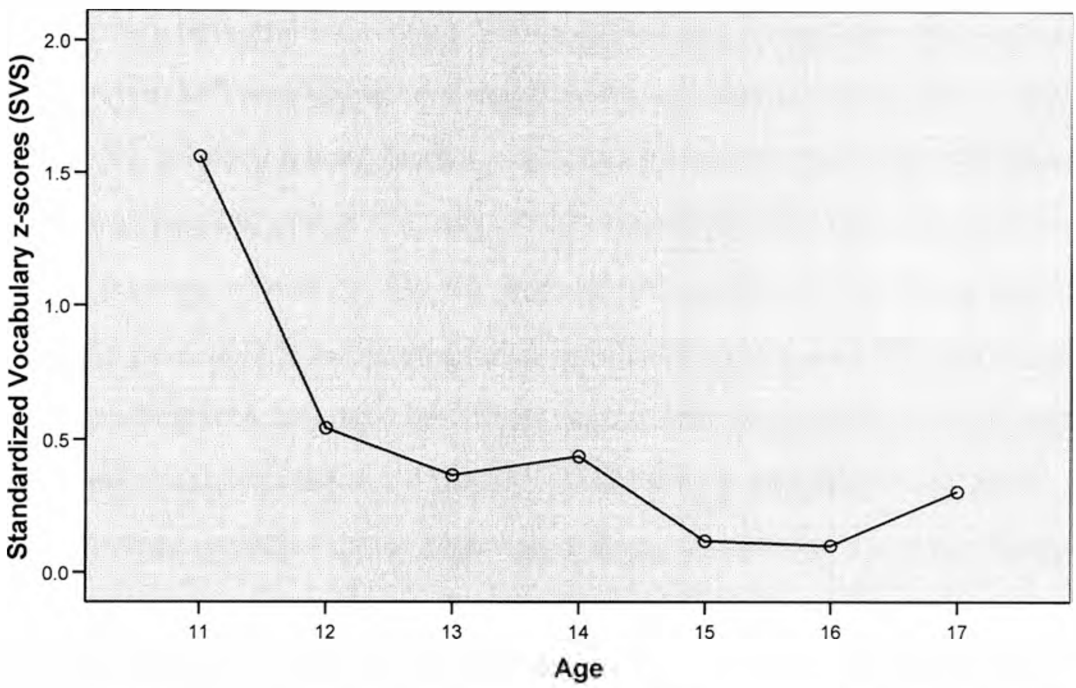

Figure 7.3c. Standardized vocabulary (SVS) z-scores for high-school boys.

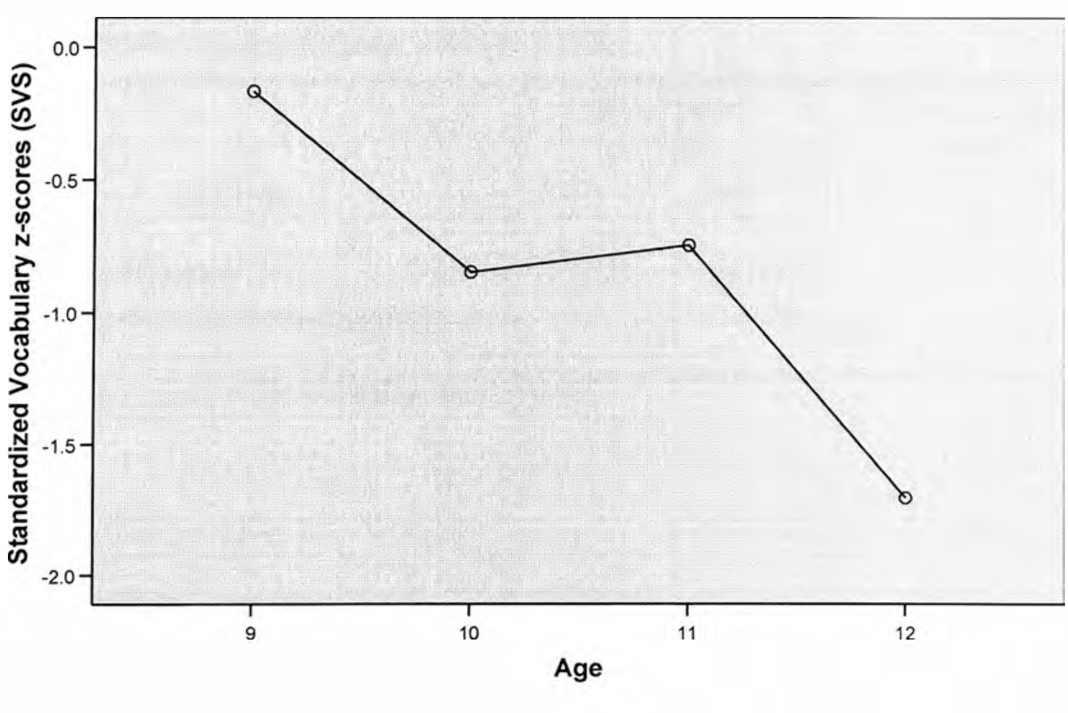

Figure 7.3d. Standardized vocabulary (SVS) z-scores for primary-school boys.

A final set of analyses were performed to test the construct validity of the executive functioning and non-executive functioning (SVS) constructs. Table 7.7 displays the correlation coefficients for the composite executive function variable scores, and unstandardized (UVS) and standardized vocabulary (SVS) scores by school type (i.e. primary and high schools). The findings that UVS and executive function are correlated $r = .23$ for high school participants, and $r = .44$ for primary school participants ($p < .01$), demonstrates that although both vocabulary knowledge and executive function abilities vary between individuals, within individuals, these two constructs are related. As expected, SVS was highly, and significantly, correlated with UVS ($r = .74$, high school and $r = .92$, primary school, both $p < .01$), but the correlation with executive function scores was smaller, and in the case of high-school participants, not significant ($r = .39$, $p < .01$, primary school; $r = .08$, *n.s.*, high school). Although the size of the effect is not large, the relationship between executive function scores and SVS among primary school participants, but not high school participants suggests that at younger ages, these two constructs are more closely related than in the adolescent years. Overall, these findings provide further evidence that the standardized scores of vocabulary (SVS) represents a measure of intellectual functioning that is largely independent of executive functioning.

Table 7.7. Standardized vocabulary scores (SVS) correlations with executive function and unstandardized vocabulary scores (UVS).

	High Schools (n = 221)		Primary Schools (n =87)	
Variables	UVS	SVS	UVS	SVS
Executive Function	.23**	.08 n.s.	.44**	.39**
Unstandardized Vocabulary (UVS)		.74**		.92**

** Correlation is significant at the 0.01 level (1-tailed).

Summary

By examining the means and standard deviations by sex, school type, and age, evidence was found for statistical differences between group mean scores in the data. As suspected, the recruitment of high-school boys from a high-performing school influenced these findings. Compared to high-school girls, high-school boys had higher average scores on all tests of executive function, despite the fact that the majority of these tasks were measuring cognitive abilities in which females usually demonstrate superior performance (i.e. verbal tasks; Halpern & LaMay, 2000). The unusual performance by this group of boys is further evidenced by the findings that in the primary-school samples, differences between girls and boys' scores were much smaller, and the only significant findings were for superior performance by girls compared to boys. These findings could have an influence on the analyses investigating the relationships between executive function with pubertal development, and with antisocial behaviour. Although no problematic dispersion patterns emerged for the majority of executive function tasks, the large standard deviations in Stroop scores suggests that this task was a sensitive measure of individual differences.

The executive function supervariable comprising of five intercorrelated executive function tasks (Sequencing, Stroop, Phonemic Fluency, Semantic-Phonemic, and Alpha-Number) was found to be a valid measure of executive function. Construct validity for the composite measure of executive function was established by the findings that unstandardized and standardized vocabulary scores were highly correlated with each other but correlations with executive function scores were much lower. Construct validity was further established for both executive function and general intellectual function by examining relationships between these constructs with age and with (parent-identified) clinical disorders. It was concluded that sufficient evidence was found for the measurement validity of the measures of executive function and non-executive function and that these constructs are measuring distinct cognitive processes. Thus, statistical tests examining executive functioning differences in future analyses will include a control for general intellectual functioning (SVS).

The results from analyses investigating relationships between executive function and pubertal development and antisocial behaviour are presented in the next section, which explores whether temporary reductions in executive functioning exist during pubertal development onset and whether this deficit mediates a relationship between pubertal development onset and antisocial attitudes and behaviour.

SECTION 4: RESULTS

A primary aim of this research was to examine whether a relationship exists between pubertal development and antisocial behaviour and attitudes, and whether temporary reductions in executive functioning occurring mid-puberty mediate this relationship. A secondary aim was to examine whether early pubertal onset predicts higher levels and longer duration of antisocial behaviour and attitudes, and whether early puberty is also associated with greater and longer lasting executive functioning reductions, which may explain this relationship. The previous three chapters described how these three constructs (pubertal development, executive functioning, antisocial behaviour/attitudes) were operationalized, and established that the variables were valid and reliable measures for these constructs.

The first chapter investigates whether pubertal development stage and pubertal timing are associated with antisocial behaviour and attitudes. The second and third chapters examine whether executive function is associated with pubertal development stage and timing, and antisocial behaviour, respectively. For primary-school participants (n = 90) it was not possible to measure first-age of, and current, antisocial behaviour participation; so, unless otherwise specified, analysis was based on data from high-school boys and girls only (n = 223). The specific tests for each set of hypotheses are described in the relevant section of each chapter. The fourth, and final, chapter of this section describes the process of mediation analysis, some of the difficulties encountered with this cross-sectional data set, and the findings regarding the extent to which executive functioning mediate the relationship between pubertal stage and antisocial behaviour, and pubertal timing and antisocial behaviour.

Chapter 8: Pubertal Development and Antisocial Behaviour and Attitudes

Because several different measures of pubertal development and antisocial behaviour (ASB) were collected, the relationship between these two constructs was investigated using several approaches. The first set of analyses examined the relationship between retrospective reports of age of puberty onset and age of peak antisocial behaviour participation to investigate whether the age of peak ASB participation was associated with the age of puberty onset and the relationship between ASB and pubertal timing. The second set of analyses examined the relationship between current (past 12 months) participation in ASB and current pubertal stage and pubertal timing. The third set of analyses examined the relationship between cumulative (all reported) participation in ASB and pubertal timing. The fourth set of analyses reported in this chapter examined the relationship between current antisocial attitudes and current pubertal stage and pubertal timing.

Puberty Onset and Peak Antisocial Behaviour

This first set of analyses examined the relationship between retrospective reports of pubertal onset and peak antisocial behaviour participation. It was hypothesized that for those adolescents who had attained puberty, the age of peak participation in antisocial behaviour would be associated with the reported age of puberty onset, and that, compared to on-time and late-maturing adolescents, early-maturing adolescents would report an earlier age of peak participation in antisocial behaviour. Of the sample of 126 boys and 75 girls who had attained puberty, a measure for age of peak-ASB participation could be reliably computed for 89 boys and 40 girls. For these adolescents, it was hypothesized that the reported age of peak-antisocial behaviour would be significantly positively correlated with the reported age of puberty onset, and that early-maturing adolescents would begin participation in ASB at a significantly younger age than those adolescents maturing on-time or late.

Pubertal Onset Age

[11]Pubertal onset age was significantly positively correlated with age of peak-ASB participation for boys ($r = .54$, $p < .001$, $n = 89$; Figure 8.1a) and girls ($r = .61$, $p < .001$, $n = 40$; Figure 8.1b). The size of the effect is substantial, particularly given that, in this sample, age of peak-ASB and pubertal onset age are both (normally) distributed with a range between ages 8 and 16. Age of peak-ASB participation occurred anywhere between ages 10 and 16 for girls ($M = 12.6$, $SD = 1.43$), and between ages 8 and 16 for boys ($M = 12.3$, $SD = 1.78$). Pubertal onset age was reported as occurring anywhere between ages 8 and 15 for girls ($M = 12.1$, $SD = 1.04$), and between ages 10 and 16 for boys ($M = 13.0$, $SD = 1.26$).

Figure 8.1a. Correlations between pubertal onset age and peak-ASB age for girls.

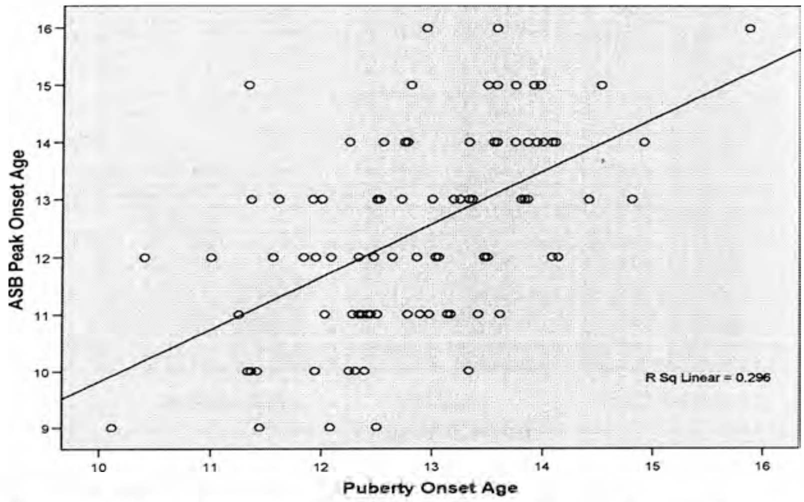

Figure 8.1b. Correlations between pubertal onset age and peak-ASB age for boys.

[11] High school girls (n=40) and boys (n = 89) with reliably computed pubertal onset age only

Pubertal Timing

A between subjects ANOVA with planned contrasts was run separately for girls and boys to investigate whether those adolescents who reported attaining puberty earlier than their peers, also reported an earlier age of peak-ASB participation.

[12]As predicted, there was a significant effect of pubertal timing on age of peak-ASB participation for girls ($F_{2,40} = 7.178, p < .005, \eta_p^2 = .26$) and boys ($F_{2,93} = 14.196, p < .001, \eta_p^2 = .23$; Figure 8.2). Planned contrasts revealed that early-maturing girls began peak-ASB participation at a significantly younger mean age ($M = 11.4$) than girls who matured on-time ($M = 12.7, p < .05$), or late ($M = 13.5, p < .005$), but girls who matured on-time or late did not differ in age of peak-ASB participation. Similarly, early-maturing boys began peak-ASB participation significantly younger ($M = 10.8$) than boys maturing on-time ($M = 12.4, p < .005$), or late ($M = 13.5, p < .001$), but boys who matured on-time or late did not differ in age of peak-ASB participation.

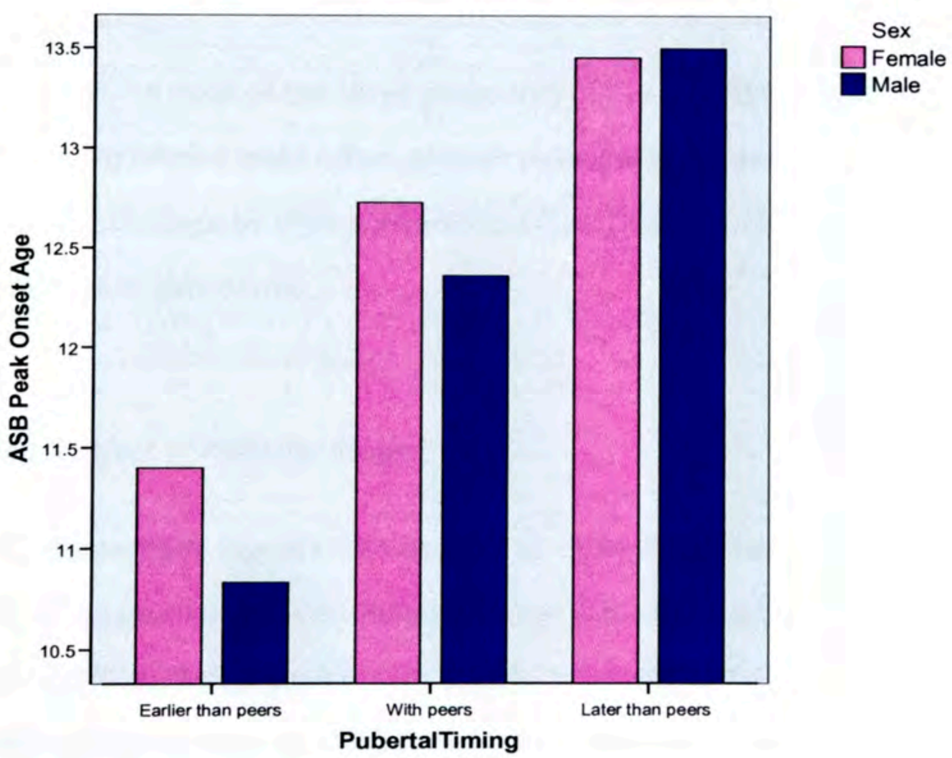

Figure 8.2. Peak-ASB age by pubertal timing group for girls and boys.

[12] High school girls and boys with reliably computed pubertal onset age only

Pubertal Development and Current Antisocial Behaviour

Given the previous evidence that puberty is associated with an increase in ASB participation (see Chapter 1), it was hypothesized that mid-pubertal adolescents would report significantly higher levels of Current ASB than pre-pubertal or late-pubertal adolescents. It was also hypothesized that, compared to their on-time and late-maturing peers, those adolescents who reported early maturation would report significantly higher levels of Current ASB, indicating persistent ASB participation. Univariate analysis of covariance was performed separately for girls and boys, on three measures of Current ASB (ASB-Major, ASB-Minor, ASB-Total) with pubertal half-stage (hereafter referred to as Pubertal Stage) 1.0 to 4.5 and pubertal timing (early, on-time, late) as fixed factors and the age at time of interview (current age) as a covariate. Current age was held as a covariate because, typically, older adolescents participate in higher levels of ASB (See Chapter 6 for details).

Girls

For girls, on each of the three measures of Current ASB (Major, Minor, Total), there was a significant main effect of both pubertal stage and pubertal timing, and a significant stage by timing interaction (see Table 8.1 for F-values, p-values, effect sizes, and power estimates).

Main Effect of Pubertal Stage

As displayed in Figures 8.3a to 8.3c, all three measures of Current ASB (Major, Minor, Total) showed a 'peak' at Pubertal Stage 2.5. Because this peak occurs mid-pubertal as hypothesized, planned comparisons were performed to examine the extent of mean differences in Current ASB between those girls currently in Pubertal Stage 2.5 and those in earlier and later pubertal stages (p-values summarized in Table 8.2). These planned comparisons revealed that girls in Mid-Pubertal Stage 2.5 reported significant ($p < .05$; ASB-Major, ASB-Total), or marginally significant ($p < .10$, ASB-Minor) higher levels of Current ASB compared to girls in all preceding pubertal stages (1.0 to 2.0), and significantly higher levels of Current ASB-Major, ASB-Minor, and ASB-Total ($p < .001$) compared to girls in all later (3.0 to 4.5) pubertal stages. The levels of Current ASB reported by mid-pubertal Stage 2.5 girls were also significantly higher than those reported by girls in adjacent pubertal stages. Compared to girls in Stage 3.0, girls in Stage 2.5 reported significantly greater Current ASB-Major ($p < .001$), ASB-Minor ($p = .01$), and ASB-Total ($p < .01$). Compared to girls in Stage 2.0, girls in Stage 2.5 reported significantly greater Current ASB-Major ($p < .001$); but no significant differences were found between Stage 2.5 and 2.0 in reported Current ASB-Minor or ASB-Total. Thus, there is good evidence that reported levels of current ASB, especially major ASB, peak at approximately pubertal Stage 2.5 for girls, regardless of current age (refer back to Figure 6.6a for mean ASB by age).

Table 8.1. *F*-values, *p*-values, effect sizes, and power for age-adjusted Current ASB (Major, Minor, Total)[13] by pubertal stage and pubertal timing for girls[14].

ANCOVA	df	*F*-value	*p*-value	ES (η_p^2)	power
Current Total ASB:					
Pubertal Stage	6,60	2.563	.028	.20	.808
Pubertal Timing	2,60	6.630	.003	.18	.899
Stage * Timing Interaction	8,60	2.753	.012	.27	.906
Current Minor ASB:					
Pubertal Stage	6,61	2.424	.036	.19	.783
Pubertal Timing	2,61	5.607	.006	.16	.841
Stage * Timing Interaction	8,61	2.187	.041	.22	.814
Current Major ASB:					
Pubertal Stage	7,62	7.964	.000	.47	1.00
Pubertal Timing	2,62	9.057	.000	.23	.969
Stage * Timing Interaction	8,62	8.688	.000	.53	1.00

[13] Note that similar results are found for hypothesized associations with Total ASB and Minor ASB as these scales are highly similar.

[14] High school girls only; n = 75

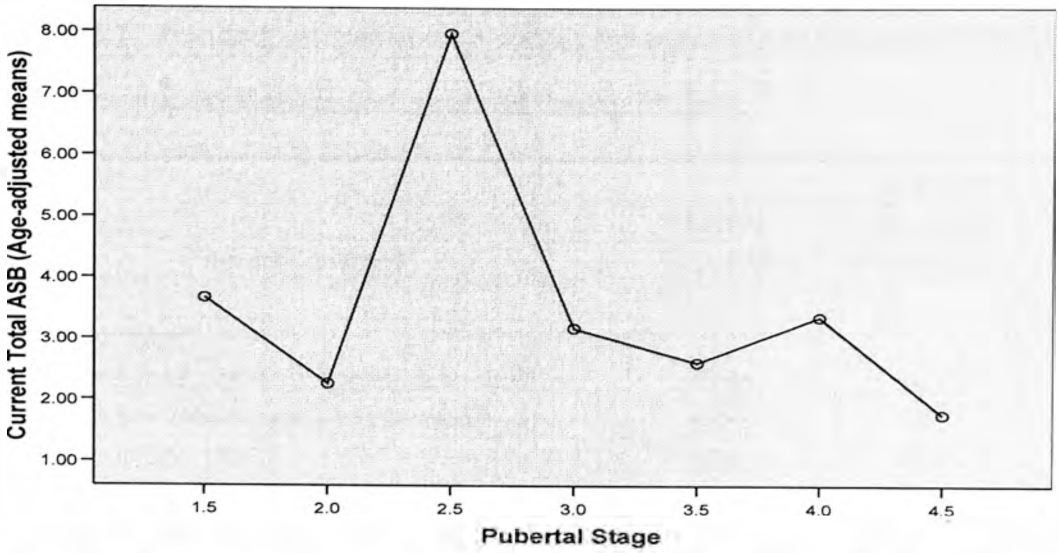

Figure 8.3a. Current ASB-Total by pubertal stage (adjusted for age) for girls.

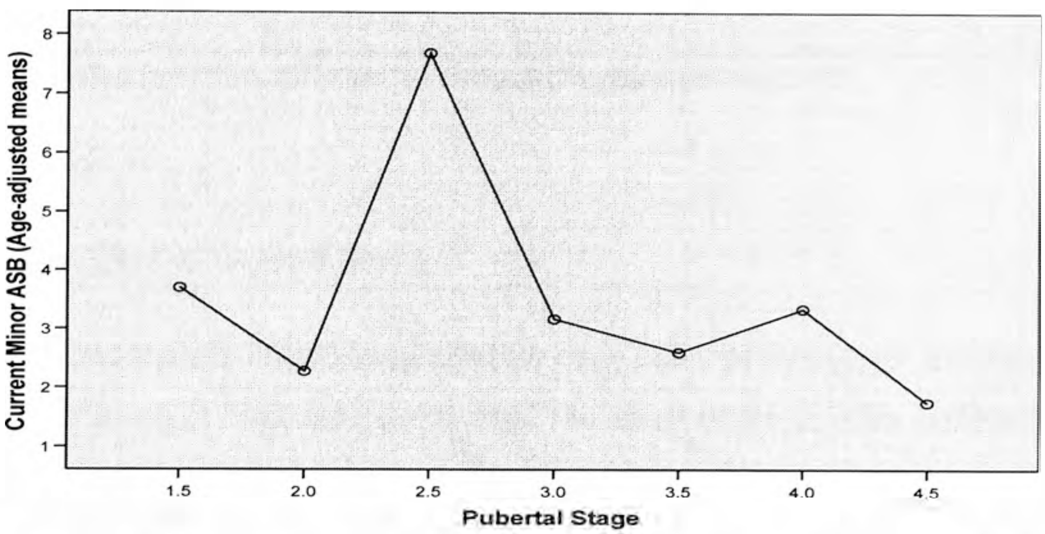

Figure 8.3b. Current ASB-Minor by pubertal stage (adjusted for age) for girls.

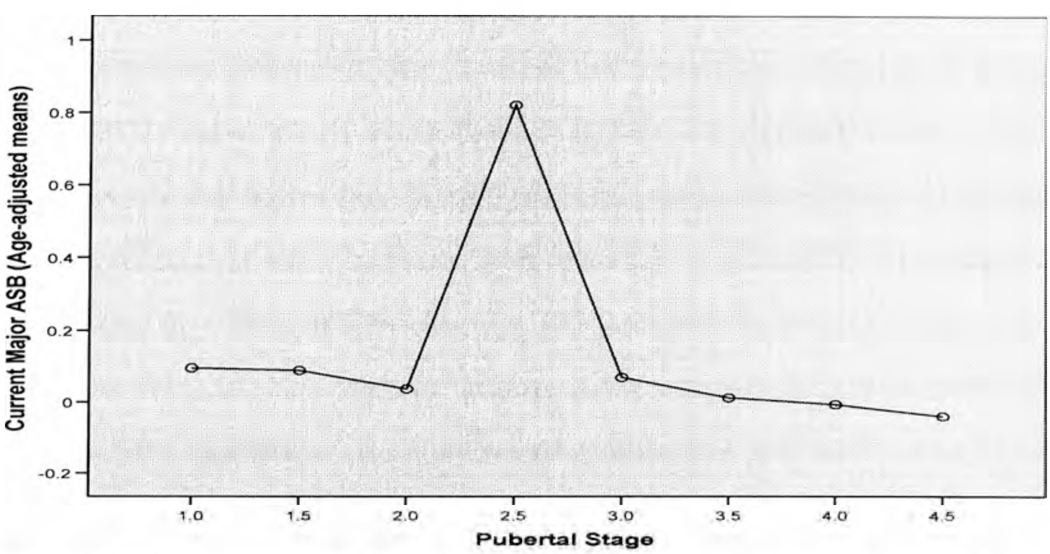

Figure 8.3c. Current ASB-Major by pubertal stage (adjusted for age) for girls.

Table 8.2. Planned comparisons *p*-values for age-adjusted Current ASB (Major, Minor, Total) by pubertal stage and pubertal timing for girls.[15]

	p-value		
Planned Contrast*	Current Total ASB	Current Minor ASB	Current Major ASB
Pubertal Stage:			
Stage 2.5 vs previous stages (1.0 – 2.0)	.050	.063	.022
Stage 2.5 vs later stages (3.0 – 4.5)	.001	.001	.000
Stage 2.5 vs 3.0	.008	.010	.000
Stage 2.0 vs Stage 2.5			.000
Pubertal Timing:			
Early vs On-time	.008	.024	.000
Early vs Late	.539	.429	.006
On-time vs Late	.037	.093	.093

*Includes Helmert, difference, and simple planned contrasts

Main Effect of Pubertal Timing

The next analysis investigated whether early pubertal timing was associated with higher levels of reported current ASB. The effect of the possible variance shared by the current age of the participant (i.e. age at interview) was included in the analyses; ANCOVA revealed that pubertal timing predicted higher levels of current antisocial behaviour for girls. As illustrated in Figure 8.4, those girls who matured earlier than their peers reported significantly higher levels of Current ASB-Major, ASB-Minor, and ASB-Total than those girls who matured on-time or late. This significant effect of pubertal timing is mostly accounted for by the ASB reported by girls who matured early compared to on-time. Simple planned comparisons (summary presented in Table 8.1) revealed that early-maturing girls reported significantly higher levels of Current ASB-Major (p = .001), ASB-Minor ($p < .05$), and ASB-Total ($p < .01$) than those girls who matured on-time. However, for comparisons between early and late-maturing girls only Current ASB-Major was significantly greater for girls who matured early (p = .005) than those who matured late.

[15] High school girls only; n = 75

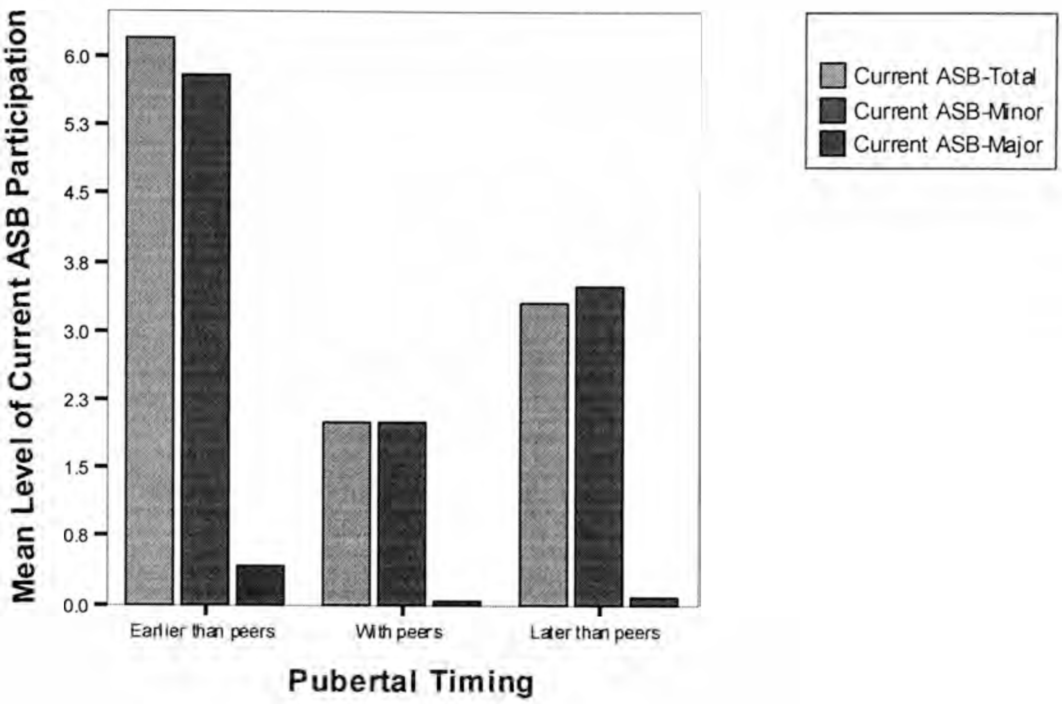

Figure 8.4. Age-adjusted Current ASB-Total, ASB-Minor, and ASB-Major by pubertal timing for girls.[16]

Interaction between Pubertal Stage and Pubertal Timing

Analyses revealed a significant interaction between pubertal stage and pubertal timing for girls ($F_{8,60}$ = 2.753, p < .05). From examination of the graphs (Figures 8.5a to 8.5c) it appears that the interaction between pubertal stage and pubertal timing is largely due to early-maturing girls who show very high levels of ASB at the mid-pubertal stages (Stages 2.5 and 3.0). In contrast, the on-time and late-maturing girls show very little evidence of an association between pubertal stage and ASB (with the possible exception of a peak in ASB-Major for late-maturing girls). Note: Because the early-maturing girls entered puberty as young as 9 years of age, we do not have pre-puberty data for those girls.

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[16] High school girls only; n = 75

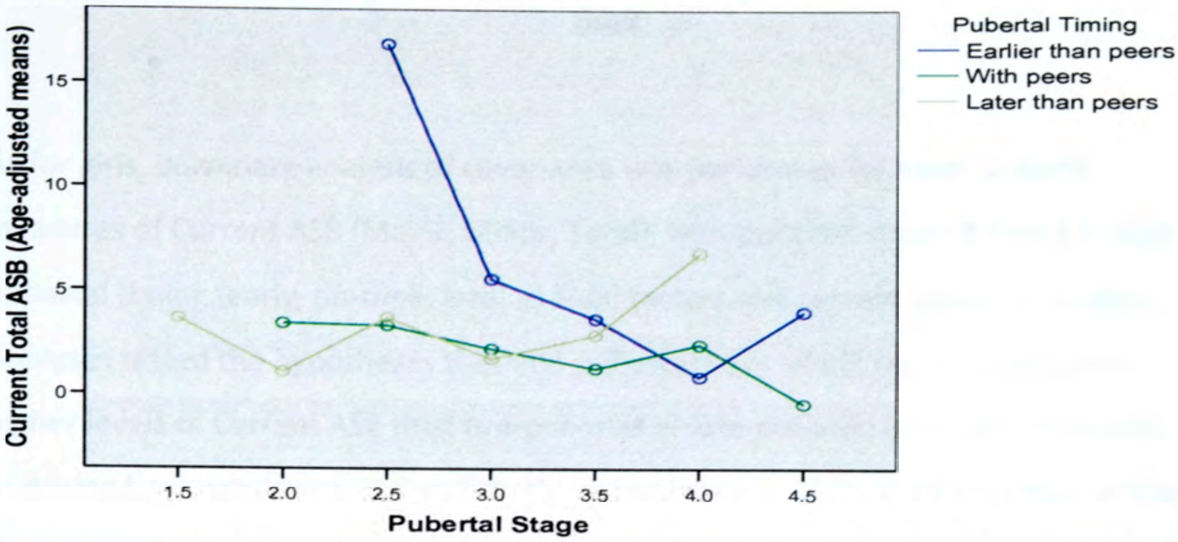


Figure 8.5a. Age-adjusted pubertal stage and timing interaction on current ASB-Total for girls.

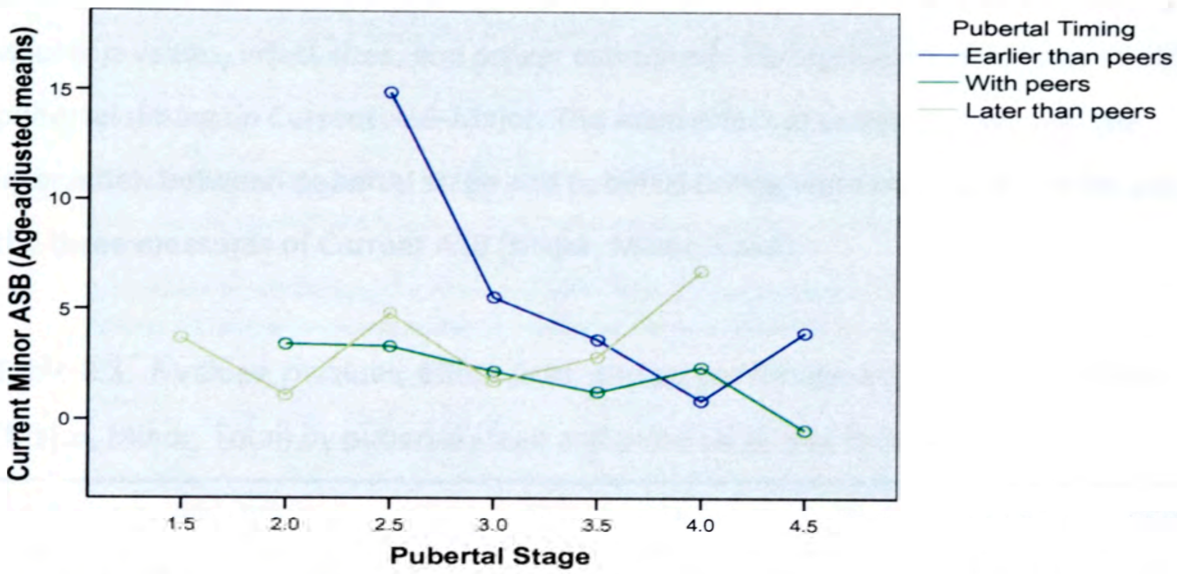


Figure 8.5b. Age-adjusted pubertal stage and timing interaction on Current ASB-Minor for girls.

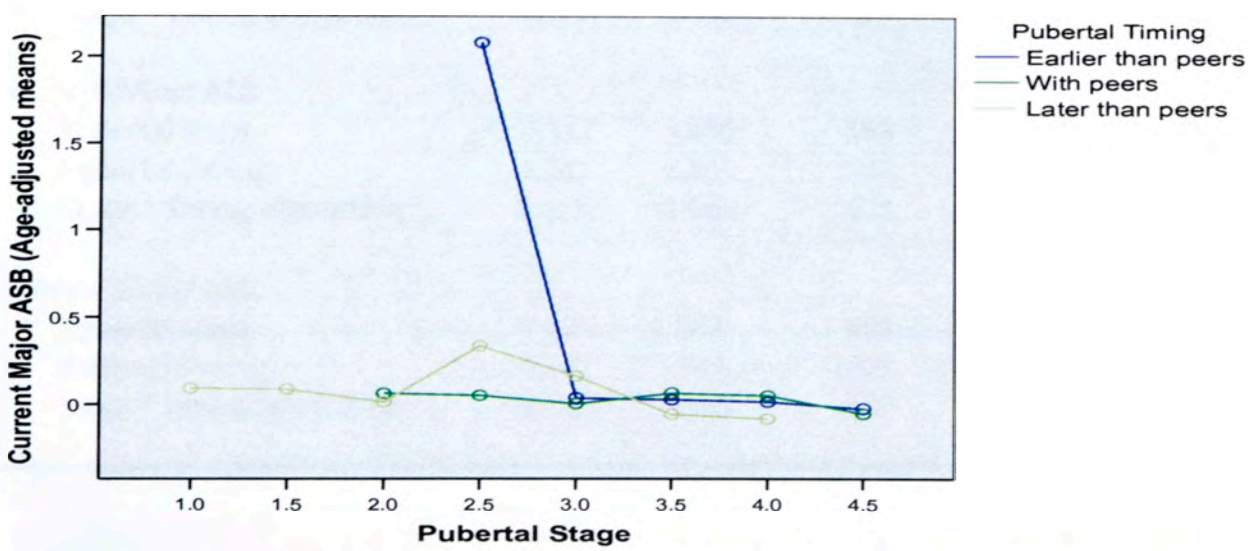


Figure 8.5c. Age-adjusted pubertal stage and timing interaction on current ASB-Major for girls.

Boys

As for girls, univariate analysis of covariance was performed for boys on three measures of Current ASB (Major, Minor, Total), with pubertal stage (1.0 to 4.5) and pubertal timing (early, on-time, late) as fixed factors and current age as a covariate. Analyses tested the hypotheses that mid-pubertal boys would report significantly higher levels of Current ASB than pre-pubertal or late-pubertal boys, and that early-maturing boys would report significantly higher levels of Current ASB relative to their on-time and late-maturing peers. Approaching significance ($p < .10$), there was a main effect for pubertal timing on Current ASB-Minor and ASB-Total (see Table 8.3 for *F*-values, *p*-values, effect sizes, and power estimates). No significant effect was found for pubertal timing on Current ASB-Major. The main effect of pubertal stage and the interaction between pubertal stage and pubertal timing were not significant for any of the three measures of Current ASB (Major, Minor, Total).

Table 8.3. *F*-values, *p*-values, effect sizes, and power for age-adjusted Current ASB (Major, Minor, Total) by pubertal stage and pubertal timing for boys.[17]

ANCOVA	*df*	*F*-value	*p*-value	ES (η_p^2)	power
Current Total ASB:					
Pubertal Stage	7,117	1.002	.433	.06	.417
Pubertal Timing	2,117	2.598	.079	.04	.509
Stage * Timing Interaction	11,117	1.539	.127	.13	.762
Current Minor ASB:					
Pubertal Stage	7,117	1.068	.388	.06	.444
Pubertal Timing	2,117	2.669	.074	.04	.521
Stage * Timing Interaction	11,117	1.588	.111	.13	.778
Current Major ASB:					
Pubertal Stage	7,121	.395	.903	.02	.171
Pubertal Timing	2,121	.348	.707	.01	.105
Stage * Timing Interaction	11,121	1.560	.119	.12	.770

[17] High school boys only; n = 126

Main Effect of Pubertal Stage

The non-significant effect of pubertal stage is illustrated in Figures 8.6a to 8.6c, on all three measures of Current ASB (Major, Minor, Total), there was no discernable pattern by pubertal stage (other than a general trend in the direction of increasing levels of ASB as boys progress through pubertal stages). When analysis of covariance was performed separately for each ASB item on pubertal stage (1.0 to 4.5), however, a trend emerged for a 'peak' in Current ASB to occur at Stage 4.0 for many ASB items (see Table 8.4); no other patterns by pubertal stage emerged. These findings suggest the possibility that for boys, if a peak in ASB participation occurs at all, it may occur in later stages of puberty compared to the mid-pubertal peak found for girls (refer back to Figure 6.6b for mean ASB by age).

Table 8.4. Significance values by Pubertal Stage 4.0 – 4.5 contrasts for selected (age-adjusted) Current ASB categories for boys[18] (all other comparisons, non-significant).

ASB category	*p* values	ASB items in category
Vandalism	$p < .05$	Vandalized Personal Property Damaged Things in Public Places Damaged School Property Vandalized Public Property
Minor Theft	$p < .05$	Shoplifted From Stores Stolen Under $10
Vandalism	$p < .05$	Vandalized Personal Property Stolen Over $10 at One Time
Major Theft	$p < .05$	Sold or Bought Stolen Goods Taken Purse or Wallet
Violent	$p = .108$	Used a Weapon in a Fight Forced Sex

[18] High school boys only; n = 126

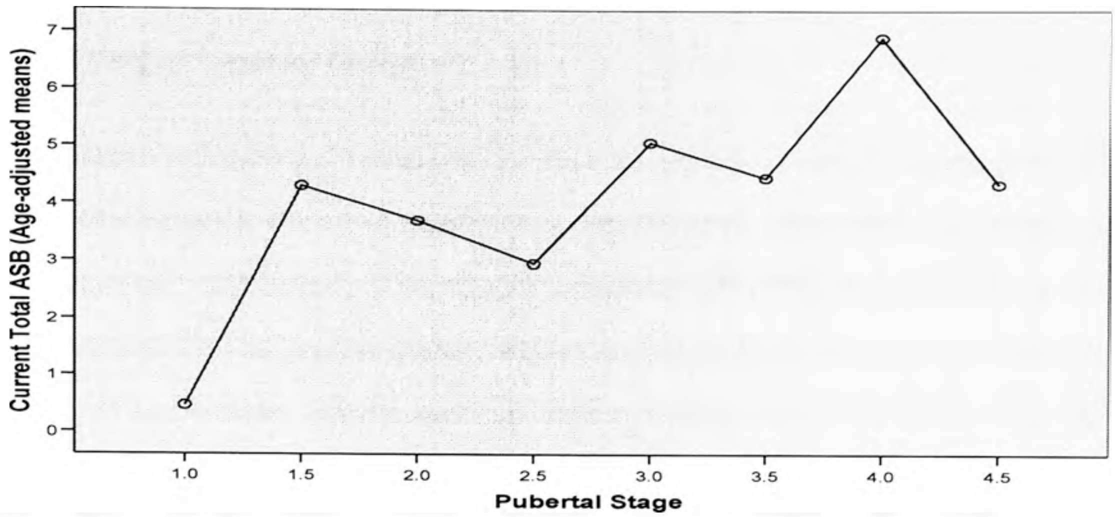


Figure 8.6a. Age-adjusted Current ASB-Total by pubertal stage for boys.

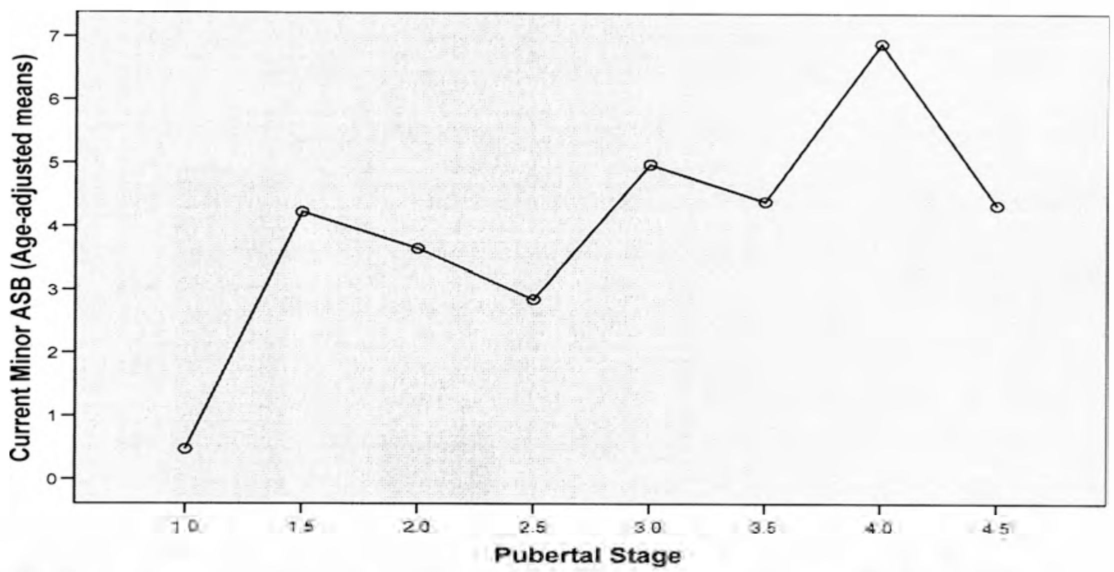


Figure 8.6b. Age-adjusted Current ASB-Minor by pubertal stage for boys.

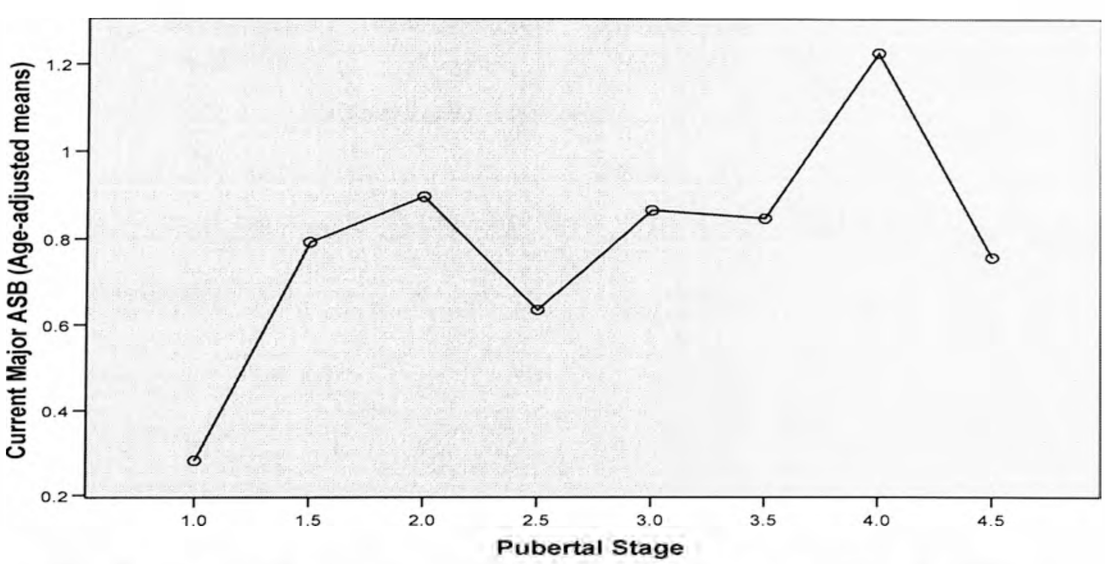


Figure 8.6c. Age-adjusted Current ASB-Major by pubertal stage for boys.

Main Effect of Pubertal Timing

As displayed in Figure 8.7 compared to their on-time and late-maturing peers, boys who matured early, reported significantly higher levels of Current ASB-Minor, and ASB-Total, (but not ASB-Major). The overall significant effect for pubertal timing was mostly accounted for by the greater ASB reported by boys who matured early compared to on-time. Simple planned comparisons (summary presented in Table 8.5) revealed that early-maturing boys reported significantly higher Current ASB-Minor and ASB-Total than those boys who matured on-time ($p < .01$), late-maturing boys ($p < .05$), and on-time and late maturing groups combined ($p < .05$).

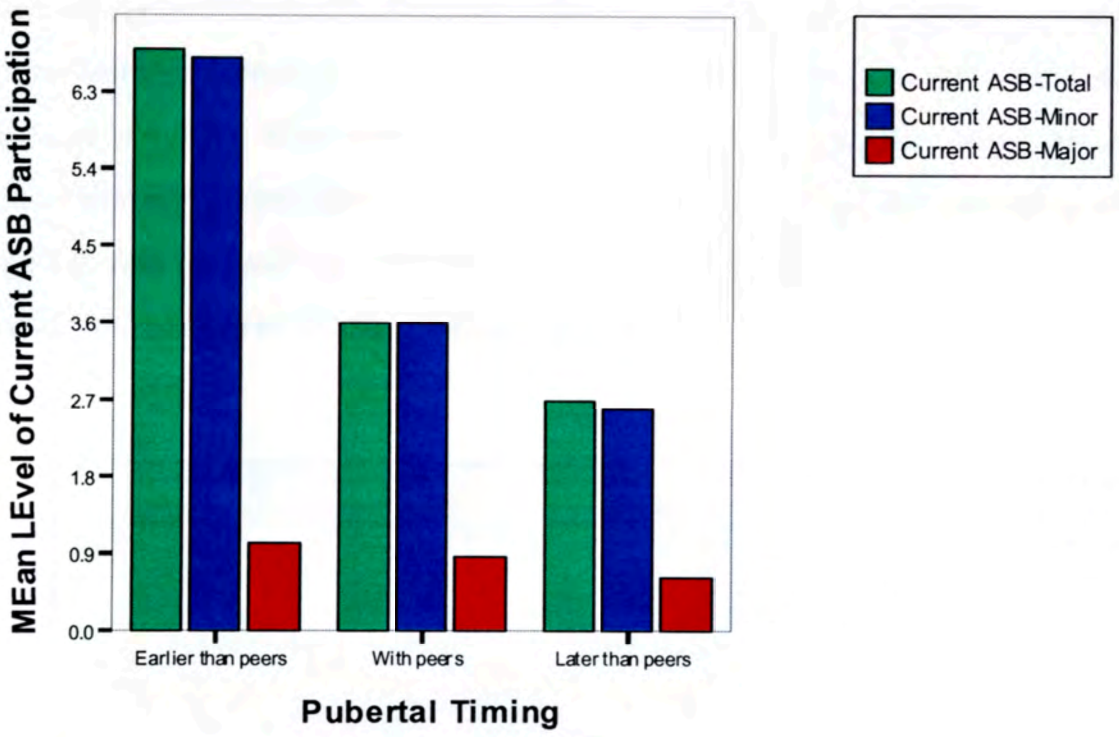


Figure 8.7. Age-adjusted Current ASB-Total, ASB-Minor, and ASB-Major by pubertal timing for boys.[19]

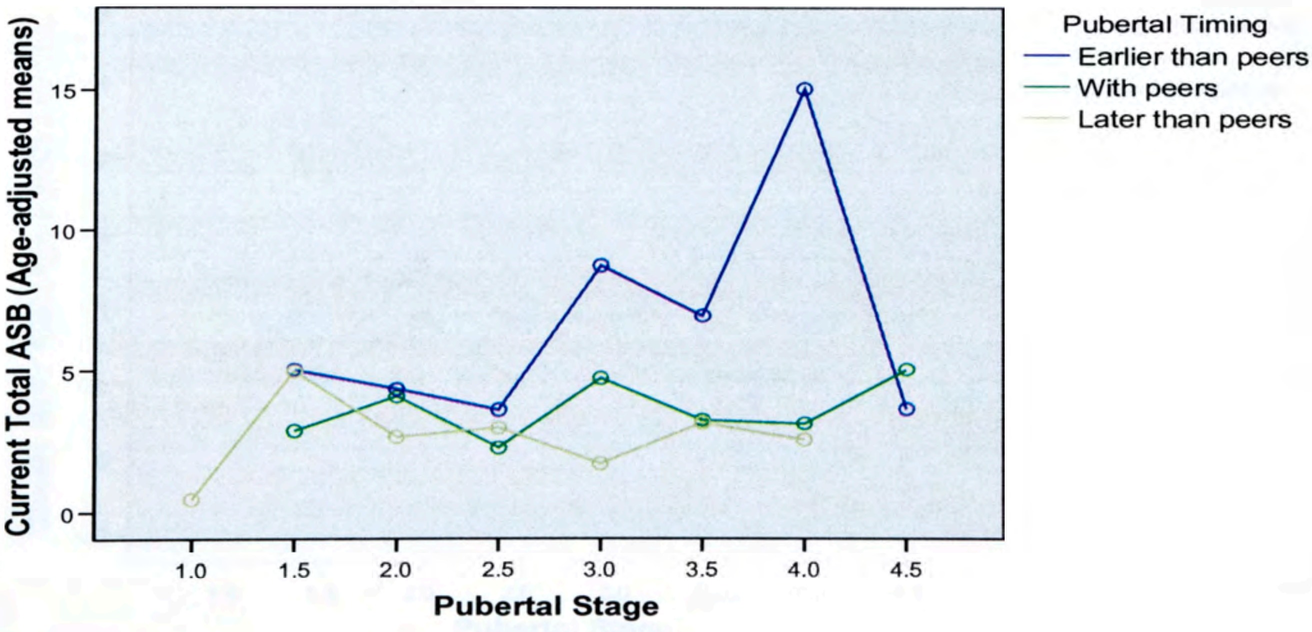
[19] High school boys only; n = 126

Table 8.5. Planned comparisons *p*-values for (age-adjusted) Current ASB (Major, Minor, Total) by pubertal timing for boys. [20]

	p-value		
Pubertal Timing Planned Contrasts	Current Total ASB	Current Minor ASB	Current Major ASB
Early vs On-time	.001	.001	.062
Early vs Late	.005	.005	.119.
On-time vs Late	.759	.769	.927

Interaction between Pubertal Stage and Pubertal Timing

Analyses revealed that the interaction between pubertal stage and pubertal timing approached significance for Current ASB-Major (p = .119), ASB-Minor (p = .111), and ASB-Total (p = .127). From examination of the profile plots (Figures 8.8a to 8.8b) it appears that early maturing boys show a peak in all measures of Current ASB at around Stage 4.0, with on-time and late maturing boys showing less evidence of an association between the measures of ASB and pubertal stage.



[20] High school boys only; n = 126

Figure 8.8a. Age-adjusted pubertal stage and pubertal timing interaction on Current ASB-Total for boys.

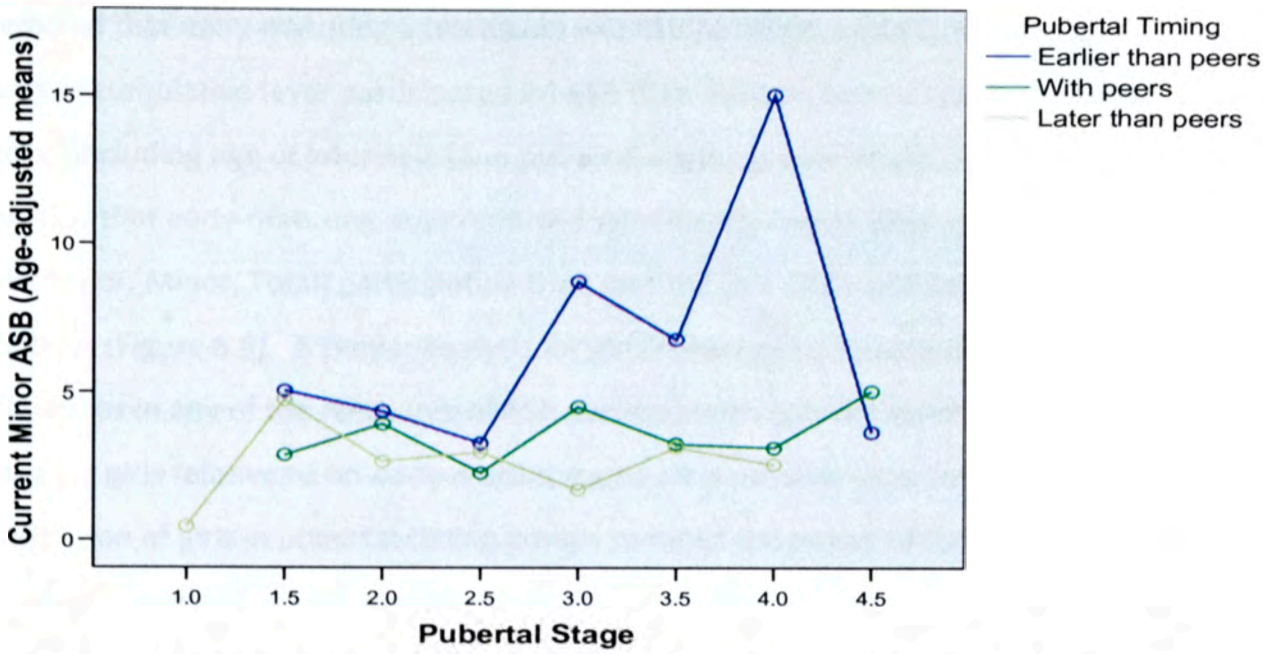


Figure 8.8b. Age-adjusted pubertal stage and pubertal timing interaction on Current ASB-Minor for boys.

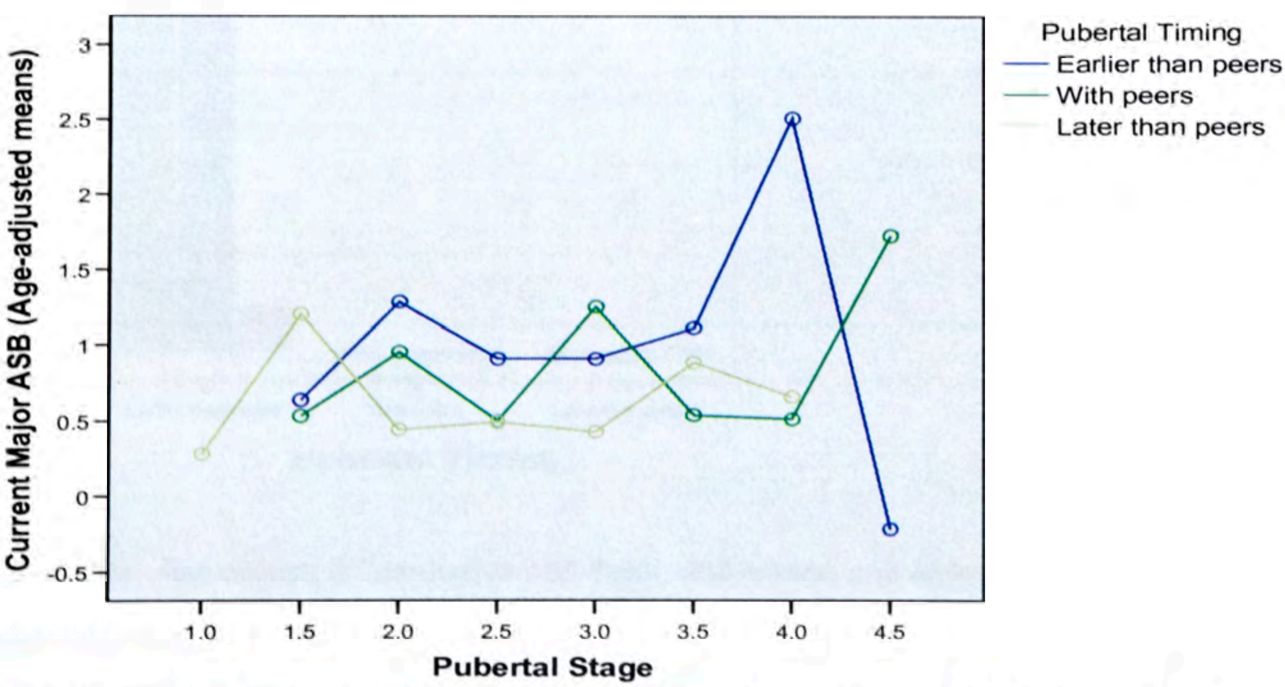


Figure 8.8c. Age-adjusted pubertal stage and pubertal timing interaction on Current ASB-Major for boys.

Pubertal Timing and Cumulative Antisocial Behaviour

Compatible with the finding reported above in Section 2 that higher levels of current ASB (past 12 months) participation were associated with early pubertal timing, it was predicted that early-maturing adolescents would also report participating in higher levels of cumulative (ever participated in) ASB than their on-time and late-maturing peers. Including age of interview (and pubertal stage) as a covariate, ANCOVA revealed that early-maturing boys reported significantly higher levels of cumulative ASB (Major, Minor, Total) participation than on-time ($p < .005$) and late-maturing ($p < .05$) boys (Figure 8.9). A similar analysis for girls revealed no statistically significant differences in any of the measures of ASB participation reported by on-time and late-maturing girls relative to on-early-maturing girls. It is possible that the unequal distribution of girls in pubertal timing groups reduced the power of the test to find any significant differences; observed power was in the range of .2 for all three (ASB-Major, ASB-Minor, ASB-Total) tests.

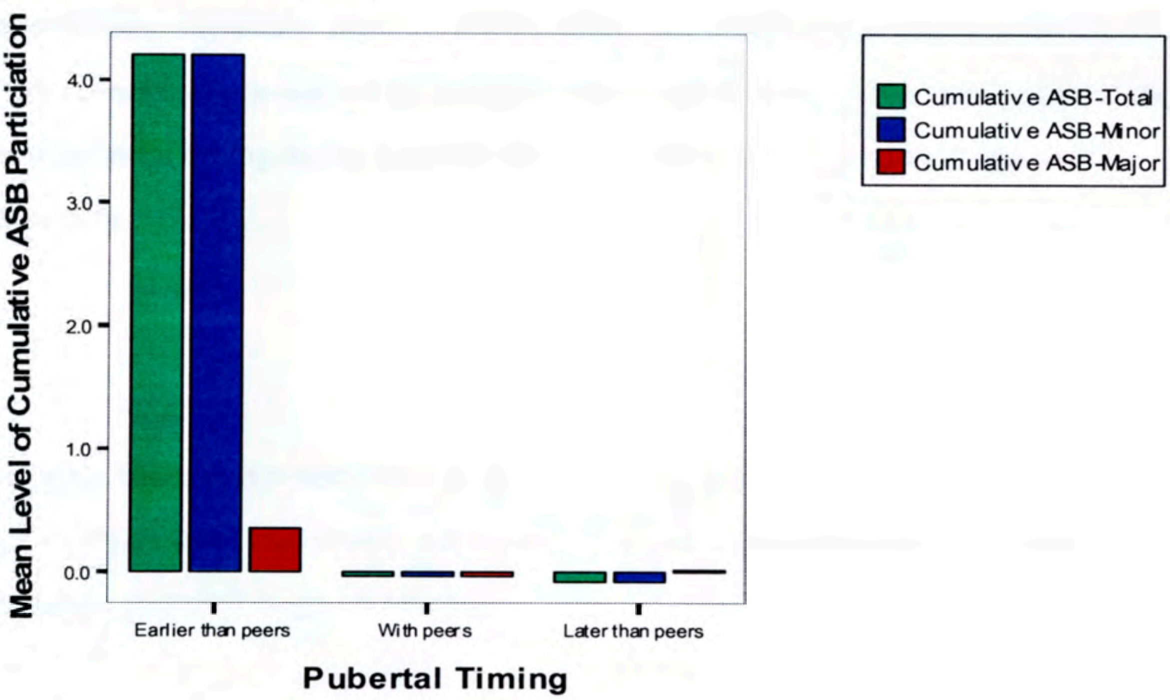


Figure 8.9a. Age-adjusted Cumulative ASB-Total, ASB-Minor, and ASB-Major by pubertal timing for boys.[21]

[21] High school boys only; n = 126

The above findings suggest, however, that it is possible that the effect of early-pubertal timing on ASB participation is longer lasting for boys (evidenced by significant effects on Cumulative ASB). For girls, the lack of significant differences in pubertal timing for Cumulative ASB in contrast to the significant main effects and interaction between pubertal stage and timing for Current ASB, suggests that, for girls, the effect of early-pubertal timing on ASB participation may be limited to the mid-pubertal stages.

Pubertal Development and Current Antisocial Attitudes

It was hypothesized that mid-pubertal adolescents would report significantly greater current antisocial attitudes (ASA) than pre-pubertal or late-pubertal adolescents. It was also hypothesized that compared to their on-time and late-maturing peers, those adolescents who reported early maturation would report significantly greater current antisocial attitudes (indicating persistent antisocial attitudes). To investigate these hypotheses, univariate analysis of covariance was performed separately for (all, i.e. high school and primary school) boys (n = 193) and girls (n = 120), with pubertal stage and pubertal timing (early, on-time, late) as fixed factors and current age as a covariate.

Girls

For girls, there was a significant main effect of pubertal timing ($F_{2,33} = 5.225$, $p = .01$, $\eta_p^2 = .24$) on total ASA scores, but no effect of pubertal stage, and no interaction between pubertal stage and timing.

Main Effect of Pubertal Stage

Although not statistically significant, plotting of ASA scores against pubertal stage shows a trend for mid-pubertal girls to report higher current antisocial attitudes in comparison to pre-pubertal and late-pubertal girls (Figure 8.10).

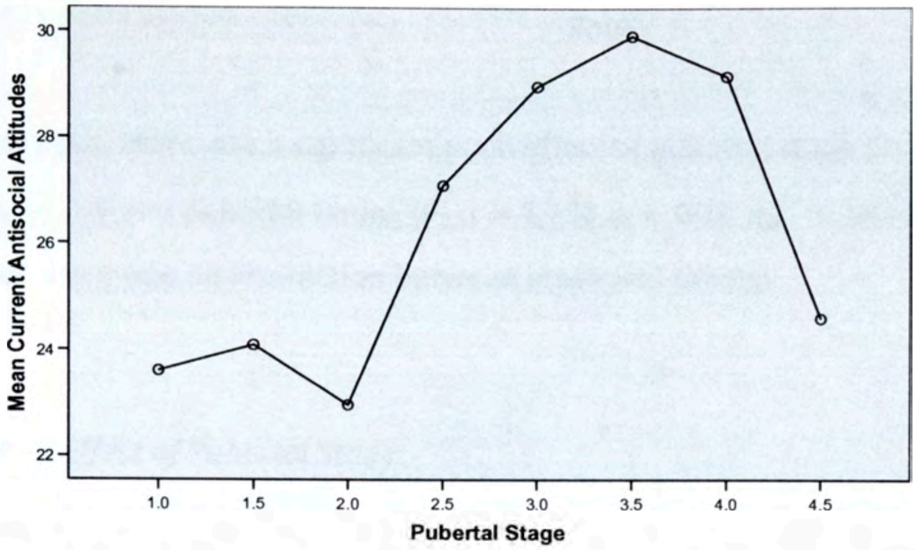


Figure 8.10. Age-adjusted Current antisocial attitudes by pubertal stage for girls.

Main Effect of Pubertal Timing

As predicted, early maturing girls reported significantly higher mean total ASA than those girls who matured on-time ($p < .005$). Planned comparisons found there was no significant difference in total ASA scores between early and late-maturing girls. This is in contrast to the earlier finding that early-maturing girls reported significantly higher Current ASB than late-maturing girls. Interestingly, late-maturing girls reported a higher mean total ASA than girls who matured on-time, and this difference was marginally significant ($p < .10$; see Figure 8.11).

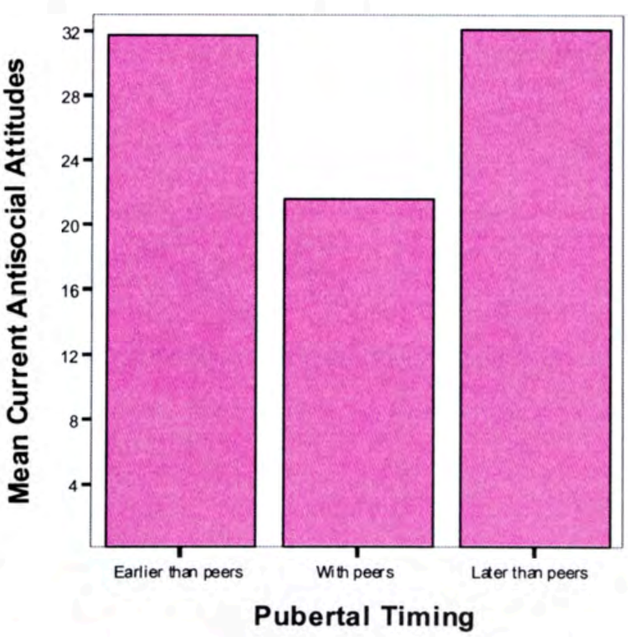


Figure 8.11. Age-adjusted Current antisocial attitudes by pubertal timing for girls.

Boys

For boys, there was a significant main effect of pubertal stage ($F_{7,185} = 2.386, p < .01, \eta_p^2 = .10$) and pubertal timing ($F_{2,47} = 7.133, p < .005, \eta_p^2 = .23$) on total ASA scores, but there was no interaction between stage and timing.

Main Effect of Pubertal Stage

Planned comparisons revealed that boys in pubertal Stage 3.0 reported significantly higher mean total ASA compared to the total mean effect of boys' scores in all previous stages (1.0 through 2.5) ($p < .01$; Figure 8.12). A range of stages is included in both pre-pubertal (i.e. Stage 1.0 and 1.5) and mid-pubertal (i.e. Stage 2, 2.5 and 3.0), therefore, post hoc tests were used to investigate the significant effect of pubertal stage, which revealed that boys in pubertal Stage 3.0 scored significantly higher ASA scores than boys in pubertal Stage 1.0 ($p < .05$). Although there was a trend for boys in all subsequent later stages to obtain lower ASA scores, scores of pubertal Stage 3.0 boys were not significantly higher than the total mean effect of boys' scores in all later stages; therefore, the data suggests a linear trend for an increase in antisocial attitudes with age regardless of pubertal stage.

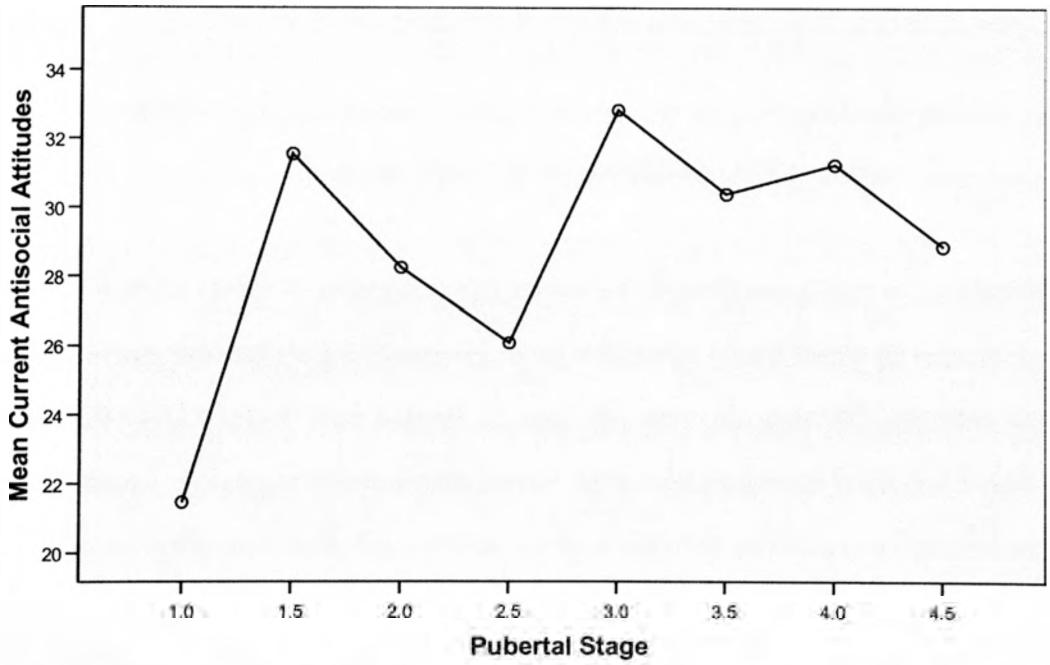


Figure 8.12. Age-adjusted Current antisocial attitudes by pubertal stage for boys.

Main Effect of Pubertal Timing

Post hoc investigation of the effect of pubertal timing revealed that, as predicted, (after controlling for age) early maturing boys reported significantly higher mean total ASA than late-maturing boys ($p < .05$), on-time and late-maturing boys combined ($p < .05$), and boys who matured on-time ($p < .01$; Figure 8.13).

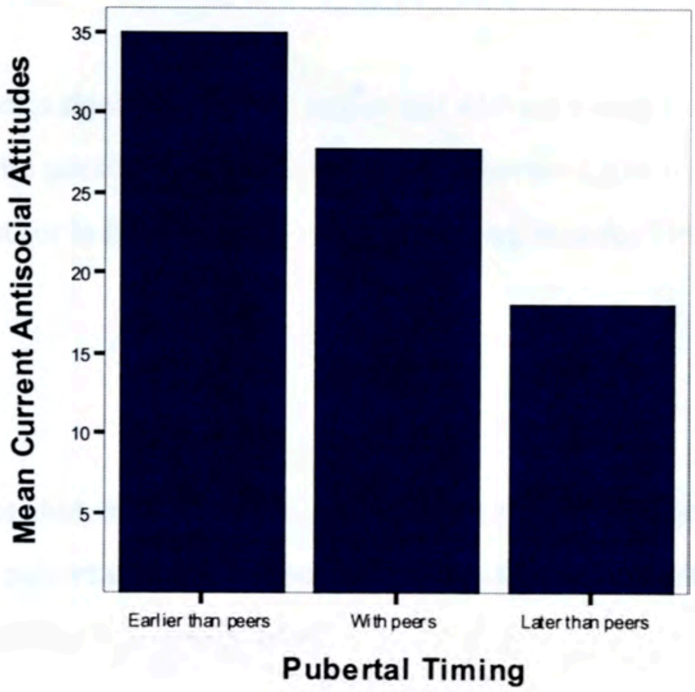


Figure 8.13. Age-adjusted Current antisocial attitudes by pubertal timing for boys.

Summary of Findings for Pubertal Development and ASB/ASA

Puberty Onset & Peak Antisocial Behaviour

Despite a wide range in reported age of pubertal onset and age of peak-ASB participation, both girls and boys were significantly more likely to report an age of peak-ASB participation that was at or near the age of reported pubertal onset. Furthermore, amongst these adolescents who had attained pubertal onset, separate analyses for girls and boys found that early-maturing adolescents began participating in ASB at a significantly younger age than their on-time and late-maturing peers.

Pubertal Stage & Current ASB

Girls. Girls in the mid-pubertal Stage 2.5 group reported significantly higher levels of Current ASB (Major, Minor, Total) than all other pubertal stages, providing good evidence that reported levels of Current ASB peak during mid-puberty for girls.

Boys. The findings of a significant 'peak' in Current ASB occurring in pubertal Stage 4.0 for boys, suggests the possibility that the effect of pubertal onset on current ASB participation may occur in later pubertal stages for boys than for girls.

Pubertal Timing & Current ASB

The findings indicate that, in this sample, early pubertal onset predicts higher levels of Current ASB across pubertal stages for both girls (ASB-Major, ASB-Minor, and ASB-Total) and boys (ASB-Minor and ASB-Total).

Combined effect of Pubertal Stage and Pubertal Timing & Current ASB

When the effects of pubertal stage and pubertal timing were considered together, a clear pattern emerged which found that the effect of pubertal onset on ASB participation was limited to those adolescents who were both early-maturers and in a particular pubertal stage (mid-pubertal stages 2.5 and 3.0 for girls; late-pubertal stage 4.0 for boys). Both on-time and late-maturing girls and boys show very little evidence of an association between the measures of ASB and pubertal stage.

Pubertal Timing & Cumulative Antisocial Behaviour

When the data were examined for possible long-term effects of pubertal timing on ASB participation, it was found that early-maturing boys reported significantly higher levels of Cumulative (all reported) ASB participation than boys who matured on-time or late. This effect was not found for girls. The inclusion of pubertal stage in the analyses establishes that this finding is not the result of early-maturing boys participating in greater ASB due to a comparatively earlier pubertal-onset, and thus having had more years to participate in ASB. Thus, there is evidence that, for boys, early pubertal timing may predict higher levels of ASB participation that persist over time.

Pubertal Development & Current Antisocial Attitudes

For both girls and boys, some evidence was found for independent main effects of pubertal stage and pubertal timing on antisocial attitudes, but no evidence that these effects interact. Separate analyses for girls and boys revealed that early-maturing adolescents reported significantly higher antisocial attitudes than those adolescents who matured on-time. There is also strong evidence to suggest that reports of antisocial attitudes were higher amongst those adolescents currently in mid-puberty.

Conclusion

In summary, evidence was found to support a relationship between pubertal onset and ASB participation, and a relationship between pubertal timing and ASB participation. Adolescents began participating in ASB shortly following pubertal onset, and participated in higher levels of ASB during mid-puberty. Those adolescents who matured early, began participation in ASB at younger ages and continued participating in higher levels of ASB compared to their on-time and late-maturing peers, but this effect was particularly significant if they were currently in a mid-pubertal stage. Similar findings were found for a relationship between pubertal onset and antisocial attitudes. Although not always statistically significant, there was a tendency for mid-pubertal adolescents to report higher antisocial attitudes than pre-pubertal or late-pubertal adolescents.

The above findings provide evidence that a relationship exists between adolescent ASB participation and pubertal stage and pubertal timing. The next two chapters examine whether these measures of pubertal development are also associated with adolescents' executive functioning. Chapter 9 examines whether a temporary reduction in executive functioning is associated with a mid-pubertal development stage, and whether those adolescents who matured earlier than their peers experienced a current (persistent) reduction in executive functioning. Chapter 10 examines whether relatively lower executive functioning is experienced by those adolescents who also reported higher levels of Current and Cumulative (persistent) ASB participation.

Chapter 9: Pubertal Development and Executive Functioning

It was hypothesized that adolescents currently in a mid-pubertal stage would score lower on tests of executive function than adolescents who were currently pre-pubertal, or post-pubertal, and that compared to on-time and late-maturing adolescents, those adolescents who matured earlier than their peers would score lower on tests of executive function. Primary-school participants responded to all measures of executive function and pubertal development, but not all measures of antisocial behaviour. Therefore, primary-school participants were excluded from some of the following analyses.

In the previous chapter, current age was included as a covariate to account for the likelihood that relatively older adolescents would report higher levels of ASB. Similarly, we would expect older adolescents to obtain higher scores of executive functioning. Further, it was expected that even amongst children of the same age, individual differences in general intellectual functioning would exist. Thus, by controlling for individual differences in intellectual functioning (i.e. SVS), age-related variations in executive functioning were also controlled. Univariate analysis of covariance was performed separately for boys and girls, with pubertal stage and pubertal timing (early, on-time, late) as fixed factors and general intellectual functioning (SVS) as a covariate.

Girls (Primary and High-School)

A 2 x 2 ANOVA on all girls (primary and high-school participants revealed a significant main effect for pubertal timing on executive function scores, There was a significant (but unexpected) main effect of pubertal stage ($F_{2,94}$ = 4.930, p = < .001, η_p^2 = .27), and no interaction between stage and timing ($F_{2,94}$ = 0.335, p = .981).

Main Effect of Pubertal Stage

As revealed in Figure 9.1a, executive function scores increased as girls progressed through pubertal stages. This unexpected linear increase in executive function scores could be related to increases in age; the inclusion of primary-school participants, results in a wider age-range, and older girls are more likely to be in later stages of pubertal development. This phenomenon does not occur in analyses performed with high-school girls only (discussed below).

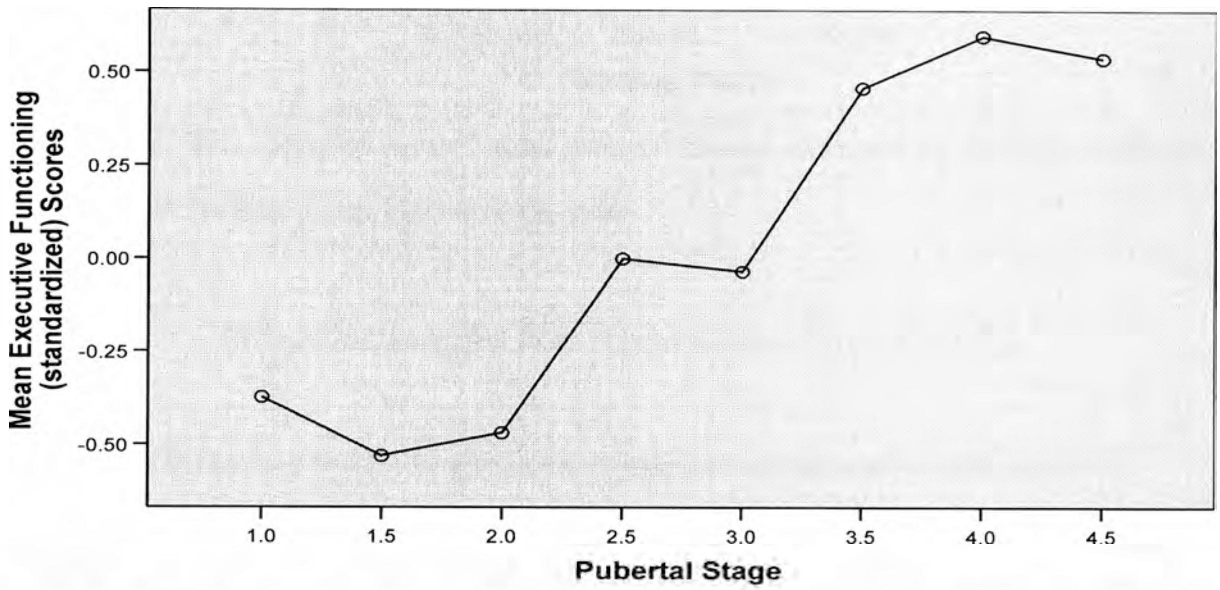


Figure 9.1a. SVS-adjusted mean (standardized) executive function scores by pubertal stage for primary and high-school girls.

Main Effect of Pubertal Timing

Investigation of the significant main effect of pubertal timing revealed that early-maturing girls scored significantly lower on tests of executive function than on-time maturing girls ($p < .05$), and late-maturing girls ($p < .001$; Figure 9.1b).

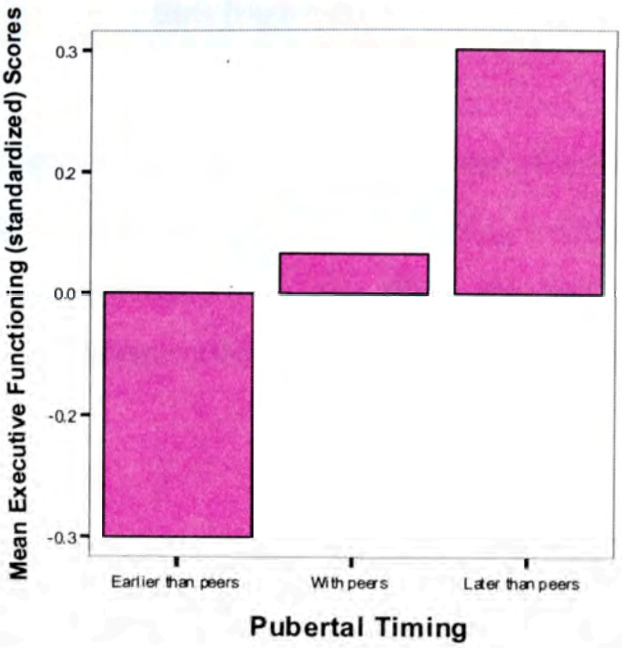


Figure 9.1b. SVS-adjusted mean (standardized) executive function scores by pubertal timing for all (primary and high-school) girls.

Interaction between Pubertal Stage and Pubertal Timing

Figure 9.1c illustrates the finding that no significant interaction occurs between pubertal stage and pubertal timing for girls. Although not significant, compared to on-time and late-maturing girls, there was a trend for early-maturing girls to score lower on executive functioning regardless of current pubertal stage.

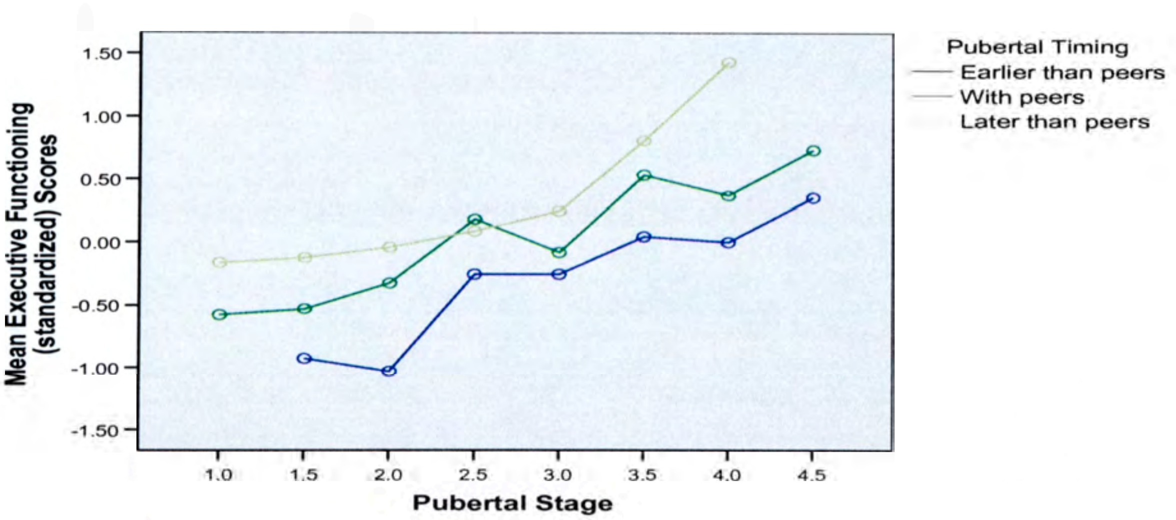


Figure 9.1c. SVS-adjusted mean (standardized) executive function scores by pubertal stage and pubertal timing for all (primary and high-school) girls.

Girls (High-School only)

When only high school girls were included in the analyses, there was a significant main effect of pubertal stage on executive function scores ($F_{2,61}$ = 2.110, p = .05, η_p^2 = .20, but no significant results were found for a main effect of pubertal timing ($F_{7,61}$ = 2.240, p = .115, η_p^2 = .07), or for an interaction between stage and timing ($F_{8,61}$ = .612, p = .76).

Main Effect of Pubertal Stage

As Figure 9.2a illustrates, higher executive function scores in later pubertal stages in this analysis represents a 'recovery' of executive functioning following a mid-pubertal (Stage 2.0) reduction in scores. The observed effect (with the exclusion of primary-school girls) is likely due to the more restricted range of girls' ages when only high-school girls are included in the analysis. Planned contrasts revealed that girls in mid-pubertal Stage 2.0 scored significantly lower (p < .05) executive function scores than the mean of all subsequent stages (2.5 through 4.5), but similar comparison for the earlier stages (1.0 and 1.5) were not significant; no other stages were significantly different from later stages.

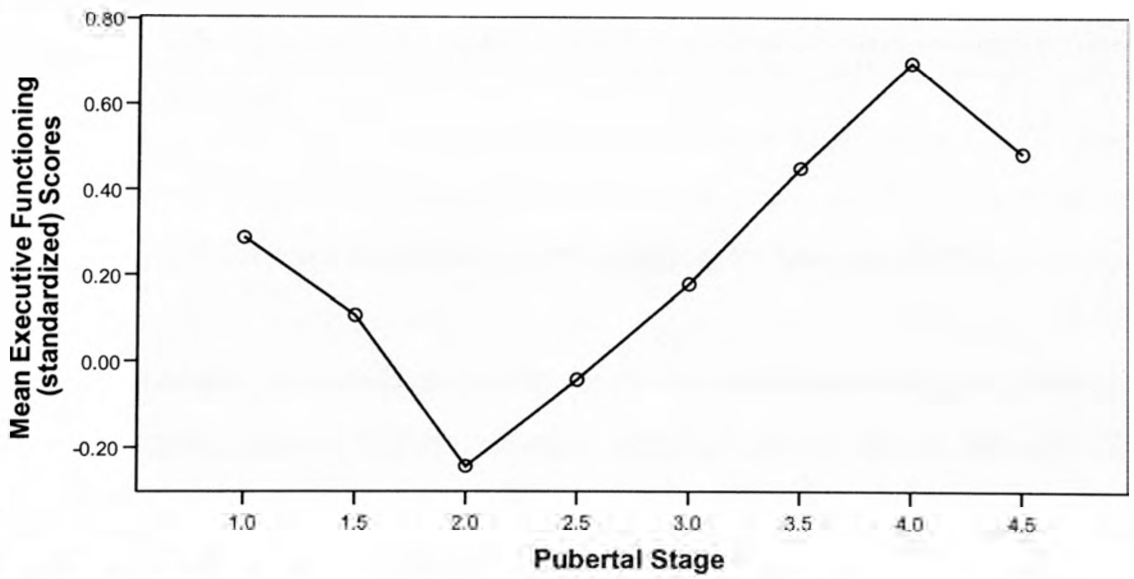


Figure 9.2a. SVS-adjusted mean (standardized) executive function scores by pubertal stage for high-school girls.

Main Effect of Pubertal Timing

Although the main effect was not significant, similar to analyses for all girls above, the exclusion of primary-school girls from analyses found that early-maturing girls had (marginally) significantly lower executive function scores that late-maturing girls ($p <$ .10), but not significantly lower than on-time maturing girls (Figure 9.2b).

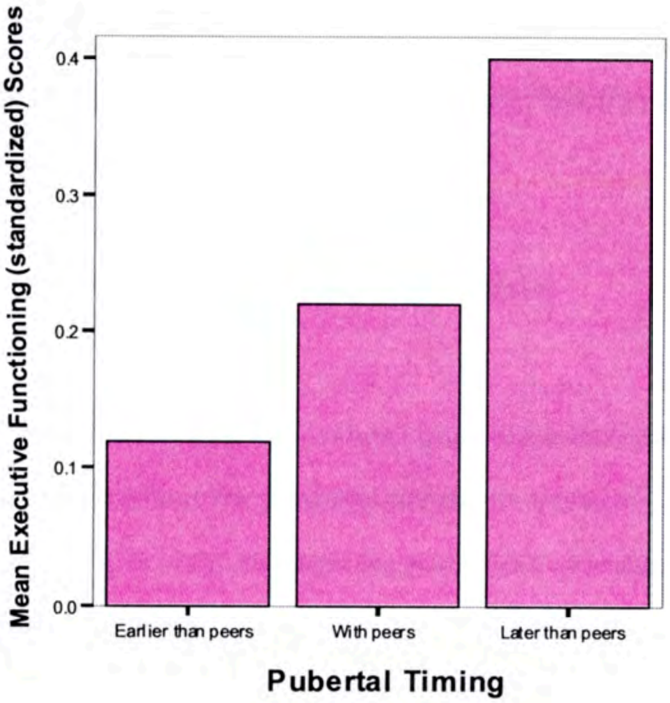


Figure 9.2b. SVS-adjusted mean (standardized) executive function scores by pubertal timing for high-school girls.

Interaction between Pubertal Stage and Pubertal Timing

As described above, there was no interaction between pubertal stage and timing for high-school girls. Figure 9.2c illustrates that, although not significant, compared to on-time and early-maturing girls, late-maturing girls scored higher on executive function tasks, particularly in late-pubertal stages.

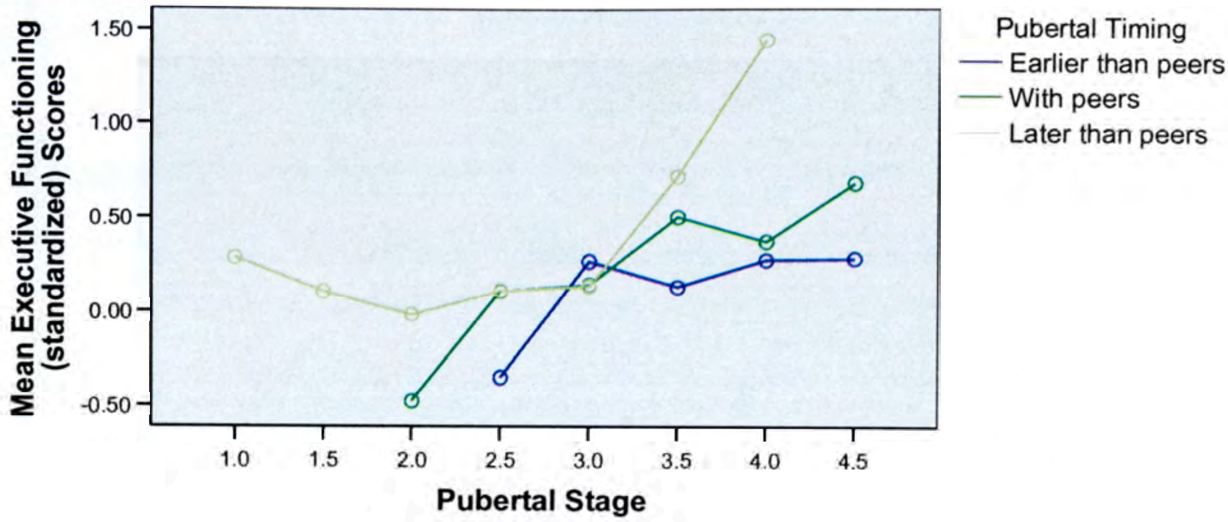


Figure 9.2c. SVS-adjusted mean (standardized) executive function scores by pubertal stage and pubertal timing for high-school girls.

Boys (Primary and High-School)

As with girls, when both primary and high-school boys were included in the analyses, there was a significant main effect for pubertal timing on executive function scores ($F_{2,168}$ = 11.558, $p < .001$, $\eta_p^2 = .12$). In addition, the effect of pubertal stage was a sign of an increase in executive function scores as boys progressed through pubertal stages ($F_{7,168}$ = 11.49, $p < .001$, $\eta_p^2 = .32$). The interaction between pubertal stage and timing was not significant ($F_{12,168}$ = 1.364, $p = .188$).

Main Effect of Pubertal Stage

Similar to girls, executive function scores increased as boys progressed through pubertal stages (Figure 9.3a). This linear increase in executive function scores could be related to increases in age; the inclusion of primary school participants resulted in a wider age-range, and older boys are more likely to be in later stages of pubertal development. As with girls, this phenomenon does not occur in analyses performed with high-school boys only (discussed below).

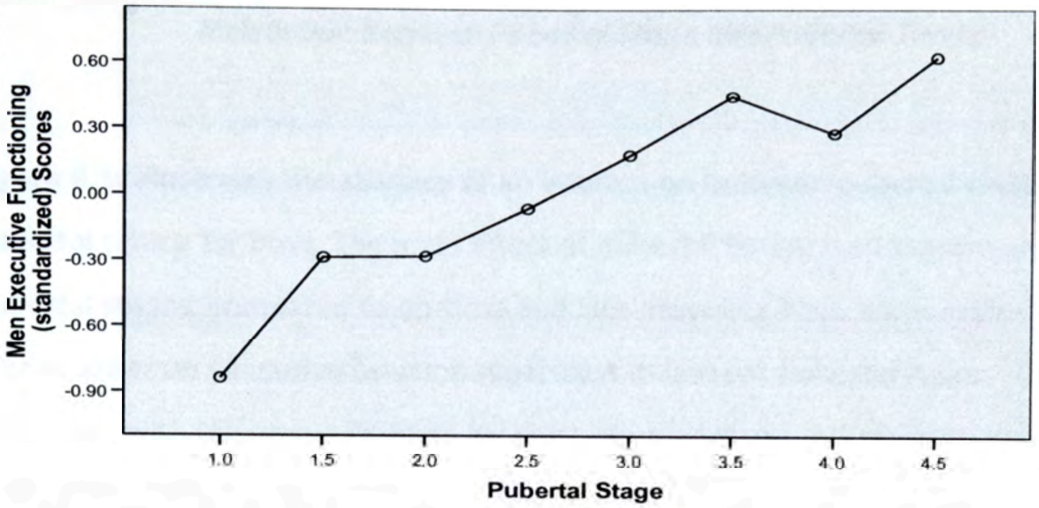


Figure 9.3a. SVS-adjusted mean (standardized) executive function scores by pubertal stage for all (primary and high-school) boys.

Main Effect of Pubertal Timing

As was found with primary and high school girls, when both primary and high-school boys were included in analyses, early-maturing boys scored significantly lower on executive function than on-time maturing boys ($p = .01$), and late-maturing boys ($p < .001$; Figure 9.3b).

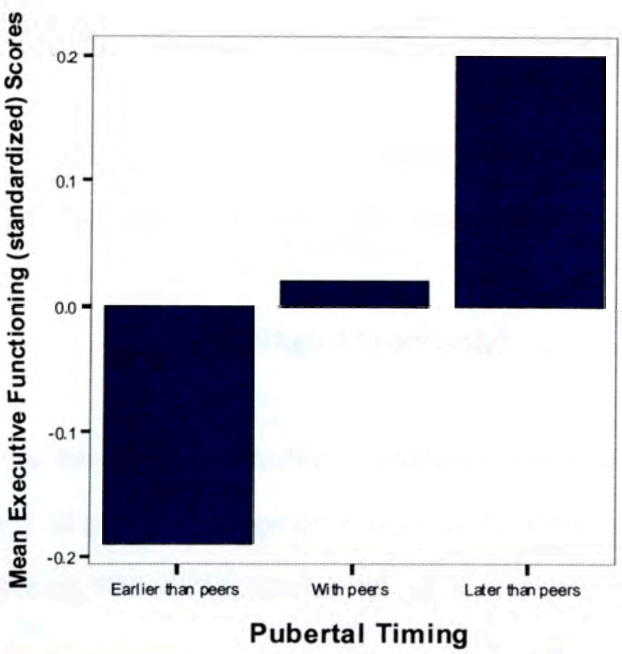


Figure 9.3b. SVS-adjusted mean (standardized) executive function scores by pubertal timing for all (primary and high school) boys.

Interaction between Pubertal Stage and Pubertal Timing

Figure 9.3c illustrates the absence of an interaction between pubertal stage and pubertal timing for boys. The main effect of pubertal timing is consistent across pubertal stages; compared to on-time and late-maturing boys, early-maturing boys scored lower on executive function regardless of current pubertal stage. This is consistent with the above findings for girls; when analyses include primary and high-school adolescents only pubertal timing predicts executive function scores.

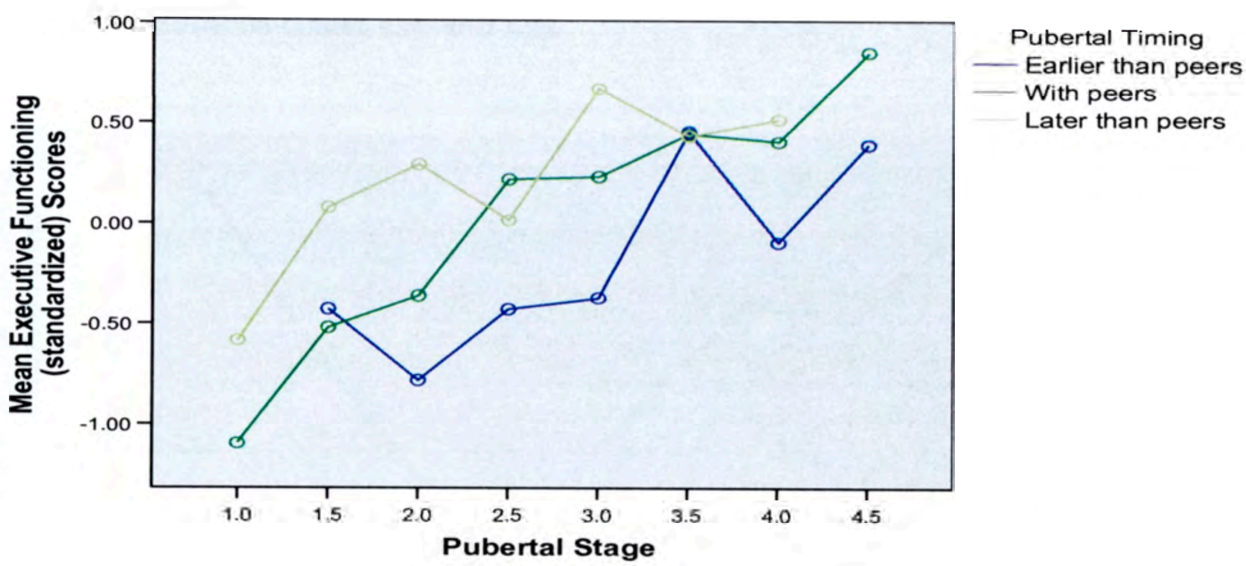


Figure 9.3c. SVS-adjusted mean (standardized) executive function scores by pubertal stage and pubertal timing for primary and high-school boys.

Boys (High-School only)

When only high-school boys were included in analyses, there was a marginally significant main effect of pubertal stage on executive function scores ($F_{7,119}$ = 1.849, p = < .10, η_p^2 = .10), but no effect of pubertal timing or interaction between stage and timing.

Main effect of Pubertal Stage

When high-school boys' executive function scores were plotted against pubertal stage, the shape of the graph (Figure 9.4a) is consistent with the hypothesized dip in executive function at mid puberty. The effect is confirmed by planned (Helmert) contrasts which revealed that boys in mid-pubertal stages had significantly lower executive function scores than the mean of the scores of the boys in all subsequent stages respectively (Stage 2.0 (p = .06), 2.5 (p = .05), and 3.0 ($p < .05$). As for high-school girls, high-school boys at mid-pubertal stages did not differ significantly from those at pre-pubertal stages (1.0 and 1.5).

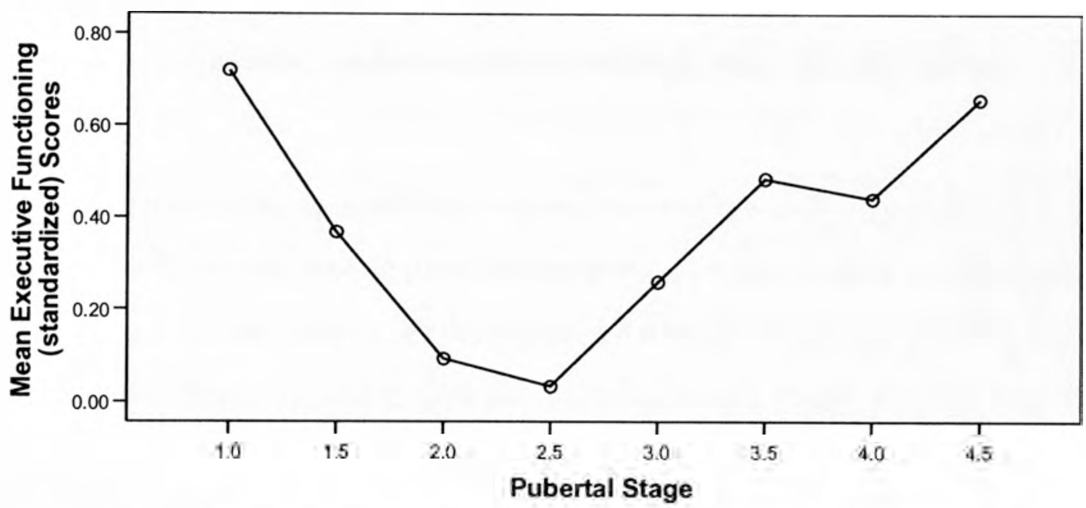


Figure 9.4a. SVS-adjusted mean (standardized) executive function scores by pubertal stage for high-school boys.

Main Effect of Pubertal Timing

Similar to the pattern found for girls, and for primary and high-school boys, although mean executive function scores were lower for early-maturing (compared to on-time and late-maturing) high-school boys (see Figure 9.4b), the size of the effect was very small and not significant ($F_{2,119}$ = .715, p = .492, η_p^2 = .012).

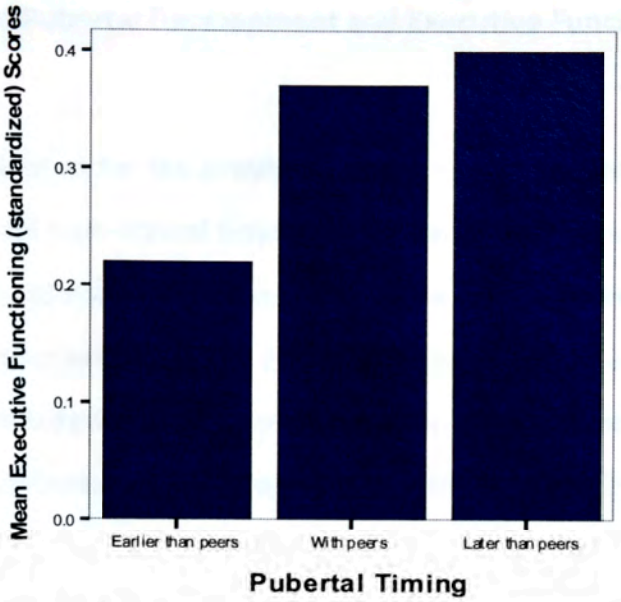


Figure 9.4b. SVS-adjusted mean (standardized) executive function scores by pubertal timing for high-school boys.

Interaction between Pubertal Stage and Pubertal Timing

Although no statistically significant interaction was found ($F_{11,119}$ = .807, p = .633), Figure 9.4c illustrates that all three timing groups (early, on-time and late), executive function test scores were lower in mid-pubertal stages (i.e. Stage 2.0, 2.5, 3.0), than in pre-pubertal (Stage 1.0 and 1.5) or late-pubertal stages (Stage 3.5, 4.0, 4.5). There is some suggestion that, as for girls, this effect is smaller for late-maturing boys, and larger for early-maturing boys, when compared to other pubertal timing groups.

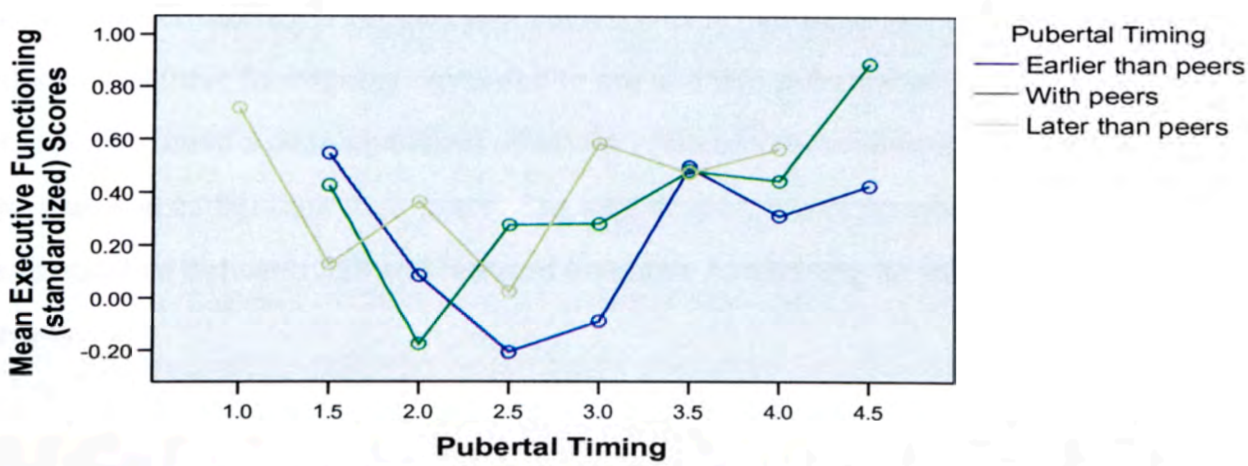


Figure 9.4c. SVS-adjusted mean (standardized) executive function scores by pubertal stage and pubertal timing for high- school boys.

Summary of Pubertal Development and Executive Functioning Findings

There was some evidence for the predicted dip in executive functioning at mid puberty; mid-pubertal high-school boys and girls were both found to have significantly lower executive function scores than peers in either earlier or later pubertal stages. However, for both boys and girls, this effect was not observed when primary-school participants were included in the analyses. In contrast, there was evidence for the predicted effect of pubertal timing when primary-school participants were included in the analyses, but this effect was reduced when they were excluded. Analyses including both primary and high-school participants found that adolescents who had entered puberty earlier than their peers had significantly lower executive function scores than those who began puberty either on-time or later than their peers.

No significant interactions were found between pubertal stage and timing for any groups; however, referring back to Figures 9.2c (girls) and 9.4c (boys), when only high school participants were included in the analyses, there was some indication of a trend for early-maturing, mid-pubertal groups to obtain lower executive function scores than late-maturing, late-pubertal groups.

Conclusion

When the results from analyses including only high-school students presented in this chapter are considered, it appears that adolescents in mid-pubertal stages experienced reduced executive functioning compared to pre and late-pubertal adolescents. Results for girls also found a near-significant effect for reduced executive functioning for girls who matured earlier than their peers. The next chapter examines whether a link can be established between ASB and reduced executive functioning for adolescents in this sample.

Chapter 10: Executive Functioning and Antisocial Behaviour

Previous research has found that the association between reduced executive functioning and ASB holds only for high levels of ASB (e.g. Giancola, Mezzich, & Tarter, 1998). Participants[22] were grouped into high and low ASB groups computed as two standard deviation points above (high), or two standard deviation points below (low) the mean ASB score), and tests for significance differences in executive function score were performed. Effect sizes for significant differences are reported as Cohen's *d* (1988), where the size of the effect, small (d = .2), medium (d = .5), or large (d = .8 and above) indicates, respectively, a non-overlap of 14.7%, 33%, and 47.4% in the two distributions. Age-adjusted ASB scores were computed by regressing age at time of interview on ASB scores separately for girls and boys. Similarly, a new executive function variable (adjusted for general intellectual functioning) was created by regressing SVS on executive function scores. Thus, a total of six independent variables were included: Current ASB (Major, Minor, Total), and Cumulative ASB (Major, Minor, Total).

Executive Function and Current ASB Participation

Current ASB-Major

As displayed in Figure 10.1a, girls in the high Current ASB-Major group scored significantly lower on executive function tests than girls in the low Current ASB- Major group (t_{77} = 4.142, p = .001, one-tailed, d = .47). The same pattern held for boys, but here the difference only approached significance (t_{78} = 1.196, p = .118, one-tailed, d = .20).

[22] high school (n = 223) and primary school (n = 90) boys (n = 193) and girls (n = 120)

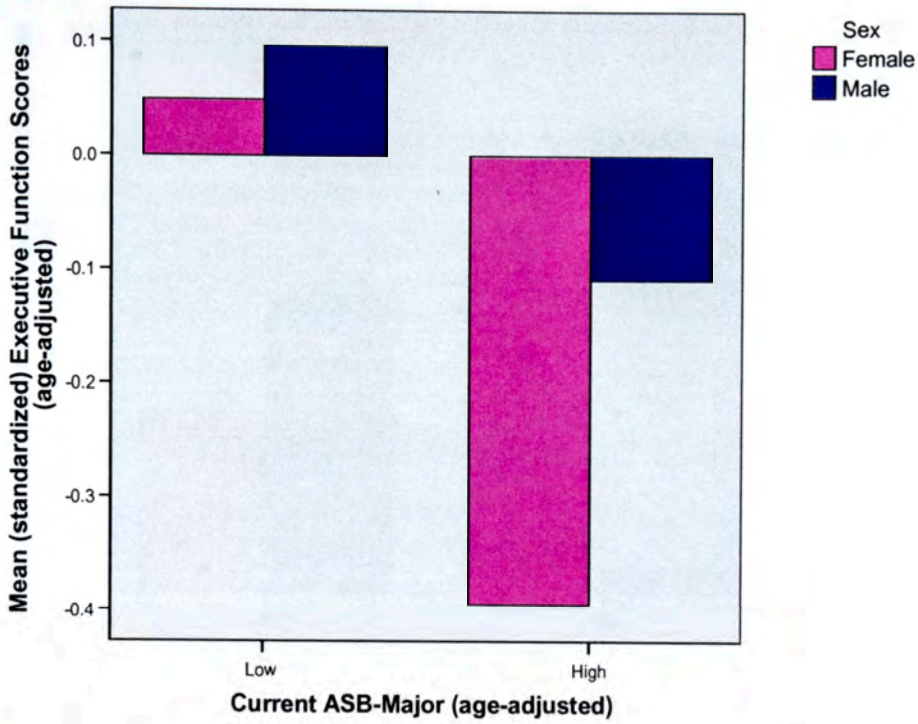


Figure 10.1a. SVS-adjusted mean (standardized) executive function scores, by low and high age-adjusted, current ASB-Major group for (high school and primary school) girls and boys.

Current ASB-Minor and ASB-Total

For both girls and boys, there was no significant difference in executive function scores between low and high groups for Current ASB-Minor or Current ASB-Total (t_{27} = .053, p = .48, one-tailed for both groups).

As illustrated in Figures 10.1b and 10.1c, for both Current ASB-Minor and ASB-Total, there is less than .1 of a standard deviation difference in executive function scores between low and high groups, whereas, girls in the high Current ASB-Major group obtained executive function scores that were .5 of a standard deviation lower than girls in the low Current ASB-Major group.

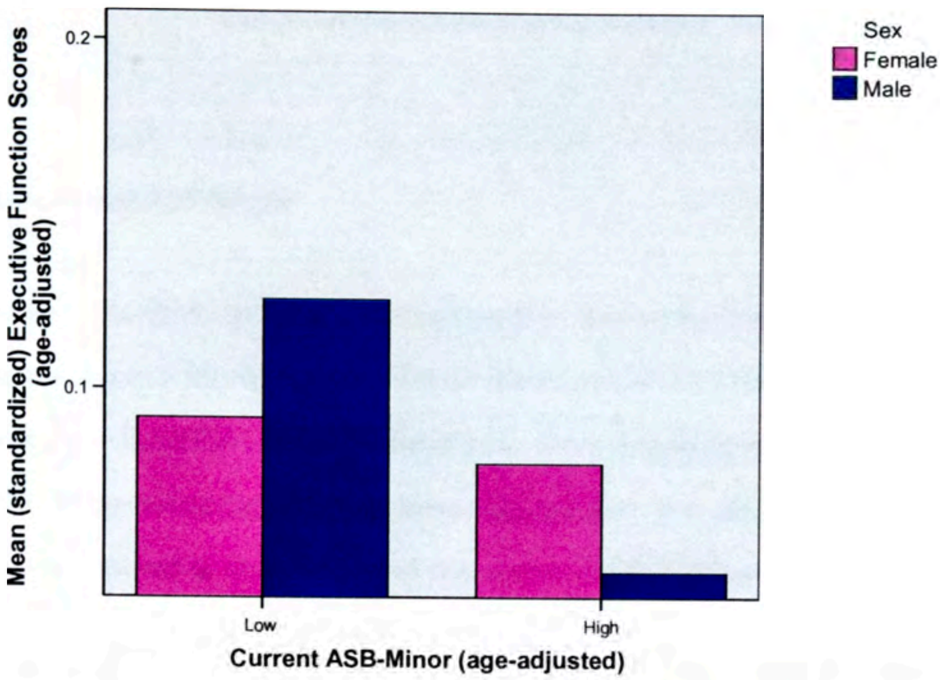


Figure 10.1b. SVS-adjusted mean (standardized) executive function scores, by low and high age-adjusted, current ASB-Minor group for (high school and primary school) girls and boys.

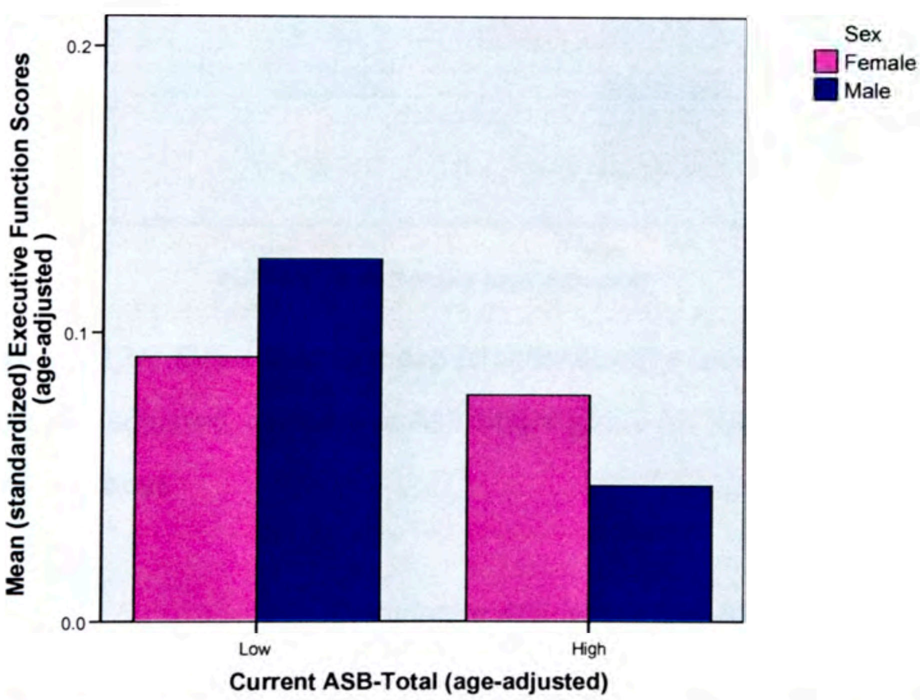


Figure 10.1c. SVS-adjusted mean (standardized) executive function scores, by low and high age-adjusted, current ASB-Total group for (high school and primary school) girls and boys.

Executive Function and Cumulative ASB Participation

Cumulative ASB-Major

As with the findings for executive function scores by Current ASB groups, similar patterns were found for cumulative measures of ASB (see Figure 10.2a). This time, executive function scores for *boys* who were engaging in high levels of Cumulative ASB- Major were significantly lower (t_{54} = 1.716, $p < .05$, one-tailed, $d = .56$) than for those involved in little ASB, and the same test for girls was only marginally significant (t_{69} = 1.366, $p < .10$, one-tailed, $d = .37$).

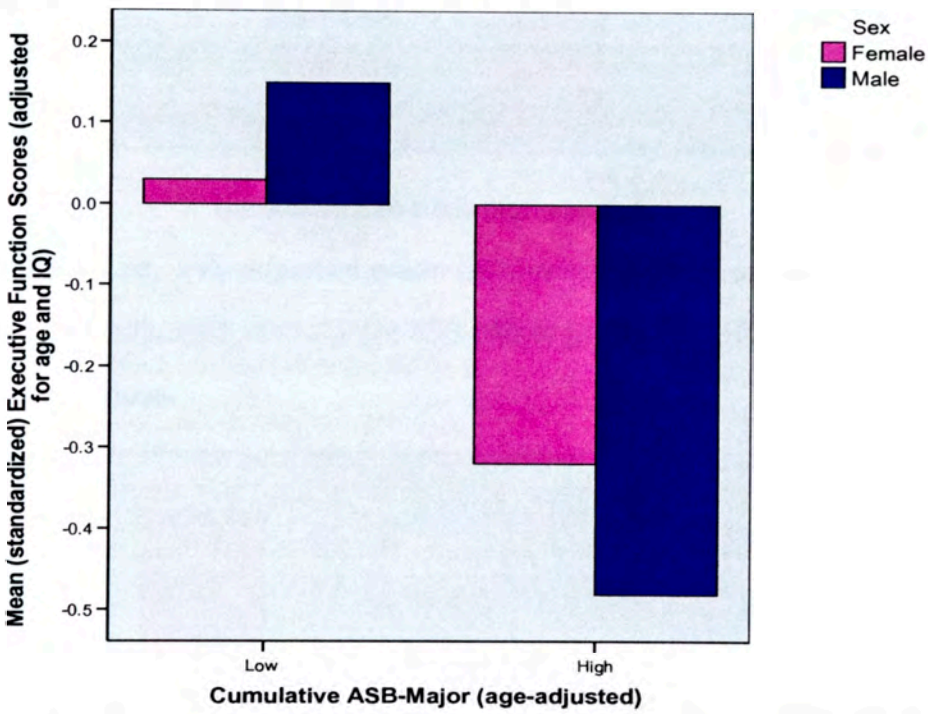


Figure 10.2a. SVS-adjusted mean (standardized) executive function scores, by low and high age-adjusted, cumulative ASB-Major group for (high school and primary school) girls and boys.

Cumulative ASB-Minor and ASB-Total

As illustrated in Figures 10.2b and 10.2c, executive function scores for girls in the high Cumulative ASB-Total were marginally significantly lower than girls' scores in the low group (t_{10} = 1.504, $p < .10$, one-tailed, $d = .40$), and a similar difference approached significance for ASB-Minor groups (t_{11} = 1.275, p = .115, one-tailed, d = .34). For boys, there was no statistically significant difference in executive function scores between low and high groups for Cumulative ASB-Minor (t_{19} = -.179, p = .43, one-tailed) or ASB-Total (t_{18} = -.019, p =.48, one-tailed).

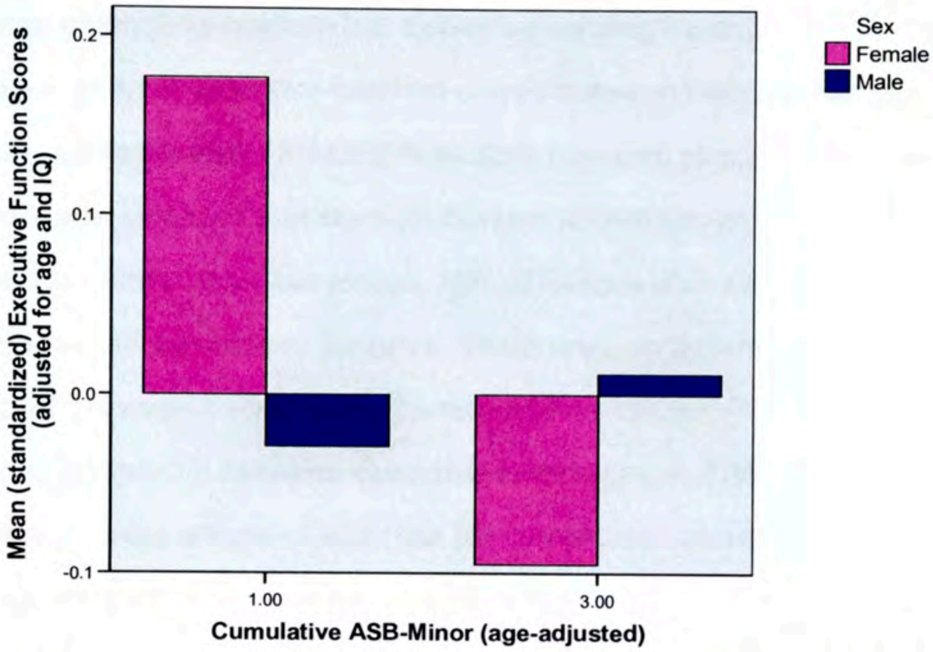


Figure 10.2b. SVS-adjusted mean (standardized) executive function scores, by low and high age-adjusted, cumulative ASB-Minor group for (high school and primary school) girls and boys.

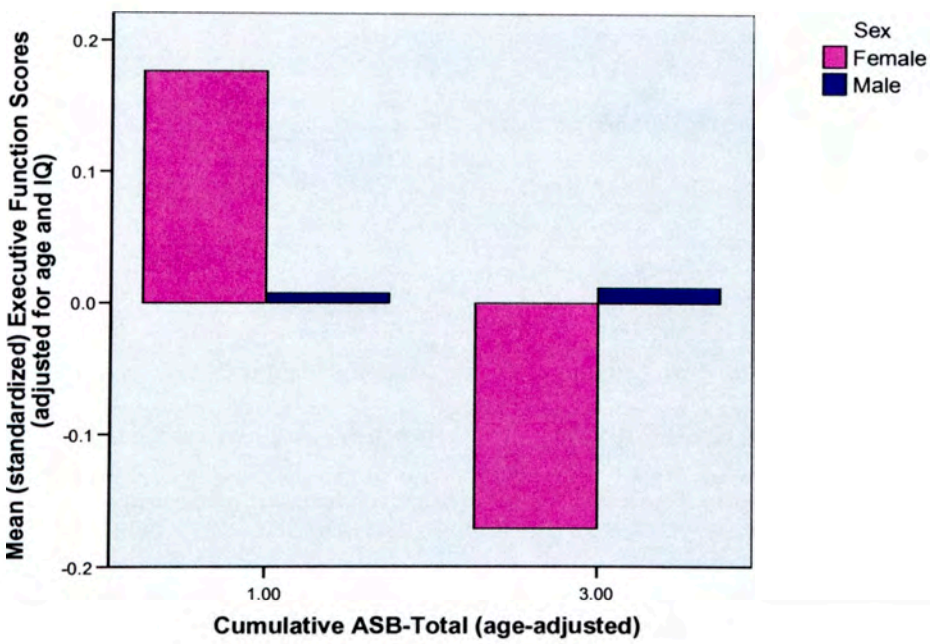


Figure 10.2c. SVS-adjusted mean (standardized) executive function scores, by low and high age-adjusted, cumulative ASB-Total group for (high school and primary school) girls and boys.

Summary of Executive Functioning and ASB Findings

The above findings provide some positive evidence for a link between ASB and reduced executive functioning in this sample. The majority of tests produced effect sizes in the range of small to medium (i.e. Cohen's *d* ranging from .20 to .56), indicating that the non-overlap of executive function scores between high and low ASB groups ranged from approximately 15% to 35% or both boys and girls. For measures of current ASB, there was evidence that the high Current ASB-Major groups had lower executive function scores than low groups; this difference was statistically significant for girls and approached significance for boys. There were no differences in executive function scores between high and low Current ASB-Minor and ASB-Total groups. The evidence for a relationship between executive functioning and ASB is stronger for enduring (cumulative) patterns of ASB than for current ASB participation, however. Girls obtained significantly (or near-significantly) lower executive function scores if they were in the high Cumulative ASB (Major, Minor, Total) groups, as opposed to the low ASB groups. For boys, only the measure of Cumulative ASB-Major revealed significant differences in executive function scores between high and low groups.

Chapter 11: Mediation effects of Executive Function on Pubertal Development and Antisocial Behaviour

A primary aim of this research was to investigate whether a temporary reduction in executive function mediates the relationship between pubertal development and participation in antisocial behaviour. Mediation is a process, which accounts for the relationship between a predictor variable (in this case, pubertal stage) and the outcome (or criterion) variable (in this study, current ASB). The mediator (executive function) suggests a possible explanation for how or why the relationship occurs (see Baron & Kenny, 1986). It was hypothesized that a mid-pubertal 'peak' in ASB would be mediated by a mid-pubertal 'dip' in executive function. It was also hypothesized that a relationship between pubertal timing and current participation in ASB would be mediated by enduring reductions in executive function. Specifically, it was predicted that early-maturing adolescents would participate in greater current ASB, and that this relationship would be mediated by lower executive function scores.

According to Baron and Kenny (1986), in the case of perfect mediation, controlling the mediator will eliminate the effect of the predictor on the criterion, whereas in the case of partial mediation, the relationship between the predictor and the criterion will be reduced but will remain significant. Baron and Kenny's mediator model is shown in Figure 11.1.

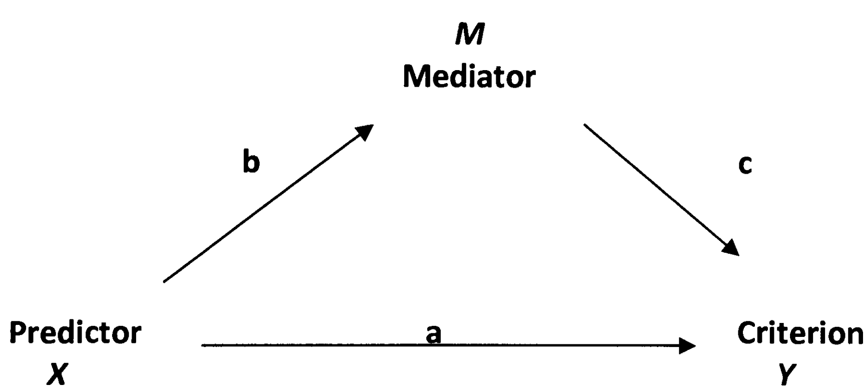


Figure 11.1. Mediator model example.

To test for mediation, it is necessary to perform three regression equations. First, the criterion is regressed on the predictor (Step 1). If this relationship is significant, then the mediator is regressed on the predictor variable (Step 2), and the criterion is regressed simultaneously on the predictor and the mediator (Step 3). The mediator role is confirmed if paths *a* and *b* are both significant, and if after controlling for path *b*, the previously significant relationship between the criterion and the predictor (path *a*) becomes non-significant. As prescribed by Baron and Kenny (1986), the amount of reduction in the effect of X (predictor) on Y (criterion) is not equivalent to either the change in variance explained or the change in *F* or *p* value. Thus, commonly, the Sobel (1982) test for mediation is used (see Preacher & Hayes, 2004).

Only high-school boys and girls were provided items measuring current ASB, therefore, primary-school participants were not included in any of the following mediator models. For girls and boys separately, a series of mediator analyses were performed to examine the possible mediating effects of executive function on three sets of relationships: 1) pubertal stage and Current ASB, 2) pubertal timing and Current ASB, and 3) pubertal timing and Cumulative ASB.

These regression equations are tests of a linear relationship, and for tests predicting the effects of pubertal timing (as presented below), three separate analyses (early vs late; early vs on-time; early vs late) were performed for each test examining the mediator effects of executive function on relationships between pubertal timing and Current ASB and Cumulative ASB. However, this study is also predicting non-linear relationships between executive function and pubertal stage, and ASB and pubertal stage. Thus, to test whether executive function 'dips' and ASB 'peaks' mid-puberty, two linear equations were tested. A linear decrease in executive function and linear increase in ASB should occur from pre-pubertal to mid-pubertal stages, and a corresponding linear increase in executive function and linear decrease in ASB should occur from mid-pubertal to post-pubertal stages.

Complications arose with this data set, however, which indicated that these tests could not always be performed as planned. The major issues concerned the low number of late-pubertal, (and no post-pubertal), adolescents in this sample, and a further problem caused by the fact that the executive functioning dip occurred at a different stage (earlier) than the peak in ASB. Although conceptually, it may be expected that an executive function dip may precede the peak in ASB participation, this phenomenon presented complications for mediation analysis. As a result, in some cases, only pre-pubertal to mid-pubertal regressions were performed, and in others, these tests were performed on non-identical paths (e.g. for girls, executive function to mid-pubertal Stage 2.0 and ASB to mid-pubertal Stage 2.5).

All regression equations were performed using the enter method. As mentioned previously (see for example, Chapter 10), current age and general intellectual functioning (i.e. SVS) are significant predictors of ASB and executive function respectively, and thus these effects must be controlled for when investigating the mediating effects of pubertal stage and pubertal timing on ASB. Correlational analyses revealed that SVS and current age were positively correlated amongst high school girls, but only at $r = .28$ ($p < .01$), and there was no correlation between these variables found for high school boys ($r = .03$, $p = .35$). These low correlations indicate that the individual variation in general intellectual function between individuals cannot be associated with age; thus both SVS and current age were entered into all regression equations to account for the confounding effects of these variables on ASB and executive function measures.

Pubertal Stage Mediation Analysis

To investigate whether reduced executive functioning mediates a relationship between pubertal development onset and participation in antisocial behaviour, it was hypothesized that during the mid-stages of puberty, adolescents would report higher levels of Current ASB, and would obtain lower executive function scores, than their pre-pubertal, or late-pubertal peers. To test this hypothesis, mediation analysis was performed separately for girls and boys by running a series of regression equations using the enter method. The confounding effects of age and SVS on the mediator model were included in all analyses.

Girls

For girls, the analyses performed earlier (refer to chapters 8, 9 & 10) indicate that the three independent relationships between pubertal stage, executive function, and ASB are statistically significant. However, performing mediation analysis was complicated by the fact that the dip in executive function (i.e. Stage 2.0) occurred prior to the peak in adolescent ASB (i.e. Stage 2.5). To test the linear relationship between pubertal stage (predictor) and antisocial behaviour (criterion), it was necessary to perform this test with only those individuals who were in pubertal stages 1.0 to 2.5. To test the linear relationship between pubertal stage (predictor) and executive function (mediator), however, it was necessary to analyze the data only from individuals in pubertal stages 1.0 to 2.0. Thus, this test was analyzed with two different approaches to address this complication as discussed below.

Pubertal Status

The problem of a mid-pubertal 'executive function dip' and 'ASB peak' occurring at different pubertal stages (Stage 2.0 and Stage 2.5 respectively) was first approached by regressing Current ASB on a specially-constructed Pubertal Status variable. For the purpose of this analysis, the Pubertal Status variable comprised pre-pubertal Stages 1.0 and 1.5, mid-pubertal Stages 2.0 and 2.5, and late-pubertal Stages 3.0 to 4.5. Thus, Current ASB (Major, Minor, Total) was regressed on pubertal status in two directions (pre-pubertal to mid-pubertal, and mid-pubertal to late-pubertal). Path diagrams were constructed on the basis of these regression analyses as illustrated in Figures 11.2 and 11.3.

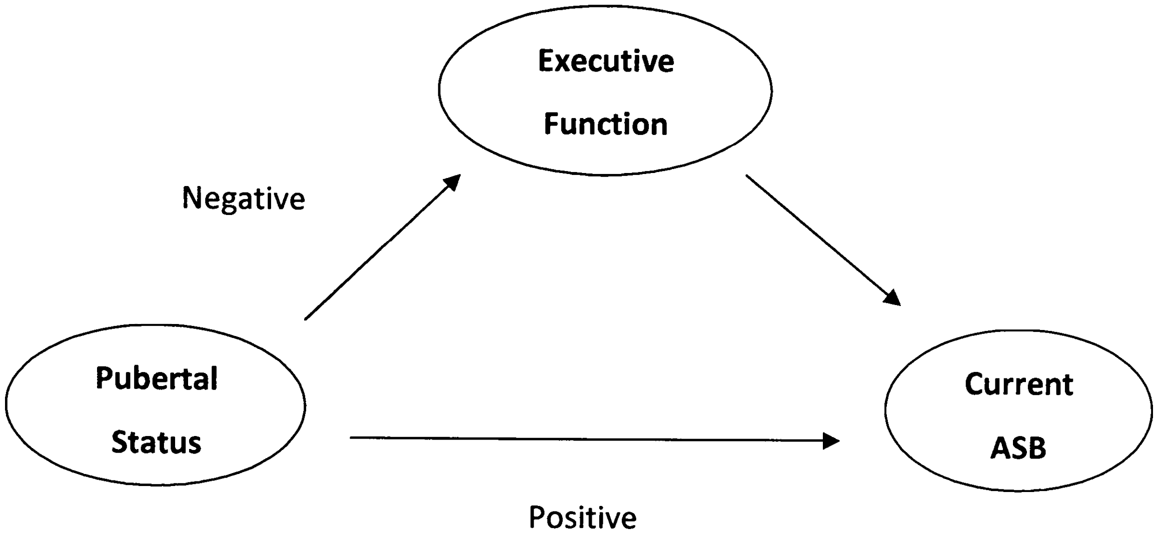


Figure 11.2. Mediator model: Pubertal Status (pre-pubertal to mid-pubertal) on Current ASB mediated by Executive Function.

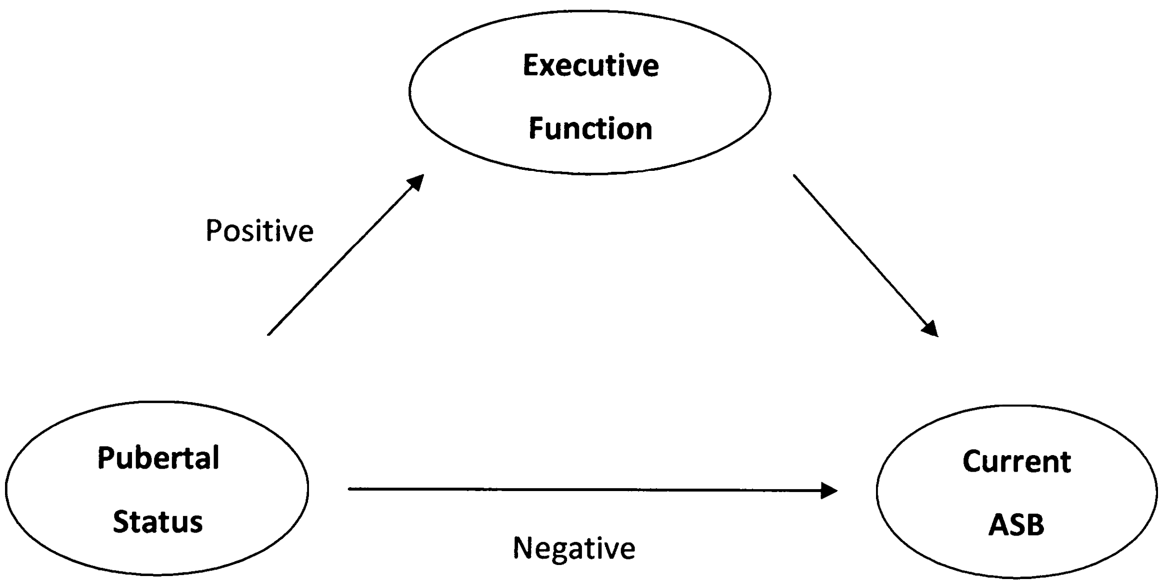


Figure 11.3. Mediator model: Pubertal Status (mid-pubertal to late-pubertal) on Current ASB mediated by Executive Function.

Although graphically (Figure 11.4), a trend was observed for a mid-pubertal dip in executive function, with a corresponding peak in Current ASB (Major, Minor, Total) participation, the only significant effect found was when executive function was regressed on mid-pubertal to late-pubertal status (β =.250, t = 1.759, p < .10; n = 77);

thus, Step 3 was not performed (see Table 11.1 for all coefficients and significance values).

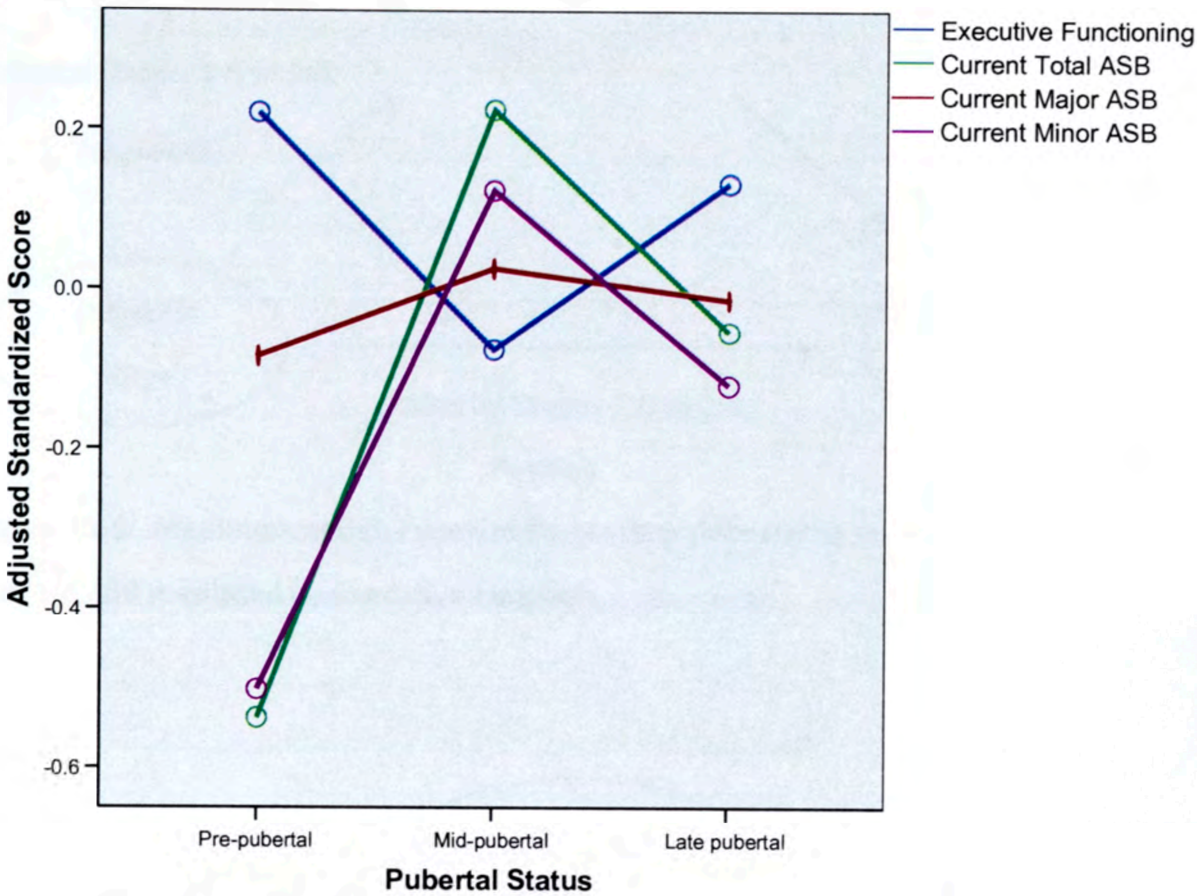


Figure 11.4. Executive Function 'dip' and Current ASB-Major, ASB-Minor and ASB-Total 'peak' by Pubertal Status for girls (age-adjusted, standardized scores).

Pubertal Stage

As a second approach, two separate path diagrams were analyzed for regressions of Current ASB and executive function on pubertal stage. For the pre-pubertal to mid-pubertal analyses, Current ASB (Major, Minor, Total) was regressed on pubertal stages 1.0 to 2.5, and executive function was regressed on pubertal stages 1.0 to 2.0 (see Figure 11.5). For the mid-pubertal to late-pubertal analyses, Current ASB was regressed on pubertal stages 2.5 to 4.5, and executive function was regressed on pubertal stages 2.0 and 4.5 (see Figure 11.6).

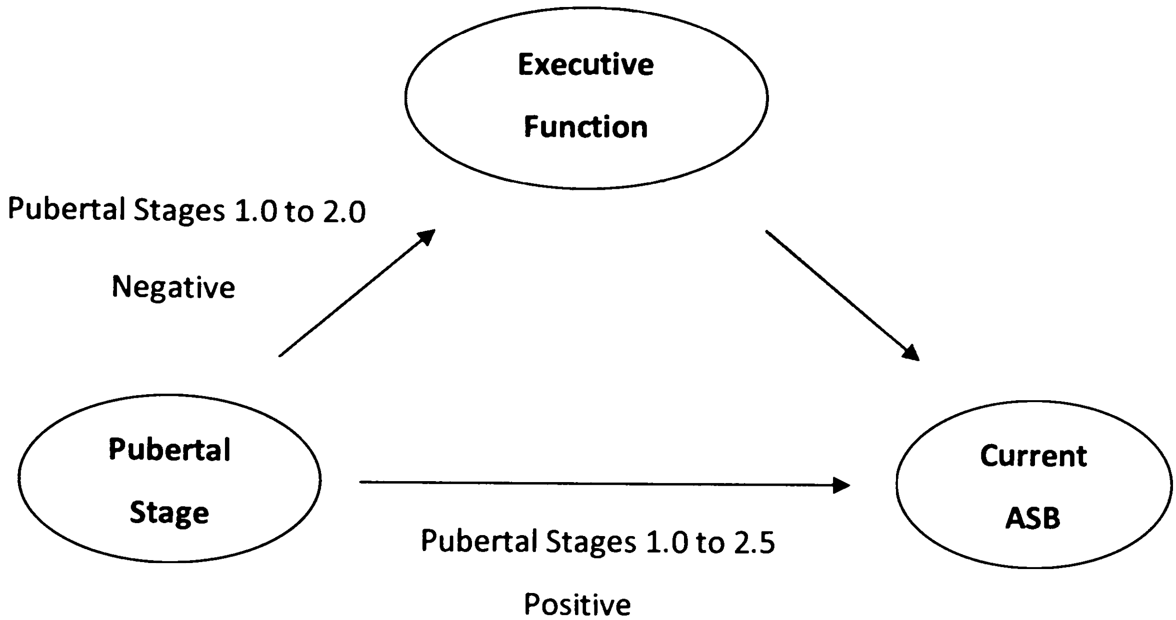


Figure 11.5. Mediator model: Pubertal Stages (pre-pubertal to mid-pubertal) on Current ASB mediated by Executive Function.

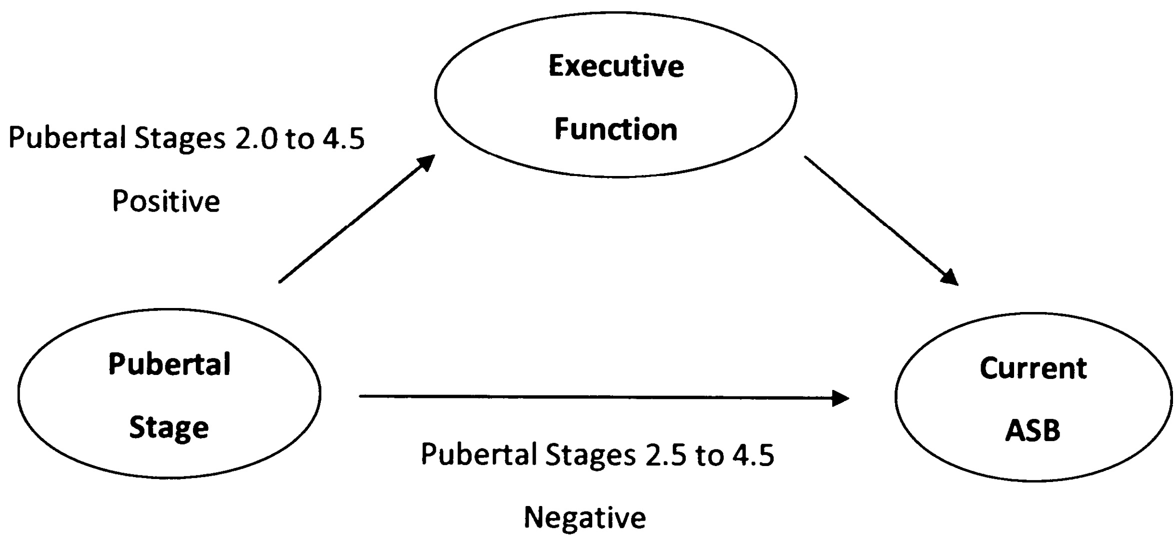


Figure 11.6. Mediator model: Pubertal Stages (mid-pubertal to late-pubertal) on Current ASB mediated by Executive Function.

The path coefficients and significance values for the executive function and Current ASB by pubertal stage mediator model are presented in Table 11.2. Pre-pubertal to mid-pubertal analyses revealed values that approached significance when Current ASB

(Major, Minor, Total) was regressed on pubertal Stages 1.0 to 2.5 (Step 1). Thus, executive function was regressed on pubertal Stages 1.0 to 2.0, which was significant ($p < .05$; Step 2). Step 3 analyses were attempted by regressing Current ASB and executive function on pubertal stages 1.0 to 2.5 (see Table 11.1). The lack of reduction in Step 1 *p*-values is likely due to the fact that no linear relationship exists between pubertal stage and executive function when Stage 2.5 scores are included.

Mid-pubertal to late-pubertal analyses revealed no significant linear relationship between Current ASB (Major, Minor, Total) and pubertal stage, or executive function and pubertal stage, thus Step 3 analyses were not performed.

Table 11.1. Regression analyses to test for mediation: Current ASB (Major, Minor, Total) and Executive Function on Pubertal Status for girls.

Predictor	Criterion	*n*	*β*	*t*	*p*
	Pubertal Status: pre-pubertal (1.0 to 1.5) to mid-pubertal (2.0 to 2.5)				
	Step 1 (path *a*)				
Pubertal Status	Current ASB-Major	28	.27	1.16	.256
	Current ASB-Minor	28	.20	0.92	.363
	Current ASB-Total	27	.24	1.09	.287
	Step 2 (path *b*)				
Pubertal Status	Executive Function	29	-.25	- 1.12	.275
	Step 3 (path *c*)				
	Not performed				
	Pubertal Status: mid-pubertal (2.0 to 2.5) to late-pubertal (3.0 to 4.5)				
	Step 1 (path *a*)				
Pubertal Status	Current ASB-Major	78	-.09	- .65	.517
	Current ASB-Minor	77	-.08	- .62	.541
	Current ASB-Total	76	.05	.39	.700
	Step 2 (path *b*)				
Pubertal Status	Executive Function	**78**	**.217**	**1.69**	**.095**
	Step 3 (path *c*)				
	Not performed				

β = standardised path coefficient.

Table 11.2. Regression analyses to test for mediation: Current ASB (Major, Minor, Total) and Executive Function on Pubertal Stage for girls.

Predictor	Criterion	*n*	*β*	*t*	*p*
	Pubertal Stages: pre-pubertal to mid-pubertal				
	Step 1 (path *a*)				
Pubertal Stages 1.0 to 2.5	Current ASB-Major	28	.30	1.43	.167
	Current ASB-Minor	28	.32	1.61	.120
	Current ASB-Total	27	.31	1.56	.133
	Step 2 (path *b*)				
Pubertal Stages 1.0 to 2.0	Executive Function	**11**	**-1.06**	**- 2.40**	**.048**
	Step 3 (path *c*)				
Pubertal Stages 1.0 to 2.5	Current ASB-Major & EF	28	.30	1.41	.173
	Current ASB-Minor & EF	28	.33	1.67	.110
	Current ASB-Total & EF	27	.33	1.64	.115
	Pubertal Stages: mid-pubertal to late-pubertal				
	Step 1 (path *a*)				
Pubertal Stages 2.5 to 4.5	Current ASB-Major	70	- .17	- 1.04	.302
	Current ASB-Minor	69	- .15	- 0.96	.340
	Current ASB-Total	68	- .11	- 0.67	.503
	Step 2 (path *b*)				
Pubertal Stages 2.0 to 4.5	Executive Function	78	.20	1.36	.179
	Step 3 (path *c*)				
	Not performed				

β = standardised path coefficient.

One final strategy explored was to dummy code pubertal stages, so that pre-pubertal (Stages 1 and 1.5) and late-pubertal (Stages 3 to 4.5) stages were collapsed into one variable, and mid-pubertal (Stages 2 and 2.5) stages were collapsed into another. Regressing executive function on recoded pubertal stages indicated that mid-pubertal girls scored significantly lower on tests of executive function than pre-pubertal and late-pubertal girls combined ($t = -2.537$, $p < .05$); however regressing Current ASB on recoded pubertal stages did not reach significance (Total ASB: $t = -1.046$, $p = .30$; Major ASB: $t = .898$, $p = .37$; Minor ASB: $t = -1.541$, $p = .13$). Therefore, no further tests of this mediation analysis were performed.

Boys

Earlier tests of the independent relationships found that as with girls, boys show a 'dip' in executive function at approximately mid-puberty (Stages 2.0 to 3.0; refer to Chapter 9), and analyses of individual ASB items indicated a trend for Current ASB to peak at late-pubertal Stage 4.0 (see Chapter 8), suggesting that adolescent boys may experience a peak in ASB participation in the late pubertal stages following a mid-pubertal dip in executive function. Because these two independent relationships occurred at different pubertal stages, it was not possible to test this model with mediation analysis. However, although not significant, when executive function and Current ASB (Major, Minor, Total) were plotted against pubertal status (pre, mid, late), a trend was observed for an interaction between reduced executive function and higher ASB to occur at late-puberty (see Figure 11.7).

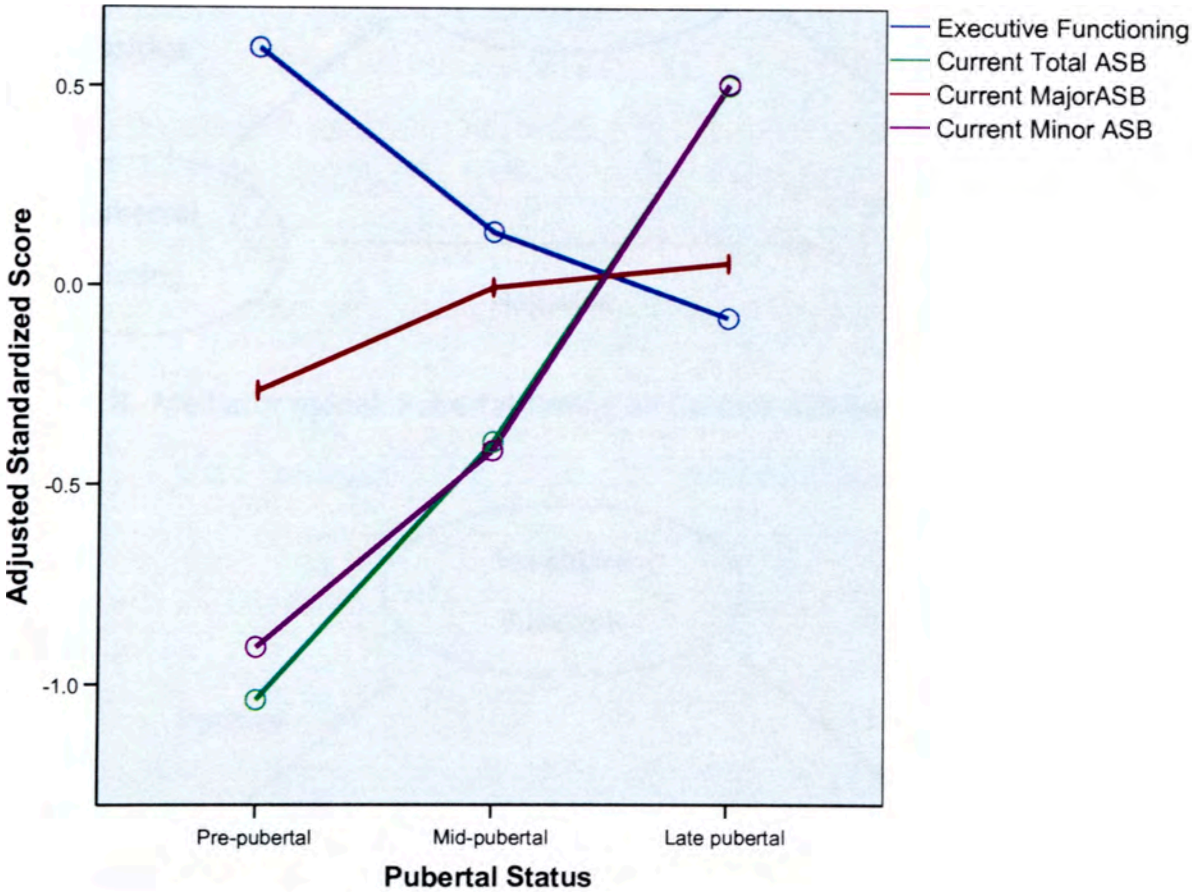


Figure 11.7. Executive Function 'dip' and Current ASB-Major, ASB-Minor and ASB-Total by Pubertal Status for boys (age-adjusted, standardized scores).

Pubertal Timing Mediation Analysis

Analyses were undertaken to test the effects of early timing on a persistent reduction in executive function and, consequently, participation in relatively higher levels of Current and Cumulative ASB for all timing groups, (early, on-time, late), and all timing group contrasts (early vs late, early vs on-time, on-time vs late,). It was hypothesized that compared to on-time and late-maturing peers, early-maturing adolescents would report higher levels of Current and Cumulative ASB that was mediated by comparatively lower executive functioning (refer to Figures 11.8 and 11.9). To test this hypothesis, mediation analysis was performed separately for girls and boys by running a series of regression equations using the enter method for each of the ASB criterion.

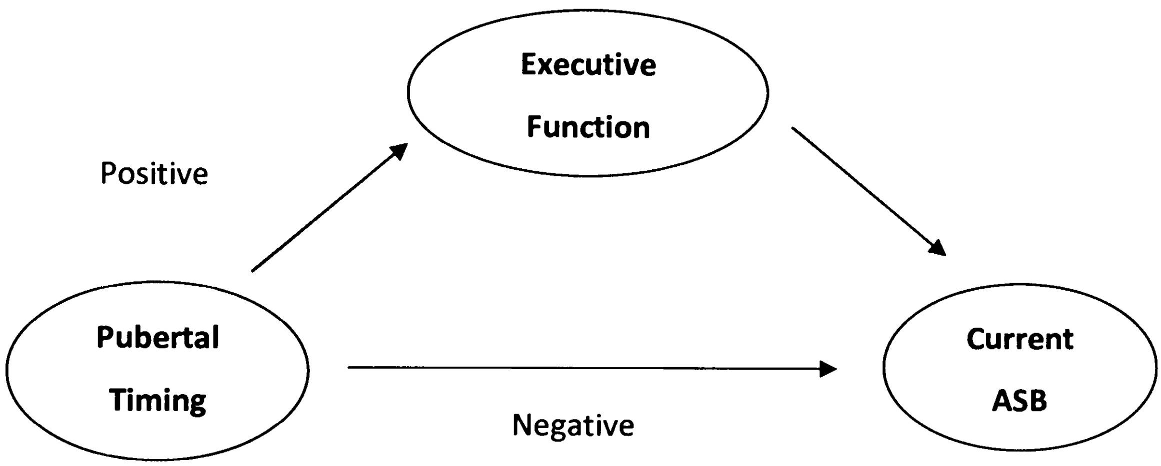


Figure 11.8. Mediator model: Pubertal Timing on Current ASB mediated by Executive Function.

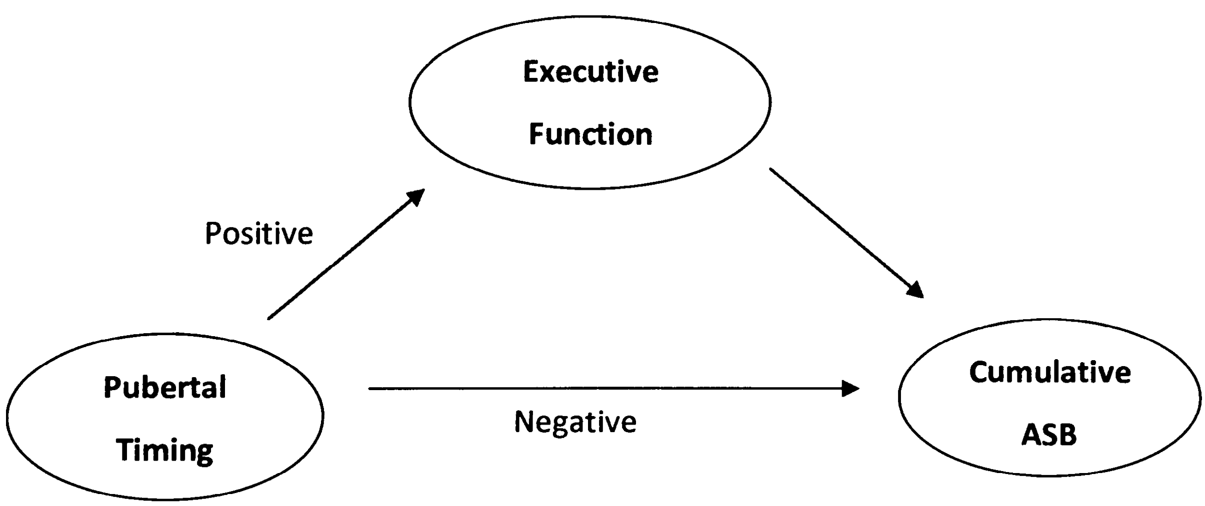


Figure 11.9. Mediator model: Pubertal Timing on Cumulative ASB mediated by Executive Function.

Girls

Current and Cumulative ASB

Figures 11.10 and 11.11 illustrate that although higher levels of Current ASB-Minor and Current ASB-Total were reported by early-maturing girls in comparison to on-time and late-maturing girls, there were no findings of reduced executive function between these groups. Current ASB (Major, Minor, Total) and executive function were regressed individually on pubertal timing in three separate analyses: 1) early, on-time, and late; 2) early vs late; 3) early vs on-time. As presented in Tables 11.3 and Table 11.4, for all timing group contrasts, no significant results were found when current ASB or cumulative ASB was regressed on pubertal timing or when executive function was regressed on pubertal timing; therefore, mediation analysis was not performed for any further tests of Current ASB or Cumulative ASB by pubertal timing for girls.

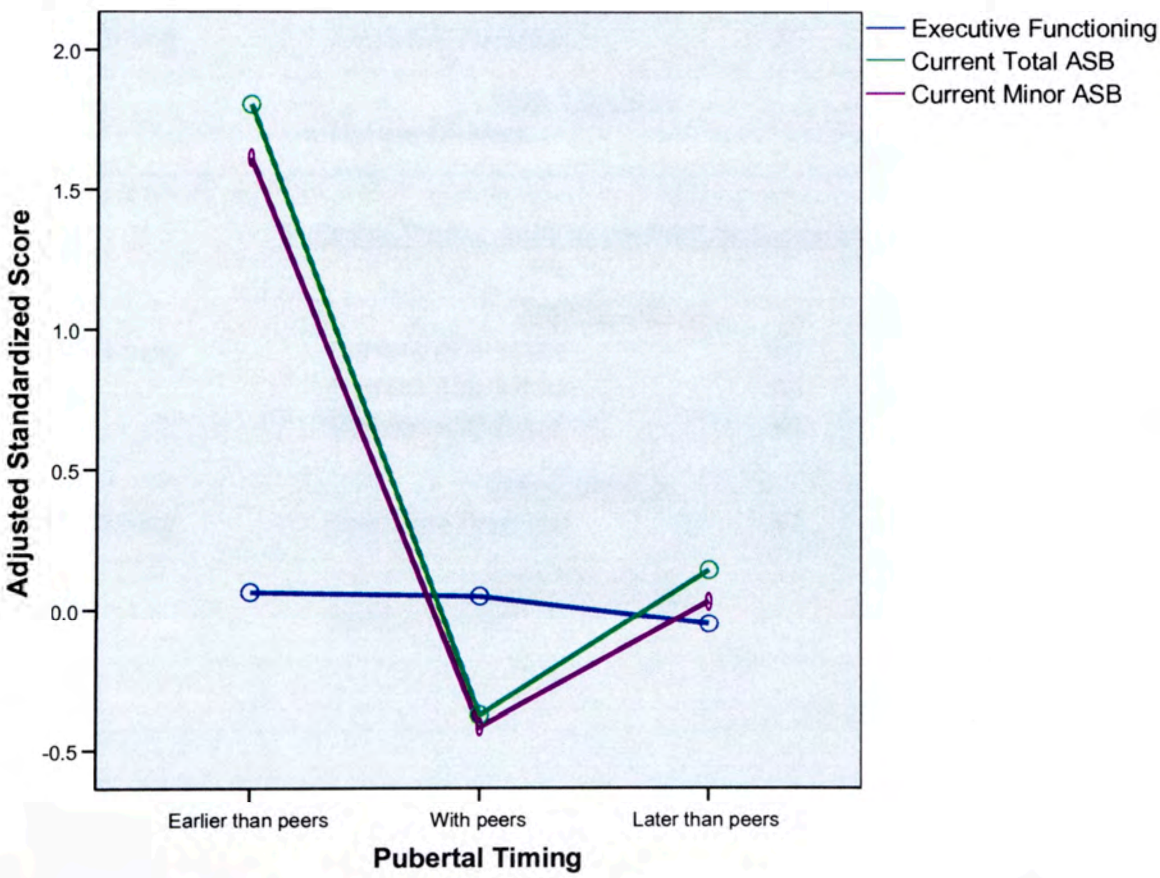


Figure 11.10 Current ASB-Minor and ASB-Total and Executive Function by Pubertal Timing for girls (age-adjusted, standardized scores).

Table 11.3. Regression analyses to test for mediation: Current ASB (Major, Minor, Total) and Executive Function on Pubertal Timing for girls.

Predictor	Criterion	*n*	*β*	*t*	*p*
	Pubertal Timing: all timing groups: early, on-time, late				
	Step 1 (path *a*)				
Pubertal Timing	Current ASB-Major	81	-.031	-.276	.783
	Current ASB-Minor	79	-.085	-.748	.457
	Current ASB-Total	78	-.131	-1.148	.255
	Step 2 (path *b*)				
Pubertal Timing	Executive Function	81	.001	-.008	.994
	Step 3 (path *c*)				
	Not performed				
	Pubertal Timing: early vs late timing groups				
	Step 1 (path *a*)				
Pubertal Timing	Current ASB-Major	31	-.067	-.363	.719
	Current ASB-Minor	30	-.175	-.940	.355
	Current ASB-Total	29	-.229	-1.220	.233
	Step 2 (path *b*)				
Pubertal Timing	Executive Function	31	.014	.076	.940
	Step 3 (path *c*)				
	Not performed				
	Pubertal Timing: early vs on-time timing groups				
	Step 1 (path *a*)				
Pubertal Timing	Current ASB-Major	62	-.161	-1.263	.211
	Current ASB-Minor	**61**	**-.256**	**-2.033**	**.047**
	Current ASB-Total	**61**	**-.265**	**-2.108**	**.039**
	Step 2 (path *b*)				
Pubertal Timing	Executive Function	62	.050	.389	.699
	Step 3 (path *c*)				
	Not performed				

Table 11.4. Regression analyses to test for mediation: Cumulative ASB (Major, Minor, Total) and Executive Function on Pubertal Timing for girls.

Predictor	Criterion	*n*	*β*	*t*	*p*
	Pubertal Timing: all timing groups: early, on-time, late				
	Step 1 (path *a*)				
Pubertal Timing	Cumulative ASB-Major	81	-.072	-.642	.523
	Cumulative ASB-Minor	81	-.040	-.352	.726
	Cumulative ASB-Total	80	-.103	-.918	.361
	Step 2 (path *b*)				
Pubertal Timing	Executive Function	81	-.001	-.008	.994^
	Step 3 (path *c*)				
	Not performed				
	Pubertal Timing: early vs late timing groups				
	Step 1 (path *a*)				
Pubertal Timing	Cumulative ASB-Major	31	-.128	-.694	.493
	Cumulative ASB-Minor	32	-.101	-.559	.581
	Cumulative ASB-Total	31	-.201	-1.106	.278
	Step 2 (path *b*)				
Pubertal Timing	Executive Function	31	.014	.076	.940
	Step 3 (path *c*)				
	Not performed				
	Pubertal Timing: early vs on-time timing groups				
	Step 1 (path *a*)				
Pubertal Timing	Cumulative ASB-Major	62	-.112	-.871	.387
	Cumulative ASB-Minor	61	-.148	-1.153	.254
	Cumulative ASB-Total	61	-.166	-1.292	.201
	Step 2 (path *b*)				
Pubertal Timing	Executive Function	62	.050	.389	.699
	Step 3 (path *c*)				
	Not performed				

^ n.s. effect is in opposite direction of hypothesis.

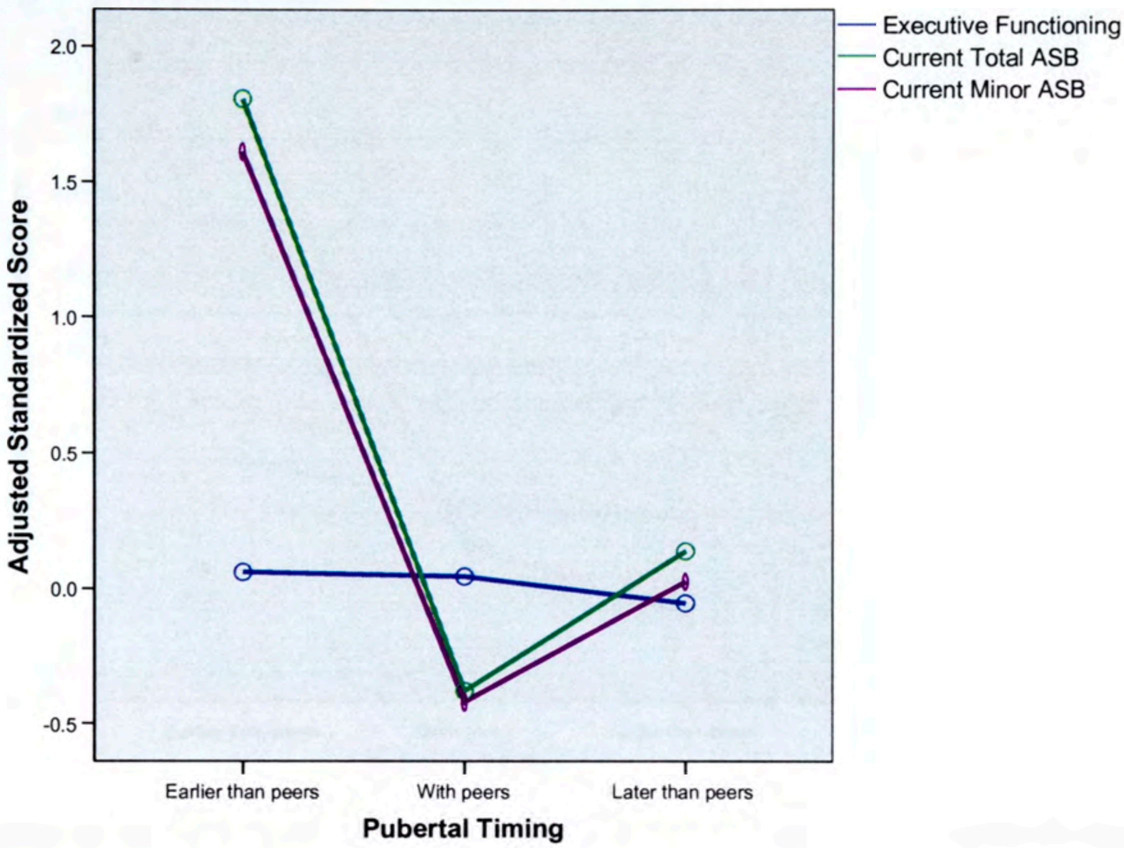


Figure 11.11. Cumulative ASB-Minor and ASB-Total and Executive Function by Pubertal Timing for girls (age-adjusted, standardized scores).

Boys

Current and Cumulative ASB

With the exception of ASB-Major, there was a significant increase in Current and Cumulative ASB reports by boys in early pubertal timing groups compared to on-time and late (for all pubertal timing contrasts; (β = -.22 to -.45, p < .01), and a significant decrease in executive function scores for early vs late timing comparisons (β = .25, p < .05; see Figures 11.12 and 11.13). However, when executive function and ASB were regressed on pubertal timing simultaneously, the direct effect of pubertal timing group on ASB was not reduced. In fact, as presented in Tables 11.5 and Table 11.6, including executive function in the equation *increased* the effect of pubertal timing on ASB **(**β = -.23 to -.44, p < .01**);** thus Sobel tests for statistical significance (Preacher & Hayes, 2004) were not carried out.

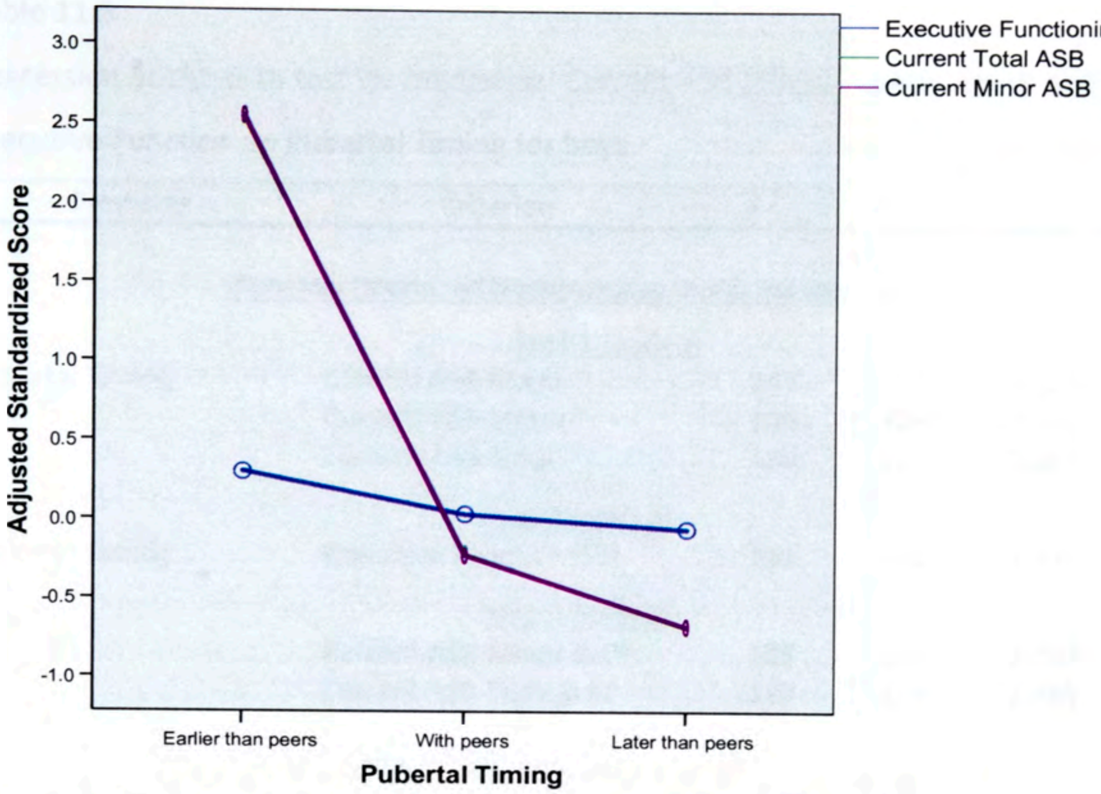


Figure 11.12. Current ASB-Minor and ASB-Total and Executive Functioning by Pubertal Timing for boys (age-adjusted, standardized scores).

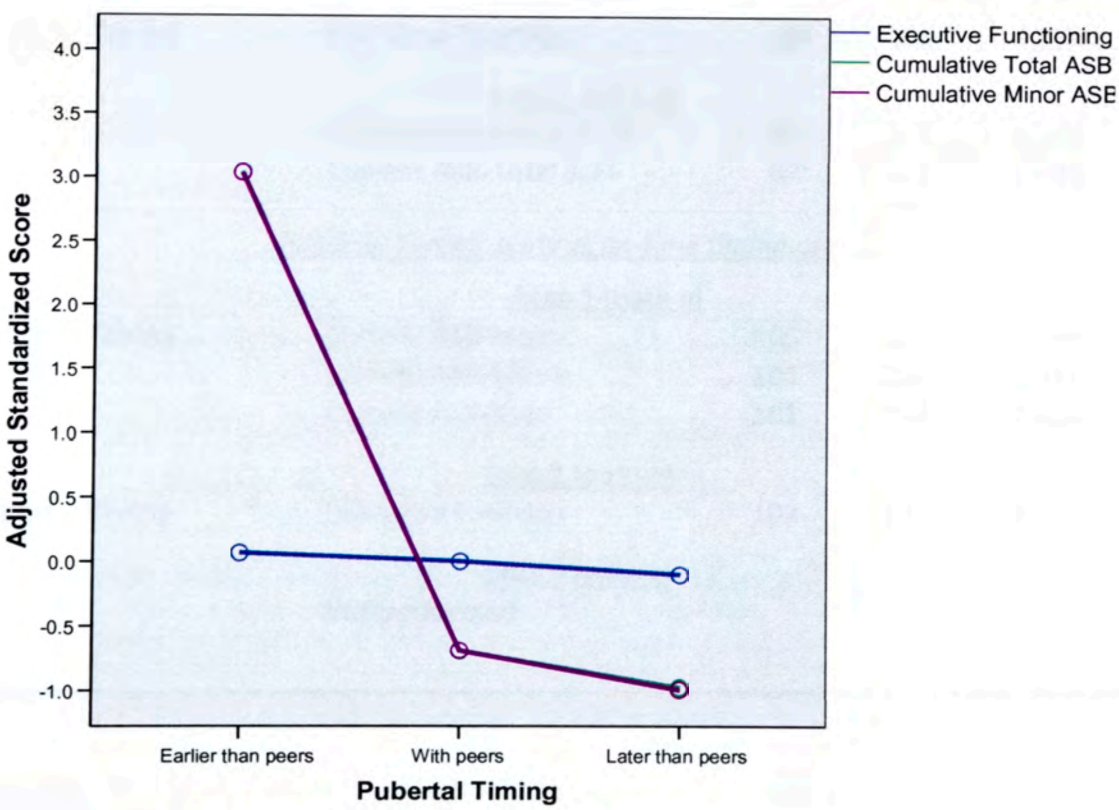


Figure 11.13. Cumulative ASB-Minor and ASB-Total and Executive Functioning by Pubertal Timing for boys (age-adjusted, standardized scores).

Table 11.5

Regression analyses to test for mediation: Current ASB (Major, Minor, Total) and Executive Function on Pubertal Timing for boys.

Predictor	Criterion	*n*	*β*	*t*	*p*
	Pubertal Timing: all timing groups: early, on-time, late				
	Step 1 (path *a*)				
Pubertal Timing	Current ASB-Major	143	-.101	-1.205	.230
	Current ASB-Minor	**139**	**-.226**	**-2.711**	**.008**
	Current ASB-Total	**139**	**-.222**	**-2.665**	**.009**
	Step 2 (path *b*)				
Pubertal Timing	Executive Function (EF)	**141**	**.158**	**1.889**	**.061**
	Step 3 (path *c*)				
	Current ASB-Minor & EF	**137**	**-.233**	**-2.737**	**.007**
	Current ASB-Total & EF	**137**	**-.229**	**-2.685**	**.008**
	Pubertal Timing: early vs late timing groups				
	Step 1 (path *a*)				
Pubertal Timing	Current ASB-Major	59	-.193	-1.484	.143
	Current ASB-Minor	**57**	**-.377**	**-3.019**	**.004**
	Current ASB-Total	**57**	**-.375**	**-3.001**	**.004**
	Step 2 (path *b*)				
Pubertal Timing	Executive Function	**59**	**.254**	**1.979**	**.053**
	Step 3 (path *c*)				
	Current ASB-Minor & EF	**57**	**-.391**	**-3.008**	**.004**
	Current ASB-Total & EF	**57**	**-.389**	**-2.992**	**.004**
	Pubertal Timing: early vs on-time timing groups				
	Step 1 (path *a*)				
Pubertal Timing	Current ASB-Major	105	-.093	-.949	.345
	Current ASB-Minor	**101**	**-.259**	**-2.672**	**.009**
	Current ASB-Total	**101**	**-.253**	**-2.606**	**.011**
	Step 2 (path *b*)				
Pubertal Timing	Executive Function	103	.134	1.363	.176
	Step 3 (path *c*)				
	Not performed				

Table 11.5. Regression analyses to test for mediation: Cumulative ASB (Major, Minor, Total) and Executive Function on Pubertal Timing for boys.

Predictor	Criterion	*n*	*β*	*t*	*p*
	Pubertal Timing: all timing groups: early, on-time, late				
	Step 1 (path *a*)				
Pubertal Timing	Current ASB-Major	143	-.104	-1.245	.215
	Current ASB-Minor	**142**	**-.297**	**-3.687**	**.000**
	Current ASB-Total	**142**	**-.293**	**-3.628**	**.000**
	Step 2 (path *b*)				
Pubertal Timing	Executive Function (EF)	**141**	**.158**	**1.889**	**.061**
	Step 3 (path *c*)				
	Current ASB-Minor & EF	**140**	**-.300**	**-3.628**	**.000**
	Current ASB-Total & EF	**140**	**-.295**	**-3.560**	**.001**
	Pubertal Timing: early vs late timing groups				
	Step 1 (path *a*)				
Pubertal Timing	Current ASB-Major	59	-.210	-1.622	.110
	Current ASB-Minor	**59**	**-.449**	**-3.796**	**.000**
	Current ASB-Total	**59**	**-.446**	**-3.767**	**.000**
	Step 2 (path *b*)				
Pubertal Timing	Executive Function	**59**	**.254**	**1.979**	**.053**
	Step 3 (path *c*)				
	Current ASB-Minor & EF	**59**	**-.442**	**-3.584**	**.001**
	Current ASB-Total & EF	**59**	**-.439**	**-3.554**	**.001**
	Pubertal Timing: early vs on-time timing groups				
	Step 1 (path *a*)				
Pubertal Timing	Current ASB-Major	105	-.199	-2.062	.042
	Current ASB-Minor	**104**	**-.384**	**-4.200**	**.000**
	Current ASB-Total	**104**	**-.380**	**-4.153**	**.000**
	Step 2 (path *b*)				
Pubertal Timing	Executive Function	103	.134	1.363	.176
	Step 3 (path *c*)				
	Not performed				

Summary of Mediation Analysis Findings

The full analysis planned for the mediating effects of executive functioning on pubertal onset and adolescent's Current ASB participation was not possible because the observed dip in executive functioning occurred in a pubertal stage that was prior to the observed peak in Current ASB. Given that some evidence has been found for the independent relationships between these three constructs, it is possible that methodological limitations have obscured the mediating effects of executive function on pubertal onset and current ASB participation. However, given that some of the evidence for these independent relationships is relatively weak, it may be that even if the full analysis had been possible no mediating effect would have been found.

There was no evidence found for a mediating effect of executive functioning on the relationships between pubertal timing and Current or Cumulative ASB reported by boys or girls, regardless of pubertal timing group comparison. Although early pubertal timing predicted higher levels of ASB and lower levels of executive function in separate regression analyses, executive function did not mediate the effect of pubertal timing on ASB, but rather increased the direct effect. Rather, including executive function in the model resulted in an increase, rather than the predicted decrease in ASB.

Conclusion

The previous three chapters provided evidence for the independent relationships between 1) pubertal development and ASB, 2) pubertal development and executive functioning, and 3) executive functioning and ASB. However, the analyses reported in this chapter revealed no evidence that executive functioning mediates the relationship between pubertal development and ASB. The next section of this thesis discusses alternative explanations for these findings, including methodological limitations and theoretical conclusions. Implications of these findings and suggestions for future research will also be proposed.

SECTION 5: GENERAL DISCUSSION

The first section of this thesis presented empirical and theoretical evidence regarding the relationships between pubertal development, executive function, and antisocial behaviour. This thesis set out to test one model of the relationship between pubertal development, executive function, and antisocial behaviour. This model proposes a causal relationship between puberty, decreased executive function, and increased antisocial behaviour. The research presented in this thesis is, to the best of our knowledge, the first direct test of this 'executive function dip' (EFD) model of the cause of increased antisocial behaviour in adolescence.

Several hypotheses were tested in this thesis relating to the proposed associations between pubertal development, executive function, and antisocial behaviour and attitudes. Chapter 12 summarizes the key findings regarding the relationships between these variables (Chapters 8, 9, and 10) and the results of mediation analyses (Chapter 11). This final section of the thesis summarizes the major findings of the analyses presented in the preceding chapters, and discusses the implications of these findings. Specifically discussed are the conclusions that can be drawn from these findings, and what the particular limitations were that prevented some questions from being addressed. The thesis concludes with some proposals for future research that may contribute to a better understanding of the associations between pubertal development, executive function, and adolescent antisocial behaviour and attitudes, and the implications of the findings presented in this thesis.

Chapter 12: General Discussion

To investigate whether executive function mediates the relationship between pubertal development and antisocial behaviour, the independent relationships between these variables were first examined. The most noteworthy results from this analysis are summarized below and are followed by a consideration of the conclusions and implications of these results. The limitations to the current research are presented, which highlight some of the obstacles to successful research in this area, and how these obstacles might be addressed by future research. Finally, this thesis concludes with a brief summary of what we have learned from the current research study and its contribution to knowledge in this area.

Summary of Findings

Pubertal Development and Executive Function

One of the most noteworthy results arising from the analyses presented in this thesis was the associations between pubertal development and executive functioning. For both boys and girls, a significant reduction in executive functioning was observed in both mid-pubertal adolescents, and early-maturing adolescents. As presented in Chapter 10, when analyses including only high-school students were considered, results indicated that adolescents in mid-pubertal stages experienced reduced executive functioning relative to pre- and late-pubertal adolescents. When both primary and high-school participants were included in the analyses it was found that adolescents who had entered puberty earlier than their peers had significantly lower executive function scores than those who began puberty either on-time or later than their peers.

Pubertal Development and Antisocial Attitudes

Another noteworthy finding was related to the association between pubertal development and antisocial attitudes. Strong evidence was found for an independent main effect of pubertal timing on antisocial attitudes; separate analyses for girls and boys revealed that early-maturing adolescents reported significantly higher antisocial attitudes than adolescents who matured on-time. There was also some evidence to suggest that higher antisocial attitudes were reported by adolescents currently in mid-puberty, particularly for girls. Although not statistically significant, mid-pubertal girls reported a 25 percent increase in antisocial attitudes in comparison to pre-pubertal, and late-pubertal, girls. For boys, mid-pubertal adolescents reported significantly greater antisocial attitudes than pre-pubertal, but not late pubertal, boys.

Pubertal Development and Antisocial Behaviour

Other results confirmed the previous findings revealed in Chapter 1, of associations between antisocial behaviour and pubertal development. The current study established that ASB participation coincides with the onset of puberty, peaks during mid-pubertal stages, and is higher amongst early-maturing adolescents. Expanding on previous research findings, our findings are discussed with reference to minor and major ASB participation for both current (i.e. past 12 months) participation, and total (cumulative) ASB ever participated in for both pubertal stage and timing.

Pubertal Onset

Despite a wide range in reported age of pubertal onset and age of peak-ASB participation, both girls and boys were significantly more likely to report an age of peak-ASB participation that was at or near the age of reported pubertal onset. Additionally, a significant relationship was found between age of puberty onset and age of participation in ASB, where earlier pubertal onset predicted a younger age of first ASB participation.

Pubertal Stage

Adolescent girls who were at a mid-pubertal stage of development reported significantly higher levels of Current ASB (all types) compared to girls in pre-pubertal, or late pubertal stages. A similar peak in ASB was found for boys, but this occurred in a later pubertal stage. Thus, there is strong evidence for a mid-pubertal peak in ASB for girls, but the results for boys suggests that the effect of pubertal onset may occur in later pubertal stages.

Pubertal Timing

Girls who reported maturing earlier than their peers, reported significantly higher ASB (all types) than girls who matured on-time or late. Similar findings were found for boys. In this sample, early pubertal onset predicts higher levels of Current minor, but not major, ASB across pubertal stages for boys. For boys, the level of participation in major ASB was effectively equivalent across pubertal timing groups, suggesting that a subgroup of adolescent boys exists who participate in more serious types of ASB regardless of the effects of pubertal timing. The implications of these findings are discussed below.

Pubertal Stage and Pubertal Timing

In addition to these effects of pubertal stage and timing, an interaction between stage and timing was found for both boys and girls. Early maturing girls who were in a mid-pubertal stage reported significantly higher current ASB then the other groups. Early maturing boys who were in a 'late' pubertal group (i.e. Stage 4) also reported significantly higher ASB participation in the 12 months preceding the survey. Both on-time and late-maturing girls and boys showed very little evidence of an association between ASB and pubertal stage, suggesting that it is the effect of pubertal timing that predicts the pubertal stage effect of increased ASB. When the data were examined for possible long-term effects of pubertal timing on ASB participation, it was found that early-maturing boys reported significantly higher levels of total *cumulative* ASB, than boys who matured on-time or late. This effect was not found for girls. The inclusion of pubertal stage in the analyses establishes that this finding is not the result of early-maturing boys participating in greater ASB due to a comparatively earlier pubertal-onset, and thus having had more years to participate in ASB. Thus, there is evidence that, for boys, early pubertal timing may predict higher levels of ASB participation that persist over time.

Executive Function and Antisocial Behaviour

The findings of an association between antisocial behaviour and executive function support previous findings with similar effect sizes in studies with children. For example, Steinben et al (2007), found that children with externalizing problems performed significantly worse on tests of response inhibition than age-matched controls, producing effect sizes which explained approximately 20% of the variance in response inhibition scores. Similar effect sizes were found in the current sample of adolescent boys and girls, indicating that the non-overlap of executive function scores between high and low ASB groups ranged from approximately 15% to 35%. The strongest relationships were found in relation to participation in major types of ASB. Adolescents reporting relatively high levels of participation in major ASB tended to score lower on measures of executive function than those in the 'low' ASB group (for boys this only approached significance). The evidence for a relationship between executive functioning and ASB was stronger for enduring (cumulative) patterns of ASB than for current ASB participation, particularly for girls. Girls reporting high levels of ASB (all types) scored lower on measures of executive function than girls in the 'low' ASB participation groups. For boys, this relationship only held for major ASB.

Mediation Analysis

Several problems were encountered when mediation analyses were attempted, and none of the mediation models were supported by the data. Two complications arose when examining possible mediating effects of executive function on the relationship between pubertal stage and antisocial behaviour. The first complication involved the non-linear path of the proposed relationship. To investigate a mid-pubertal 'dip' in executive function and 'peak' in ASB, it was necessary to create two separate regression equations (i.e. pre-pubertal to mid-pubertal stages, and mid-pubertal to late pubertal stages).

A second complication arose in relation to the data – the mid-pubertal 'dip' and the ASB 'peak', whilst both occurring mid-pubertal did not occur at exactly the same stage. For example, ANCOVA results revealed that executive function scores were significantly lower in girls who were in mid-pubertal stage 2.0 (see Chapter 9), while current ASB behaviour was significantly higher among girls in mid-pubertal stage 2.5 (see Chapter 8). Thus, only the first two steps of this mediation model were successful (i.e. ASB regressed on pubertal stages 1.0 to 2.5 and executive function regressed on pubertal stages 1.0 to 2.0). The third step involved regressing both current ASB and executive function on pre-pubertal to mid-pubertal stages. Because the regression equations were not equivalent, the model was not testable.

Attempts were made to overcome this problem by recoding pubertal stage into three stages of development, pre-pubertal (Stages 1.0 and 1.5), mid-pubertal (Stages 2.0 and 2.5), and late-pubertal (Stages 3.0 to 4.5). This strategy proved unsuccessful; the most likely explanation is that the effects are limited and short-lived, and that a more 'fine-grained' approach to analysis is required. Thus, the EFD model of mediating effects of executive function on the relationship between adolescents' current pubertal stage and ASB participation could not be fully tested. The limited testing of the model that was possible did not find any support for the model.

In contrast to pubertal stage models, pubertal timing mediation analyses were relatively straight-forward. For example, for boys, all pubertal timing group contrasts revealed a significant effect of (early) pubertal timing on (increased) ASB (current and cumulative), and (early) pubertal timing on (reduced) executive function. However, the final step of the model which involved regressing executive function and ASB simultaneously on pubertal timing revealed that executive function did not appear to mediate the relationship between pubertal timing and ASB participation. Thus, no support was found for the EFD model of the relationship between pubertal timing and ASB. The most noteworthy finding here, however, was that early pubertal timing did predict significantly lower current executive function in boys. It is possible that the effect was found for boys and not for girls because the effect for boys is not dependent of current pubertal stage; this suggests that for boys, early pubertal timing predicts persistent lower executive function and increased current and persistent ASB participation. Whereas, for girls, the EFD effects of pubertal development on ASB participation is limited to early-maturing, mid-pubertal girls.

Conclusions and Limitations: Does the EFD Model Withstand Scrutiny?

Mediation Analysis

The findings reported in this thesis are consistent with previous findings that participation in ASB significantly increases with onset of pubertal development (as reviewed in Chapter 1). The current study *extends* on previous findings to conclude that early pubertal timing predicts significantly earlier ASB, greater 'current' ASB participation and also persistent ASB participation, and a persistent reduction in executive functioning. However, only a relatively weak relationship was found between executive function and ASB in this community sample of adolescents. It is possible that it is the modest strength of the relationship between executive function and ASB participation that explains the fact that no support was found for the hypotheses that executive function mediates a relationship between pubertal stage and ASB participation, or between pubertal timing and ASB participation. As discussed in further detail below, a community sample of adolescents is characterized by many protective factors to ASB participation (e.g. pro-social peers, stable, supportive parenting). Thus, it is possible that given these protection factors and the modest size of the effect of executive function on ASB and the presence of noise in the data has obscured an effect. However, the present study provided evidence that an executive function 'dip', and an ASB 'peak' are occurring concurrently. Thus, although it is possible that executive function does not mediate these relationships, it is also possible that the failure to observe an effect is due to other characteristics of the sample.

Executive Function and Antisocial Behaviour

The finding of an association between reduced executive functioning and ASB participation is consistent with a number of previous studies conducted in forensic settings, which have established that individuals who participate in relatively high levels of ASB also display lower levels of executive functioning compared to controls (e.g. Dolan & Park, 2002), in both youth and adult samples (e.g. Bergeron & Valliant, 2001). However, unlike these other studies, the research reported here replicates this result, but does so in a community (i.e. non-forensic population, which shows relatively lower levels of ASB than typically found amongst offending populations. Thus, it may be that the overall lower level of participation in ASB in this sample compromises the strength of the analysis, and that greater consistency across all types of current and cumulative ASB participation, with larger effect sizes, would have been found had this sample been more representative of the 'less protected' youth in community or offending samples. Suggestions for future studies in this area are discussed below.

Pubertal Development and Executive Function

Previous research has reported a 'dip' in executive function during adolescence that appears to coincide with the onset of puberty (McGivern et al., 2002). However, to our knowledge, the research performed here is the first direct test of an association between pubertal development and executive function processes. The findings that fluctuations in executive functioning during adolescence may be associated with pubertal onset and with the relative timing of that onset represents a significant contribution to our knowledge in this area.

The need to separate the younger (i.e. primary) from older (i.e. high school) participants to obtain these results was of some concern, however. Therefore, one explanation examined was the possibility that primary school participants and high school participants were not distributed equivalently across timing groups (see Appendix 12.1a). An examination of the data revealed fewer primary school participants were in the late-maturing groups for both girls and boys. Across school type, participants were equally distributed into early (19.2% girls; 21.0% boys), and late (18.3%, girls; 20.5% boys), pubertal timing groups. However, the proportion of primary participants (1.7% girls; 1.0% boys), in comparison to high school participants (16.7% girls, 19.5% boys) in the late-maturing groups was substantially less. This phenomenon, however, should affect only early vs late and on-time vs late comparison contrasts, as the proportion of primary participants (9.2% girls; 10.3% boys) in comparison to high school participants (10.0% girls; 10.8% boys) in the early-maturing groups was approximately equal.

Thus it appears that the relationship between early pubertal timing and reduced executive functioning in this sample is not due to a greater number of younger participants (who would be expected to perform poorer as a function of age) in an early-timing group. Rather it appears that it may be the lack of equal representation across pubertal stages (pre, mid, late) by the primary school participants that accounts for both the effect when they are included in *pubertal timing* analyses, and the lack of an effect when they are included in *pubertal stage* analyses. Approximately two-thirds of primary school participants were in a pre-pubertal stage, in comparison to less than 5% of high school participants (Appendix 12.1b). Thus, the inclusion of primary school participants in pubertal stage analyses most likely obscured the executive function dip effect because younger participants were over-represented in Pubertal Stage 1. This explanation also accounts for the different results found in the pubertal stage by timing interactions. Including primary school participants most likely obscured an effect because of the over-representation of low executive function scores by Stage 1 participants; when primary school participants were removed from the analyses, an interaction effect was found for early-maturing participants in a mid-pubertal stage scoring significantly lower on executive function.

These findings highlight the importance of ensuring the sample includes a range of ages and stages of pubertal development. The study was limited in that recruitment was conducted in schools in which the maximum age of available participants was approximately 17 years. Recruitment was further limited by the fact that adolescents in this older age group were under-represented because time commitments to their final year of high school studies prevented them from volunteering for the study. Although a small number of 17-year old boys volunteered for the study, no 17-year old girls were tested. Furthermore, boys progress through pubertal stages later than girls (see Chapter 5). Thus although the sample size of 123 girls and 203 boys recruited for the current study was substantial, the study could have been improved by including more participants, particularly in the older age groups. Future studies should address this limitation by recruiting samples that are stratified by sex, age, and pubertal stage.

Pubertal Development and Antisocial Behaviour & Attitudes

When relationships between pubertal development and ASB participation were examined, several interesting findings emerged. First, a pubertal stage and timing interaction revealed that it is early-maturing adolescents who are most at risk of increased ASB participation during pubertal onset. The finding that mid-pubertal adolescents who matured on-time or late reported significantly lower ASB participation than early-maturing adolescents suggests that it is only the sub-group of early-maturing adolescents who will display increased ASB participation during puberty onset.

Another finding of interest was that a peak in ASB participation was found in a relatively late pubertal stage for boys, in comparison to the predicted mid-pubertal peak that was observed in girls. For girls, the ASB peak occurred at Stage 2.5, but for boys, the ASB peak occurred at Stage 4. Thus, there is some evidence that the peak in ASB participation may occur in later pubertal stages in boys than girls. These findings help clarify some of the conflicting findings in the published literature regarding the associations between pubertal development and ASB in boys. For girls, the majority of studies have consistently found a relationship between both the onset and timing of puberty and delinquency (Caspi et al., 1993; Caspi & Moffitt, 1991; Haynie, 2003). However, for boys, there has been some inconsistency in the findings. Studies reporting an association between pubertal development and behaviour problems are characterized by larger samples (Storvoll & Wichstrom, 2002), or samples of older-aged boys (Piquero & Brezina, 2001), or both (e.g. Felson & Haynie, 2002). In the context of these previous findings, the findings presented in this thesis emphasize the need for large (representative) sample sizes and a longitudinal design with long follow up periods for subsequent studies.

Different patterns of results for boys and girls were also found when the data were examined for possible long-term effects of pubertal timing on ASB participation. Early pubertal timing predicted higher levels of current ASB for both girls and boys, but predicted higher levels of total cumulative ASB participation for boys only. Thus, it appears likely that the effect of early pubertal timing on ASB participation is longer lasting for boys than for girls. Buchanan et al. (1992) argue that the release of hormones early in adolescence may have greater influence because the body has not had time to adjust to the changes. Buchanan et al. further explain that it may take prolonged exposure to particular hormones (such as testosterone) to observe the effects of pubertal onset on behaviour, which they argue may offer an explanation for the lack of consistent findings for the effects of early pubertal timing in boys. The current findings that, for boys, higher levels of *enduring* (but not current) participation in ASB is predicted by early pubertal timing provides some evidence for Buchanan et al.'s explanation of the inconclusive results reported in the literature.

Finally, although early-maturing girls participated in significantly higher levels of *major* ASB, than girls who matured on-time or late, this effect was not found for boys. Rather, it was found that across all timing groups, boys reported equivalent levels of participation in *major* ASB. This difference in pattern may be explained by robust findings in the literature that a subgroup of individuals exist who chronically participate in more serious types of ASB from an early age (Lynam, 1996). Significantly more males than females typically demonstrate this early-onset, chronic ASB pattern (Loeber & Farrington, 2000), which offers an explanation for why this effect was not found amongst the males in this community sample. In comparison to boys, the early-maturing girls in the current sample reported significantly lower levels of current and cumulative participation in major ASB, and additionally, on-time and late-maturing girls reported significantly lower major ASB than early-maturing girls. The findings suggest therefore that early pubertal timing may predict major ASB only in girls, and that early pubertal timing may not differentiate between males who participate in serious ASB and those who do not. It is also possible, however, that the recruitment of males from a selective high-school prevented observing the effect in this sample of boys.

The above points highlight the importance of investigating not only the effect of pubertal development on ASB participation, but differentiating the types of ASB participation that may be affected, and how this may manifest differently for girls and boys. The majority of analyses revealed that the relationship between pubertal development and antisocial behaviour and attitudes was similar across gender. For example, early pubertal timing predicted higher levels of antisocial attitudes in both girls and boys despite the finding that boys reported significantly higher antisocial attitudes than girls. However, gender differences were observed in the non-significant trend for antisocial attitudes to peak mid-puberty. Although, for boys, significant differences were found in the hypothesized direction between pubertal stage groups, the pattern was not as clear for boys as it was for girls. For girls, no significant differences were observed between pubertal stages; however, an inverted U-shaped curve showed a trend for antisocial attitudes to increase mid-puberty, and then decrease for girls in later pubertal stages (see Chapter 8, Figure 8.10). It is possible that a peak in antisocial attitudes occurs later in boys (Stage 4), than in girls (Stages 2.5 to 3), because of longer-lasting effects of early puberty on boys than girls. However, on the basis of this data, it is unclear whether or not there is a relationship between pubertal stage and antisocial attitudes.

The finding that early pubertal timing does predict higher levels of antisocial attitudes is very important, particularly given the association between antisocial attitudes and ASB participation reported for both referred (Trevethan & Walker, 1989; Vincent, Vitacco, Grisso, & Corrado, 2003) and non-referred (Blair, 2005; Chandler & Moran, 1990) samples of children and adolescents, and the importance given to antisocial attitudes during risk assessment interviews with convicted adolescents (see Edens & Campbell, 2007 for a review). It can be argued that a possible limitation of the current study is that it was conducted with a sample of adolescents from the general population, who would exhibit lower overall antisocial attitudes in comparison to forensic samples (Chandler & Moran, 1990); hence, a stronger relationship may be found in adolescent offender samples. However, it is equally possible that offending samples may exhibit a ceiling effect of antisocial attitudes, and additionally that adolescent offender groups are over-represented by adolescents who matured early. Furthermore, given that forensic samples do not represent the majority of adolescents, it is important to study this relationship in 'normal' samples of adolescents. Thus, although it is recommended that this study be replicated in a forensic setting, these studies will require careful thought regarding method and design. Because the current study was conducted with community adolescents, and not criminal offenders, the findings cannot be used to inform offender risk assessments with adolescents. However, the findings do contribute to our understanding of the relationship between pubertal development and adolescent ASB participation in general.

Limitations of Construct Measurement

Antisocial Behaviour & Attitudes Measures

Antisocial Attitudes. Although the alpha coefficients for the two-factor model of the antisocial attitudes scale used in the current study were acceptable (i.e. Cronbach's alpha ~.75), other factor structures were not explored. It is possible that a three-factor, or even four-factor, model would produce stronger effects of the relationships between antisocial attitudes and pubertal timing, and antisocial attitudes and behaviour. Although internal validity and reliability were assessed for the scale designed for this study, criterion validity was limited to correlations with the antisocial behaviour scale. It would be useful to undertake a validity study with established measures of 'childhood psychopathy' before this scale was used in any other research. Recalling that the Antisocial Attitudes Scale was developed for the current study on the prototypical model of psychopathy measures used in forensic settings with particular focus on the Psychopathy Checklist: Youth Version (PCL:YV; Forth, et al., 2003; developed by Forth, et al., 1990), this section will discuss the limitations of the current measure with reference to studies investigating the reliability and validity of instruments developed on the construct of juvenile psychopathy.

Most early research investigating the juvenile psychopathy model found support for a two-factor model. For example, in a sample of convicted adolescents (Pardini et al., 2003), the Antisocial-Process Screening Device (APSD, formerly the Psychopathy Screening Device [PSD]) developed by Frick and Hare (2001) found support for the two-factor model found in the adult psychopathy literature: Factor 1: Impulsive/Conduct Problems, and Factor 2: Callous/Unemotional Traits. Although several studies have found support for this two-factor structure originally reported in a sample of clinic-referred children (Frick et al. 1994), several other studies have found contrasting findings. For example, Lynam (1997) also proposed a two-factor model for the (41-item) Child Psychopathy Scale (CPS), but found that the two factors were virtually redundant (r = .95), suggesting that measures on the two subscales were not measuring separate constructs.

Cooke and Michie (2001) challenged the popular two-factor model and proposed an alternative model comprising three factors; the original Interpersonal/Affective dimension was split into two separate dimensions: arrogant/deceitful and deficient affect. Several studies with youth have found support for this three-factor (callous-unemotional, narcissism, and impulsivity) structure (e.g. Forth et al., 2003b; Frick et al., 2000; Vincent et al., 2003; Vitacco, Rogers, & Neumann, 2003). Several other studies investigating psychopathy in juvenile samples (e.g. Lynam et al., 2007) have implemented a four-factor structure proposed by Hare (2003) arising from his PCL-R score findings with over 9,000 adult correctional inmates.

These apparently contradictory findings indicate that much further research is needed in this area to understand the limits of construct validity of juvenile psychopathy measurement, and the existing instruments being used. For purposes of the research presented in this thesis, the more commonly accepted two-factor model was accepted a priori. Thus, future analyses should be conducted to explore whether alternative factor structures are supported.

Antisocial Behaviour. Approximately one-third (~17 items) of the items on the Adolescent Antisocial Behaviour Scale were endorsed by between 10% and 30% of the sample, and almost one-quarter (~8 items) of the items were endorsed by over 30% of the sample. When the 34 items from Mak's (1993) Self-Report Behaviour Rating Scale were examined in the school sample, it was found that the Mak's scale and the scale used in the current study shared virtually equivalent prevalence rates, both across similar item-types (See Chapter 6) as well as the scale total (M = 6.15). As mentioned previously, the rates in the general population of adolescents is likely to be higher than the current study which included children and adolescents from a relatively high SES background. Although no SES data was reported in Mak's study, it is likely that students enrolled in Canberra secondary schools represent average to above-average SES levels. Had this study been conducted in less-privileged communities, it is likely that the self-reported participation rates would have been higher.

This study only included those adolescents who were still attending regularly, and who agreed to participate. Thus, one possible limitation of the current research is that there may have been a self-selection bias in favour of lower levels of ASB participation. Previous research suggests that 'delinquents' may be less likely to agree to participate in surveys (see, for example, Graham & Bowling, 1995; Hindelang, Hirschi, & Weis, 1981). As a result, the prevalence estimates presented in this report are more likely to underestimate, than overestimate, the true ASB participation rate amongst NSW secondary students.

We can be reasonably confident that the data obtained on the ASB scale are valid and reliable as a number of steps were taken to maximize the reliability and validity of the questionnaire (see Chapter 6 for analyses). The questionnaires were pilot tested with young adults to ensure questions were clear and well understood by participants. Assurance of confidentiality was given to the participants and they were reminded of the importance of giving honest answers. However, response bias could be another possible limitation on ASB measurement. Although the consistency in responses and the exclusion of those participants who failed the lie scale indicates that the remaining participants were responding honestly, we cannot be certain that some students did not either conceal, or alternatively, exaggerate their participation in ASB. However, the consistency between our findings and those of Mak (1993) and others suggests that the responses are typical of what can be expected from community self-report.

The ASB questionnaires designed for the current study allowed us to measure several different types of ASB (e.g. severity type, first age, average first age, current, cumulative). However, one limitation was that a measure of current ASB was excluded from the measure used in primary schools. At the request of the Department of Education and Training Ethics Committee, primary-school participants were not asked to provide responses on the ASB questionnaire other than whether they had ever participated in the behaviour, and were therefore not asked for reports of ASB participation occurring in the past 12 months. The lack of data on this measure precluded primary-school participants from being included in analyses investigating associations with current ASB participation. However, it seems unlikely that many of these children would have reported very high levels of ASB.

One final limitation of the ASB measure used in the current study is that the length of time for Current ASB was operationalized as ASB participation in the past 12 months. The measure of 12 months was selected as this is consistent with what other researchers have used (e.g. Carroll et al, 1996; Mak, 1993). However, it is a suggestion for future research to ask participants to indicate whether they had participated in each of the behaviours in the past 6 months rather than, or in addition to, in the past 12 months. As discussed below (see Future Studies) this would allow for a more precise measure of current ASB participation.

Pubertal Development Measures

As with the ASB measures, we can be reasonably confident that the self-report data obtained on the pubertal development measures are valid and reliable (see Chapter 5 for analyses). Although the self-reported mean age of onset on the variety of pubertal development indices was similar to that found in previous research, there was also some variability (see Chapter 5, Tables 5.12 and 5.13). It is difficult to know whether this observed variability reflects real differences in the samples on these markers, or is a result of the types of responses gathered with the different types of pubertal development measures used. Great care was taken to measure all of the indices (e.g. growth spurt, menarche, spermarche) of pubertal development and to ensure that the data could provide retrospective as well as current indications of pubertal stage and timing. The data were also examined thoroughly for reliability and validity of responses (see Chapter 5). For example, the findings from the pilot study that self-reported pubertal timing was less reliable than a computed indicator relative to the entire sample (see Chapter 3) greatly informed the school study. However, one of the greatest difficulties encountered by researchers in this field is how to accurately identify when cognitive or behaviour effects due to pubertal changes are occurring.

The current study is based on the premise that it is the release of pubertal hormones in the adolescent brain which accounts for the effects on executive functioning, and consequently, ASB participation. For example, Walker (2002) argues that behavioural changes in adolescents are mediated by changes in brain structure and function due to the increase in secretion of gonadal hormones during, and stress hormones following, puberty in adolescents, and that these hormones have an organizational effect as well as an activational effect on the brain. Although the current research was exploring these possible physiological effects of pubertal development on executive function and antisocial behaviour and attitudes, no physiological measures of hormone levels were taken. In part this is because hormonal measures are not without complications. For example, studies examining biological causes of pubertal development onset and behavioural change (e.g. Nottelmann, Susman, Blue et al., 1987; Nottelmann, Susman, Dorn et al., 1987; Nottelmann, Susman, Inoffgermain et al., 1987) are impeded by complications inherent in physiological measures of hormone concentrations. In the majority of studies of this kind, hormone levels and behaviour were assessed at time intervals that occurred close together (e.g. concurrently or within a time lag of one month). However, one critical issue with measurement of hormone concentrations is that it is not known how long it takes for changes in hormone levels to influence behaviour (Buchanan et al., 1992), which is also a possible influencing factor in the full model tested in this thesis. Also, because large differences in hormone levels exist between individuals, researchers would have to investigate changes within individuals over time, necessitating a longitudinal design. Thus, for accurate measurement of the effects of pubertal hormones on attitudes and behaviour, the measurement of pubertal development onset and its relationship to cognitive functioning clearly needs to be refined to isolate when particular hormonal effects may occur. In the interim, the measures used in the current study are probably acceptable, but improved methods may yield clearer results when exploring relationships between pubertal development, cognitive processes, and behaviour.

Executive Function Measures

A principle objective of the current study was to examine whether changes in executive function occur during adolescence as a function of pubertal development. To achieve this aim, very careful consideration was given to the types of executive function measures that should be included. Following recommendations of Miyake et al. (2000), it was determined that these measures had to assess three distinctive components of executive function: inhibition, updating, and shifting. The executive function literature was reviewed to determine which tests provided the most accurate measures of these executive function components. To differentiate executive function measurement from overall intellectual functioning, two non-executive function measures were also collected: the Peabody Picture Vocabulary Test (PPVT), and the Picture Arrangement subtest from the Weschler Intelligence Scale.

Analyses investigating the construct validity of these tests revealed that the Picture Arrangement test (PA) used in the pilot study was not a valid measure of non-executive function. Thus, the initial determination that PA was measuring crystallized intelligence was flawed; reconsideration of the function of this test suggests that the PA subtest is also measuring a type of executive function as PA involves *planning* the correct sequence of events displayed on the cards provided. In contrast, PPVT was significantly positively correlated with standardized scores on the Letter-Number

Sequencing subtest and not correlated with the executive function measures, and was therefore retained.

Because PPVT scores are reflective of overall level of intellectual functioning that is standardized for age, no significant differences between participant groups were expected; that is, no differences in intellectual functioning should be found in a sample of normal school children. However, the higher PPVT scores obtained by high-school boys in comparison to primary-school boys can be explained by the fact that the high-school boys in this sample were recruited from a selective school. However, the finding that high-school girls obtained significantly *lower* standardized vocabulary scores than the primary-school girls is not readily explained, and highlights the need to account for these individual differences in general intellectual functioning.

The relatively strong correlations between the measures used in this study supported the use of a composite variable of executive function (see Rosenthal, 1991). In the current study, with the exception of TMT, all correlations were equal to .5 or higher, and were statistically significant for both boys and girls. Thus, it appears that the unified measurement of executive function in the current study was atypically strong. This result is contradictory to the majority of findings in this area. For example, Miyake et al. (2000) report that the majority of studies have consistently found low intercorrelations between executive functioning tasks (usually $r = .40$ or less), and that these correlations often fail to reach statistical significance. On this basis, Miyake et al. argue that conceptualizing executive functioning as a unified construct is debatable; however, the strong correlations presented in this thesis supported the use of a composite executive function variable.

Typically, it has been found that girls perform better on executive function measures than boys (Giedd et al., 1999; Giedd et al., 2006; Giedd, Snell et al., 1996; Giedd, Vaituzis et al., 1996), yet in this study, boys outperformed girls. Thus, it appears that the relatively high intercorrelations found for boys in the current study may be related to their superior intellectual performance in general. Perhaps the relatively high executive function correlations found in the current study are not reflective of any particular testing method used (e.g. measures included), but rather represent an effect of higher-performing individuals, compared to those typically reported in clinical or forensic samples. Thus, these strong correlational results may not be found if the current study was replicated in a forensic sample. It is also worth noting however that the relatively superior performance by the current sample of boys may have had a negative impact on the current study. It is possible that the relatively high performance on executive function tasks by the participants in this sample of adolescents prevented significant findings of an association between pubertal development and antisocial behaviour with executive function, particularly for boys.

Construct validity analyses of executive function measures revealed that the majority of tests included were valid, but there were some exceptions (see Chapter 7). Analyses conducted with pilot study data indicated that the Porteus Mazes test was not measuring the same construct as the other measures (i.e. Stroop, Letter-Number Sequencing, verbal-fluency tests), and was therefore replaced with the Trail Making Test (TMT) in the school study. However, results revealed that TMT was also not correlated with the other measures. Correlation analysis and scale reliability tests revealed that, with the exception of TMT, all executive function tasks were significantly correlated with each other, and the exclusion of TMT improved the alpha coefficients substantially, particularly for girls. It is not clear why these two measures (Porteus Mazes and TMT) produced these results. It is possible that although these tests are measuring a component of executive function, it is not one that differentiates between individual abilities very well, or that the type of executive functioning is categorically different from the others. For example, it may be that the TMT is measuring the planning component of executive function rather than shifting as operationalized for the current study.

These findings do however highlight the potential value of examining the relationships between the individual executive function measures with the pubertal development and ASB measures. The use of a composite measure of executive function reduced the risk of a Type 1 error because the number of statistical comparisons was minimized. However, the findings that girls produced significantly lower correlations between all executive function tasks than boys, suggests that analyses with individual executive function variables may still be worth considering. It is possible that some of the measures may be particularly associated with pubertal development changes and/or ASB participation more so than others.

Future Studies and Policy Implications

Based on the above conclusions and limitations to the current study, it is recommended that this study be replicated in a forensic sample of adolescents, particularly with adolescents who have demonstrated relatively 'minor' behavioural problems. As mentioned above, it is possible that an incarcerated sample of adolescents may exhibit permanent executive functioning deficits that would show little change related to pubertal onset. Although it is possible that an incarcerated sample may represent those adolescents who matured earlier than their peers, it is more likely that these individuals have suffered other more 'serious' risk factors such as child abuse and neglect (e.g. Raine, 2001), or brain trauma (Kenny & Lennings, 2007). However, as reviewed at the beginning of this thesis (see Chapter 1), the majority of adolescents who come into contact with the law do so only infrequently, and are typically given a warning or probation conditions (Salmelainen, 1995; Vignaendra & Fitzgerald, 2006). These adolescence-limited offenders are a focus of particular interest for a research study such as the one conducted here with adolescents in the general community.

In addition to replicating this study in forensic samples, it is also important to replicate this study with community samples. These future studies can improve on the current study by including participants from less advantaged communities, and by encouraging participation among the older age groups. A significant limitation of the current study was not well established; the low numbers of older participants, which meant that no participants were in a post-pubertal group, and the late-pubertal group was under-represented.

Ultimately, the best research method to employ for this type of study is a longitudinal study. The current study was limited in that the time available for data collection did not allow for the inclusion of any follow-up periods, and hence a cross-sectional method was employed. A longitudinal design would provide more reliable measurement of the constructs, and better control of individual differences. In particular, a longitudinal design would provide a better estimate of when pubertal development related changes are occurring. More accurate measurement would improve the strength of the results and the related conclusions could be better supported. However, a longitudinal study such as this would represent a major undertaking, and is beyond what is possible for a PhD thesis. Ideally a longitudinal study design should include several hundred children tested every six months for approximately 10 years. This would allow investigation into pubertal related changes in executive functioning, and attitudes and behaviour within individuals from a pre-pubertal stage in childhood (e.g. age 9) to a post-pubertal stage in early adulthood (e.g. age 19).

Finally, future studies should also include an examination of the association between pubertal development and antisocial attitudes. The findings presented in this thesis from both the school study and the young adult study provide an informative base for investigating these relationships further. In addition to direct associations between antisocial attitudes with pubertal stage and pubertal timing, these studies should include an investigation into whether temporary reductions in emotional processing mediate these direct associations. As reviewed (see Chapter 2), although limited, there have been some findings to suggest that emotional processing abilities temporarily decline during adolescence. More research is required in this area to better understand adolescent cognitive patterns, emotional processing, and adolescent attitudes and behaviour.

Further, this research may have policy implications for all persons who have interactions with adolescents, whether they are crime and justice authorities, school authorities, counsellors, or parents. It is possible that the peak in ASB participation observed in adolescents who are between the ages of approximately 14 and 16 years (Baker, 1998) is, in part at least, explained by a mid-pubertal 'dip' in the cognitive processes that regulate behaviour. Although adolescent offenders cannot be excused for criminal activity during this time, an explanatory model such as the one investigated in this thesis suggests that juvenile crime is best approached with policies aimed at prevention and diversion, rather than punishment. This EFD model of adolescent ASB is not limited to juvenile crime policies, however. School teachers invest many hours interacting with adolescents who may demonstrate dramatic shifts in their ability to organize their daily activities and plan for future events. An executive function 'dip' model linking adolescent development and behaviour could help educators develop suitable learning strategies which are matched for this particular age of pubertal development groups of children. Finally, an understanding of these processes might help parents, and adolescents themselves, to better prepare for the perplexing shift in attitudes and behaviours during this developmental phase, and might better understand the possible limitations to adolescent decision-making during this period. If a relationship exists between pubertal development and antisocial attitudes and/or executive function, it is critical that this knowledge is gained and disseminated.

Conclusion

In conclusion, some evidence was found of a relationship between 1) pubertal development and ASB, 2) pubertal development and executive functioning, and 3) executive functioning and ASB in a community sample of Australian girls and boys. However, no evidence was found for a mediating effect of executive functioning on the relationship between pubertal development and ASB. Although it is may be that executive function represents a mediating role, and methodological limitations prevented the discovery of this relationship, it is also possible that there is some other explanation for the observed pattern of correlations. The most significant problem for the mediation analyses was in the analyses of current pubertal stage and current ASB participation; although it appeared that a dip in executive function, and a peak in ASB occurred mid-puberty, these events did not occur at exactly the same time. One method which may help address this limitation is by obtaining self-report measures of ASB participation occurring in the past 6 months rather than the past 12 months.

It is also possible that lack of significant mediating effects is explained by the relatively low levels of ASB participation in this particular sample of adolescents who have a relatively high SES. The sample tested appears to be particularly 'protected' by relatively high general intellectual, and in particular, executive, functioning. These protective factors have hindered the search for relationships between pubertal development and ASB participation that are associated with reductions in executive function. Thus, it is recommended that this study be replicated in other less-advantaged adolescent samples. Another suggested method is to employ longitudinal studies to isolate with greater precision when pubertal development changes are occurring, as well as any related changes in executive function or ASB participation. By following the same adolescents across the developmental changes occurring from pre-pubertal stages to post-pubertal stages, the data would indicate when specific changes are occurring with greater precision.

Despite these limitations, the results of this study make a significant contribution to our knowledge of pubertal development-related changes occurring during adolescence, and suggest that early pubertal timing is a risk factor for earlier and higher levels of ASB participation in both girls and boys, and perhaps most importantly, for *persistent* ASB participation and *persistent* executive functioning impairment. Another substantial contribution to this area of research is the finding that these early-maturing adolescents are particularly at risk for increased participation in ASB during the pubertal development onset phase. Although more research needs to be conducted in this area to confirm the relationship between pubertal development and executive function, the above findings suggest that adolescents may be experiencing a temporary deficiency in their ability to plan and control their social behaviour around the time of puberty, and that for a particular group of adolescents, these effects persist well beyond the onset of pubertal development.

In Chapter 2, I introduced the example of an adolescent who interpreted an unattended vehicle as an invitation for thrills and excitement, without regard to any the impact on the victim, or the potential negative consequences to himself. Returning to this example, the results of this thesis, although not conclusive, may help us understand the perplexing behaviour of adolescents that has puzzled older generations for decades. Based on the evidence presented here, it seems possible that our thrill-seeking adolescent is a 'victim' of hormonal processes that interfere with the normal functions of prospective thought, impulse control, perspective-taking, and risk-taking behaviour (commonly referred to as executive functioning). Thus, presented with the opportunity of an unattended vehicle with keys in the ignition, a mid-pubertal adolescent is more likely to process this as an undeniable invitation for an immediate reward without little, or any, thought to the potential consequences of his actions, or even to the likelihood of success in carrying out the plan. The results of the research presented in this thesis may provide a plausible story to explain adolescent antisocial behaviour arising from a temporary 'dip' in executive functioning resulting from the normal development process of pubertal development. Knowledge of this 'executive function dip' can guide decisions in juvenile crime policy and education models delivered in schools, but also to help adolescents and their parents negotiate this confusing phase of development. Therefore, an important focus for future research in adolescent development issues should include a comprehensive test of the EFD model.

References

ABS. (1997). Australian Standard Classification of Occupations [Electronic Version]. *Australian Bureau of Statistics*, from http://meteor.aihw.gov.au/content/index.phtml/itemId/270547

Agnew, R. (1990). The origins of delinquent events: An examination of offender accounts. *Journal of Research in Crime and Delinquency, 27*(3), 267-294.

Altschuler, D.M., & Brounstein, P.J. (1991). Patterns of drug use, drug trafficking, and other delinquency among inner-city adolescent males in Washington, D.C. *Criminology, 29*(4), 589-622.

Andershed, H., Kerr, M., Stattin, H., & Levander, S. (2002). Psychopathic traits in non-referred youths: Initial test of a new assessment tool. In E. Blaauw & L. Sheridan (Eds.), *Psychopaths: Current international perspectives* (pp. 131-158). The Hague, the Netherlands: Elsevier.

Anderson, V.A., Anderson, P., Northam, E., Jacobs, R., & Catroppa, C. (2001). Development of executive functions through late childhood and adolescence in an Australian sample. *Developmental Neuropsychology, 20*(1), 385-406.

Angold, A., Costello, E.J., & Worthman, C.M. (1998). Puberty and depression: The roles of age, pubertal status and pubertal timing. *Psychological Medicine, 28*(1), 51-61.

Arnett, J. (1992). Reckless behaviour in adolescence: A developmental perspective. *Developmental Review, 12*, 339-373.

Baddeley, A.D. (1996). Exploring the central executive. *Quarterly Journal of Experimental Psychology, 49A*, 5–28.

Baker, J. (1998). Juveniles in crime - Part 1: Participation rates and risk factors. *NSW Bureau of Crime Statistics and Research.*

Bancroft, J. (2006). Normal Sexual Development. In H. E. Barbaree & W. L. Marshall (Eds.), *The juvenile sex offender* (2nd ed., pp. 19-57). New York, NY: Guilford Press.

Barker, E.D., Seguin, J.R., White, H.R., Bates, M.E., Lacourse, E., Carbonneau, R., et al. (2007). Developmental trajectories of male physical violence and theft: Relations to neurocognitive performance. *Archives of General Psychiatry, 64*(5), 592-599.

Baron-Cohen, S. (1995). Theory of mind and face-processing: How do they interact in development and psychopathology? In D. Cicchetti & D. J. Cohen (Eds.), *Developmental psychopathology* (Vol. 1: Theory and methods. Wiley series on personality processes, pp. 343-356). Oxford, England: John Wiley & Sons.

Baron, R.M., & Kenny, D.A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*(6), 1173-1182.

Barry, C.T., Frick, P.J., DeShazo, T.M., McCoy, M.G., Ellis, M., & Loney, B.R. (2000). The importance of callous-unemotional traits for extending the concept of psychopathy to children. *Journal of Abnormal Psychology, 109*(2), 335-340.

Becker, M.G., Isaac, W., & Hynd, G.W. (1987). Neuropsychological development of non-verbal behaviors attributed to frontal-lobe functioning. *Developmental Neuropsychology, 3*(3-4), 275-298.

Bell, N.L., Lassiter, K.S., Matthews, T.D., & Hutchinson, M.B. (2001). Comparison of the Peabody Picture Vocabulary Test--Third Edition and Wechsler Adult Intelligence Scale--Third Edition with university students. *Journal of Clinical Psychology, 57*(3), 417-422.

Belson, W.A. (1975). *Juvenile Theft: The Causal Factors*. London: Harper & Row.

Bennett, T., & Wright, R. (1984). *Burglars on Burglary: Prevention and the Offender*. Aldershot: Gower.

Bergeron, T.K., & Valliant, P.M. (2001). Executive function and personality in adolescent and adult offenders vs. non-offenders. *Journal of Offender Rehabilitation, 33*(3), 27-45.

Biglan, A., Metzler, C.W., Wirt, R., Ary, D., Noell, J., Ochs, L., et al. (1990). Social and behavioral factors associated with high-risk sexual behavior among adolescents. *Journal of Behavioral Medicine, 13*, 245-261.

Bjork, J.M., Knutson, B., Fong, G.W., Caggiano, D.M., Bennett, S.M., & Hommer, D.W. (2004). Incentive-elicited brain activation in adolescents: Similarities and differences from young adults. *Journal of Neuroscience, 24*, 1793–1802.

Blair, C., Zelazo, P.D., & Greenberg, M.T. (2005). The measurement of executive function in early childhood. *Developmental Neuropsychology, 28*(2), 561-571.

Blair, J., Sellars, C., Strickland, I., Clark, F., & et al. (1996). Theory of mind in the psychopath. *Journal of Forensic Psychiatry, 7*(1), 15-25.

Blair, R.J.R. (2001). Neurocognitive models of aggression, the antisocial personality disorders, and psychopathy. *Journal of Neurology Neurosurgery and Psychiatry, 71*(6), 727-731.

Blair, R.J.R. (2005). Responding to the emotions of others: Dissociating forms of empathy through the study of typical and psychiatric populations. *Consciousness and Cognition: An International Journal. Special Issue: The Brain and Its Self, 14*(4), 698-718.

Blair, R.J.R., & Cipolotti, L. (2000). Impaired social response reversal - A case of 'acquired sociopathy'. *Brain, 123*, 1122-1141.

Blair, R.J.R., Morris, J.S., Frith, C.D., Perrett, D.I., & Dolan, R.J. (1999). Dissociable neural responses to facial expressions of sadness and anger. *Brain, 122*, 883-893.

Blair, R.J.R., & Perschardt, K.S. (2002). Empathy: A unitary circuit or a set of dissociable neuro-cognitive systems? *Behavioral and Brain Sciences, 25*(1), 27-28.

Blakemore, S.J., & Choudhury, S. (2006). Development of the adolescent brain: Implications for executive function and social cognition. *Journal of Child Psychology and Psychiatry, 47*(3-4), 296-312.

Blumstein, A., & Cohen, J. (1987). Characterizing criminal careers. *Science, 237*(4818), 985-991.

Blumstein, A., Cohen, J., & Farrington, D.P. (1988). Criminal Career Research: Its Value for Criminology. *Criminology, 26*(1), 1-35.

Blumstein, A., Cohen, J., Roth, J., & Visher, C.A. (1986). *Criminal Careers and Career Criminals* (Vol. 1). Washington DC: National Academy Press.

Blumstein, A., Farrington, D.P., & Moitra, S. (1985). Delinquency careers: Innocents, desisters, and persisters. *Crime and Justice: A Review of Research, 6*, 187-219.

Blyth, D.A., Simmons, R.G., & Zakin, D.F. (1985). Satisfaction with body image for early adolescent females: The impact of pubertal timing within different school environments. *Journal of Youth and Adolescence, 14*, 207-225.

Bogaert, A.F. (2005). Age at puberty and father absence in a national probability sample. *Journal of Adolescence, 28*(4), 541-546.

Bourgeois, J.P., Goldman-Rakic, P.S., & Rakic, P. (1994). Synaptogenesis in the prefrontal cortex of rhesus monkeys. *Cerebral Cortex, 4*, 78–96.

Broidy, L.M., Nagin, D.S., Tremblay, R.E., Bates, J.E., Brame, B., Dodge, K.A., et al. (2003). Developmental trajectories of childhood disruptive behaviors and adolescent delinquency: A six-site, cross-national study. *Developmental Psychology, 39*(2), 222-245.

Brooksgunn, J., Petersen, A.C., & Eichorn, D. (1985). Special issue: The study of maturational timing effects in adolescence 1. *Journal of Youth and Adolescence, 14*(3), 149-161.

Brooksgunn, J., & Warren, M.P. (1985). Measuring physical status and timing in early adolescence: a developmental perspective. *Journal of Youth and Adolescence, 14*(3), 163-189.

Brooksgunn, J., & Warren, M.P. (1988). The psychological significance of seconday sexual characteristics in 9-year-old to 11-year-old girls. *Child Development, 59*(4), 1061-1069.

Brooksgunn, J., & Warren, M.P. (1989). Biological and social contributions to negative affect in young adolescent girls. *Child Development, 60*(1), 40-55.

Brooksgunn, J., Warren, M.P., Rosso, J., & Gargiulo, J. (1987). Validity of self-report measures of girls pubertal status. *Child Development, 58*(3), 829-841.

Broomhall, L. (2005). Acquired sociopathy: a neuropsychological study of executive dysfunction in violent offenders. *Psychiatry, Psychology and Law, 12*(2), 367-387.

Brower, M.C., & Price, B.H. (2001). Neuropsychiatry of frontal lobe dysfunction in violent and criminal behaviour: a critical review. *Journal of Neurology Neurosurgery and Psychiatry, 71*(6), 720-726.

Brown, T.T., Lugar, H.M., Coalson, R.S., Miezin, F.M., Petersen, S.E., & Schlaggar, B.L. (2005). Developmental changes in human cerebral functional organization for word generation. *Cerebral Cortex, 15*, 275–290.

Buchanan, C.M., Eccles, J.S., & Becker, J.B. (1992). Are adolescents the victims of raging hormones: Evidence for activational effects of hormones on moods and behaviour at adolescence. *Psychological Bulletin, 111*(1), 62-107.

Bunge, S.A., Dudukovic, N.M., Thomason, M.E., Vaidya, C.J., & Gabrieli, J.D.E. (2002). Immature frontal lobe contributions to cognitive control in children: Evidence from fMRI. *Neuron, 33*(2), 301-311.

Burgess, P.W., Alderman, N., Evans, J., Emslie, H., & Wilson, B.A. (1998). The ecological validity of tests of executive function. *Journal of the International Neuropsychological Society, 4*, 547–558.

Canals, J., Vigil-Colet, A., Chico, E., & Marti-Henneberg, C. (2005). Personality changes during adolescence: The role of gender and pubertal development. *Personality and Individual Differences, 39*(1), 179-188.

Carey, S., Diamond, R., & Woods, B. (1980). Development of face recognition: A maturational component. *Developmental Psychology, 16*(4), 257-269.

Carroll, A., Durkin, K., Houghton, S., & Hattie, J. (1996). An adaptation of Mak's self-reported delinquency scale for Western Australian adolescents. *Australian Journal of Psychology, 48*(1), 1-7.

Carvajal, H., Hayes, J.E., Miller, H.R., & Wiebe, D.A. (1993). Comparisons of the vocabulary scores and IQs on the Wechsler Intelligence Scale for Children-III and the Peabody Picture Vocabulary Test--Revised. *Perceptual and Motor Skills, 76*(1), 28-30.

Casey, B.J., Giedd, J.N., & Thomas, K.M. (2000). Structural and functional brain development and its relation to cognitive development. *Biological Psychology, 54*(1-3), 241-257.

Caspi, A., Lynam, D., Moffitt, T.E., & Silva, P.A. (1993). Unraveling girls delinquency- Biological, dispositional, and contextual contributions to adolescent misbehavior. *Developmental Psychology, 29*(1), 19-30.

Caspi, A., & Moffitt, T.E. (1991). Individual-differences are accentuated during periods of social-change- The sample case of girls at puberty. *Journal of Personality and Social Psychology, 61*(1), 157-168.

Caspi, A., & Roberts, B.W. (2001). Personality development across the life course: The argument for change and continuity. *Psychological Inquiry, 12*(2), 49-66.

Cattell, R.B. (1978). *The scientific use of factor analysis in behavioral and life sciences.* New York: Plenum.

Chandler, M., & Moran, T. (1990). Psychopathy and moral development: A comparative study of delinquent and nondelinquent youth. *Development and Psychopathology, 2*(3), 227-246.

Channon, S., Pratt, P., & Robertson, M.M. (2003). Executive function, memory, and learning in Tourette's syndrome. *Neuropsychology, 17*(2), 247-254.

Chen, S., Matruglio, T., Weatherburn, D., & Hua, J. (2005). The transition from juvenile to adult criminal careers. *NSW Bureau of crime statistics and research Crime and Justice Bulletin*(86).

Choudhury, S., Blakemore, S.-J., & Charman, T. (2006). Social cognitive development during adolescence. *Social Cognitive and Affective Neuroscience. Special Issue: Genetic, Comparative and Cognitive Studies of Social Behavior, 1*(3), 165-174.

Christian, R.E., Frick, P.J., Hill, N.L., Tyler, L., & Frazer, D.R. (1997). Psychopathy and conduct problems in children: Implications for subtyping children with conduct problems. *Journal of the American Academy of Child and Adolescent Psychiatry, 36*(2), 233-241.

Cohen, J. (1988). *Statistical power analyses for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum.

Coleman, L., & Coleman, J. (2002). The measurement of puberty: A review. *Journal of Adolescence, 25*(5), 535-550.

Comings, D.E., Muhleman, D., Johnson, J.P., & MacMurray, J.P. (2002). Parent-daughter transmission of the androgen receptor gene as an explanation of the effect of father absence on age of menarche. *Child Development, 73*(4), 1046-1051.

Conklin, H.M., Luciana, M., Hooper, C.J., & Yarger, R.S. (2007). Working memory performance in typically developing children and adolescents: Behavioral evidence of protracted frontal lobe development. *Developmental Neuropsychology, 31*(1), 103-128.

Cook, T.D., & Campbell, D.T. (1979). *Quasi Experimentation: Design and Analytical Issues for Field Settings* Chicago: Rand McNally.

Cooke, D.J., & Michie, C. (2001). Refining the construct of psychopath:Towards a hierarchical model. *Psychological Assessment, 13*, 171–188.

Coumarelos, C. (1994). Juvenile offending: predicting persistence and determining the cost-effectiveness of interventions. *New South Wales Bureau of Crime Statistics and Research.*

Cromwell, P. (1994). Juvenile burglars *Juvenile and Family Court Journal, 45*(2), 85-91.

Cronbach, L.J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16*(3), 297-334.

Cronbach, L.J., Gleser, G.C., Nanda, H., & Rajaratnam, N. (1972). *The dependability of behavioral measurements: Theory of generalizability for scores and profiles.* New York, NY: Wiley.

Dawes, M.A., Dorn, L.D., Moss, H.B., Yao, J.K., Kirisci, L., Ammerman, R.T., et al. (1999). Hormonal and behavioral homeostasis in boys at risk for substance abuse. *Drug and Alcohol Dependence, 55*(1-2), 165-176.

Deckel, A.W., Hesselbrock, V., & Bauer, L. (1996). Antisocial personality disorder, childhood delinquency, and frontal brain functioning: EEG and neuropsychological findings. *Journal of Clinical Psychology, 52*(6), 639-650.

DeRose, L.M., & Brooks-Gunn, J. (2006). Transition Into Adolescence: The Role of Pubertal Processes. In L. Balter & C. S. Tamis-LeMonda (Eds.), *Child psychology: A handbook of contemporary issues* (2nd ed.). New York, NY: Psychology Press.

Diamond, R., & Carey, S. (1977). Developmental-changes in representation of faces. *Journal of Experimental Child Psychology, 23*(1), 1-22.

Diamond, R., Carey, S., & Back, K.J. (1983). Genetic influences on the development of spatial skills during early adolescence. *Cognition, 13*(2), 167-185.

Dick, D.M., Rose, R.J., Pulkkinen, L., & Kaprio, J. (2001). Measuring puberty and understanding its impact: A longitudinal study of adolescent twins. *Journal of Youth and Adolescence, 30*(4), 385-399.

Dolan, M., & Doyle, M. (2000). Violence risk prediction: Clinical and actuarial measures and the role of the Psychopathy Checklist. *British Journal of Psychiatry, 177*, 303-311.

Dolan, M., & Park, I. (2002). The neuropsychology of antisocial personality disorder. *Psychological Medicine, 32*(3), 417-427.

Dorn, L.D., Crockett, L.J., & Petersen, A.C. (1988). The relations of pubertal status to intrapersonal changes in young adolescents. *Journal of Early Adolescence, 8*(4), 405-419.

Dorn, L.D., Nottelmann, E.D., Susman, E.J., Inoff-Germain, G., Cutler, G.B., & Chrousos, G.P. (1999). Variability in hormone concentrations and self-reported menstrual histories in young adolescents: Menarche as an integral part of a developmental process. *Journal of Youth and Adolescence, 28*(3), 283-304.

Dorn, L.D., Susman, E.J., Nottelmann, E.D., Inoff-Germain, G., & Chrousos, G.P. (1990). Perceptions of puberty: Adolescent, parent, and health-care personnel. *Developmental Psychology, 26*(2), 322-329.

Dorn, L.D., Susman, E.J., & Ponirakis, A. (2003). Pubertal timing and adolescent adjustment and behavior: Conclusions vary by rater. *Journal of Youth and Adolescence, 32*(3), 157-167.

Dowden, C., & Andrews, D.A. (2000). Effective correctional treatment and violent reoffending: A meta-analysis. *Canadian Journal of Criminology-Revue Canadienne De Criminologie, 42*(4), 449-467.

Dubas, J.S., Graber, J.A., & Petersen, A.C. (1991). A longitudinal investigation of adolescents changing perceptions of pubertal timing. *Developmental Psychology, 27*(4), 580-586.

Duncan, J., Burgess, P., & Emslie, H. (1995). Fluid intelligence after frontal-lobe lesions. *Neuropsychologia, 33*(3), 261-268.

Duncan, J., Johnson, R., Swales, M., & Freer, C. (1997). Frontal lobe deficits after head injury:Unity and diversity of function. *Cognitive Neuropsychology, 14*, 713–741.

Dunn, L.M., & Dunn, L.M. (1997). *Peabody picture vocabulary test, 3rd edition*. Circle Pines, MN: American Guidance Service.

Duyme, M. (1990). Antisocial Behaviour and Postnatal Environment: A French Adoption Study *Journal of Child Psychology and Psychiatry, 31*(5), 699–710.

Edens, J.F., & Campbell, J.S. (2007). Identifying youths at risk for institutional misconduct: A meta-analytic investigation of the psychopathy checklist measures. *Psychological Services, 4*(1), 13-27.

Edens, J.F., Skeem, J.L., Cruise, K.R., & Cauffman, E. (2001). Assessment of "juvenile psychopathy" and its association with violence: A critical review. *Behavioral Sciences & the Law, 19*(1), 53-80.

Eichenbaum, H., & Bunsey, M. (1995). On the binding of associations in memory- Clues from studies on the role of the hippocampal region in paired-associate learning. *Current Directions in Psychological Science, 4*(1), 19-23.

Elliott, D.S., Ageton, S.S., Huizinga, D., Knowles, B.A., & Canter, R.J. (1983). *The prevalence and incidence of delinquent behavior:1976-1980 (The National Youth Survey Report No. 26)*. Boulder, CO: Behavioral Research Institute.

Elliott, D.S., Dunford, F.W., & Huizanga, D. (1987). The identification and prediction of career offenders utilizing self-reported and official data. In S. N. B. J. D. Burchard (Ed.), *Prevention of delinquent behavior* (pp. 90-121).

Elliott, D.S., & Menard, S. (1996). Delinquent friends and delinquent behavior: Temporal and developmental patterns. In J. D. Hawkins (Ed.), *Delinquency and crime: Current theories* (pp. 28-67). New York, NY: Cambridge University Press.

Ellis, B.J. (2002). Of fathers and pheromones: Implications of cohabitation for daughters' pubertal timing. In *The Pennsylvania state university family studies symposia series* (pp. 289). Mahwah, NJ: Lawrence Erlbaum Associates Publishers.

Ellis, B.J. (2004). Timing of pubertal maturation in girls: An integrated life history approach. *Psychological Bulletin, 130*(6), 920-958.

Ellis, B.J., & Garber, J. (2000). Psychosocial antecedents of variation in girls' pubertal timing: Maternal depression, stepfather presence, and marital and family stress. *Child Development, 71*(2), 485-501.

Ellis, B.J., McFadyen-Ketchum, S., Dodge, K.A., Pettit, G.S., & Bates, J.E. (1999). Quality of early family relationships and individual differences in the timing of pubertal maturation in girls: A longitudinal test of an evolutionary model. *Journal of Personality & Social Psychology, 77*, 387-401.

Enticott, P.G., Ogloff, J.R.P., & Bradshaw, J.L. (2006). Associations between laboratory measures of executive inhibitory control and self-reported impulsivity. *Personality and Individual Differences, 41*(2), 285-294.

Fabrigar, L.R., Wegener, D.T., MacCallum, R.C., & Strahan, E.J. (1999). Evaluating the use of exploratory factor analysis in psychological research. *Psychological Methods., 4*(3), 272-299.

Farrington, D.P. (1986). Age and crime. *Crime and Justice: A Review of Research, 7,* 189-250.

Farrington, D.P. (1997). *A critical analysis of research on the development of antisocial behavior from birth to adulthood.* Hoboken, NJ: John Wiley & Sons.

Felson, R.B., & Haynie, D.L. (2002). Pubertal development, social factors, and delinquency among adolescent boys. *Criminology, 40*(4), 967-988.

Forth, A.E., Hart, S.D., & Hare, R.D. (1990). Assessment of psychopathy in male young offenders. *Journal of Consulting and Clinical Psychology, 2,* 342-344.

Forth, A.E., Kosson, D.S., & Hare, R.D. (2003a). *The Hare PCL:YV.* Toronto, Canada: Multi-Health Systems.

Forth, A.E., Kosson, D.S., & Hare, R.D. (2003b). *The Psychopathy Checklist: Youth Version.* Toronto, Ontario: Multi-Health Systems.

Freeman, K. (1996). Young people and crime. *Crime and Justice Bulletin: NSW Bureau of Crime Statistics and Research, 32.*

Frick, P.J. (2002). Juvenile psychopathy from a developmental perspective: Implications for construct development and use in forensic assessments. *Law and Human Behavior, 26*(2), 247-253.

Frick, P.J., Bodin, S.D., & Barry, C.T. (2000). Psychopathic traits and conduct problems in community and clinic-referred samples of children: Further development of the psychopathy screening device. *Psychological Assessment, 12*(4), 382-393.

Frick, P.J., Cornell, A.H., Bodin, S.D., Dane, H.E., Barry, C.T., & Loney, B.R. (2003). Callous-unemotional traits and developmental pathways to severe conduct problems. *Developmental Psychology, 39*(2), 246-260.

Frick, P.J., & Hare, R.D. (2001). *Antisocial Process Screening Device.* Toronto, Canada: Multi-Health Systems.

Frick, P.J., & Marsee, M.A. (2006). Psychopathy and Developmental Pathways to Antisocial Behavior in Youth. In C. J. Patrick (Ed.), *Handbook of the psychopathy* (pp. 353-374). New York, NY: Guilford Press.

Frick, P.J., Obrien, B.S., Wootton, J.M., & McBurnett, K. (1994). Psychopathy and conduct problems in children. *Journal of Abnormal Psychology, 103*(4), 700-707.

Frick, P.J., Stickle, T.R., Dandreaux, D.M., Farrell, J.M., & Kimonis, E.R. (2005). Callous-unemotional traits in predicting the severity and stability of conduct problems and delinquency. *Journal of Abnormal Child Psychology, 33*(4), 471-487.

Frith, U., & Frith, C. (2001). The biological basis of social interaction. *Current Directions in Psychological Science, 10*(5), 151-155.

Gaillard, W.D., Hertz-Pannier, L., Mott, S.H., Barnett, A.S., LeBihan, D., & Theodore, W.H. (2000). Functional anatomy of cognitive development: fMRI of verbal fluency in children and adults *Neurology, 54,* 180–185.

Gallagher, H.L., & Frith, C.D. (2003). Functional imaging of 'theory of mind'. *Trends in Cognitive Sciences, 7*(2), 77-83.

Ge, X., Conger, R.D., & Elder, G.H., Jr. (1996). Coming of age too early: Pubertal influences on girls' vulnerability to psychological distress. *Child Development, 67*(6), 3386-3400.

Ge, X.J., Brody, G.H., Conger, R.D., & Simons, R.L. (2006). Pubertal maturation and African American children's internalizing and externalizing symptoms. *Journal of Youth and Adolescence, 35*(4), 531-540.

Ge, X.J., Brody, G.H., Conger, R.D., Simons, R.L., & Murry, V.M. (2002). Contextual amplification of pubertal transition effects on deviant peer affiliation and externalizing behavior among African American children. *Developmental Psychology, 38*(1), 42-54.

Ge, X.J., Conger, R.D., & Elder, G.H. (2001). Pubertal transition, stressful life events, and the emergence of gender differences in adolescent depressive symptoms. *Developmental Psychology, 37*(3), 404-417.

Ge, X.J., Kim, I.J., Brody, G.H., Conger, R.D., Simons, R.L., Gibbons, F.X., et al. (2003). It's about timing and change: Pubertal transition effects on symptoms of major depression among African American youths. *Developmental Psychology, 39*(3), 430-439.

Giancola, P.R., Mezzich, A.C., & Tarter, R.E. (1998). Executive cognitive functioning, temperament, and antisocial behavior in conduct-disordered adolescent females. *Journal of Abnormal Psychology, 107*(4), 629-641.

Giedd, J.N. (2005). Structural MRI of typical adolescent brain development. *Neuropsychopharmacology, 30*, S68-S68.

Giedd, J.N., Blumenthal, J., Jeffries, N.O., Castellanos, F.X., Liu, H., Zijdenbos, A., et al. (1999). Brain development during childhood and adolescence: a longitudinal MRI study. *Nature Neuroscience, 2*(10), 861-863.

Giedd, J.N., Clasen, L.S., Lenroot, R., Greenstein, D., Wallace, G.L., Ordaz, S., et al. (2006). Puberty-related influences on brain development. *Molecular and Cellular Endocrinology, 254*, 154-162.

Giedd, J.N., Snell, J.W., Lange, N., Rajapakse, J.C., Casey, B.J., Kozuch, P.L., et al. (1996). Quantitative magnetic resonance imaging of human brain development: Ages 4-18. *Cerebral Cortex, 6*(4), 551-560.

Giedd, J.N., Vaituzis, A.C., Hamburger, S.D., Lange, N., Rajapakse, J.C., Kaysen, D., et al. (1996). Quantitative MRI of the temporal lobe, amygdala, and hippocampus in normal human development: Ages 4-18 years. *Journal of Comparative Neurology, 366*(2), 223-230.

Gilger, J.W., Geary, D.C., & Eisele, L.M. (1991). Reliability and validity of retrospective self-reports of the age of pubertal onset using twin, sibling, and college-student data. *Adolescence, 26*(101), 41-53.

Godefroy, O., Cabaret, M., Petit-Chenal, V., Pruvo, J.-P., & Rousseaux, M. (1999). Control functions of the frontal lobes: Modularity of the central-supervisory system? *Cortex, 35*(1), 1-20.

Graber, J.A., Lewinsohn, P.M., Seeley, J.R., & BrooksGunn, J. (1997). Is psychopathology associated with the timing of pubertal development? *Journal of the American Academy of Child and Adolescent Psychiatry, 36*(12), 1768-1776.

Graber, J.A., Petersen, A.C., & Brooks-Gunn, J. ((1996)). Pubertal processes: Methods, measures, and models. In J. A. Graber, J. Brooks-Gunn & A. C. Petersen (Eds.), *Transitions through adolescence: Interpersonal domains and context* (pp. 23-53). Hillsdale, NJ: Lawrence Erlbaum Associates.

Graham, J., & Bowling, B. (1995). *Young People and Crime*. Home Office, London.

Grisso, T. (1996). Society's retributive response to juvenile violence: A developmental perspective. *Law and Human Behavior, 20*(3), 229-247.

Gunnar, M., & Collins, W.A. (Eds.). (1988). *Minnesota symposia on child deuelopment.* (Vol. 21). Hillsdale, NJ: Erlbaum.

Gurd, J.M., Amunts, K., Weiss, P.H., Zafiris, O., Zilles, K., Marshall, J.C., et al. (2002). Posterior parietal cortex is implicated in continuous switching between verbal fluency tasks: An fMRI study with clinical implications. *Brain, 125*(5), 1024-1038.

Gustafsson, J. (1984). A unifying model for the structure of intellectual abilities. *Intelligence, 8*, 179-203.

Halpern, D.F., & LaMay, M.L. (2000). The smarter sex: A critical review of sex differences in intelligence. *Educational Psychology Review, 12*(2), 229-246.

Harpur, T.J., & Hare, R.D. (1994). Assessment of psychopathy as a function of age. *Journal of Abnormal Psychology, 103*(4), 604-609.

Hay, C., Fortson, E.N., Hollist, D.R., Altheimer, I., & Schaible, L.M. (2006). The impact of community disadvantage on the relationship between the family and juvenile crime. *Journal of Research in Crime and Delinquency, 43*(4), 326-356.

Haynie, D.L. (2003). Contexts of risk? Explaining the link between girls' pubertal development and their delinquency involvement. *Social Forces, 82*(1), 355-397.

Heilbrun, K., Hart, S.D., Hare, R.D., Gustafson, D., Nunez, C., & White, A.J. (1998). Inpatient and postdischarge aggression in mentally disordered offenders: The role of psychopathy. *Journal of Interpersonal Violence, 13*(4), 514-527.

Henry, J.D., & Crawford, J.R. (2004a). A meta-analytic review of verbal fluency performance following focal cortical lesions. *Neuropsychology, 18*(2), 284-295.

Henry, J.D., & Crawford, J.R. (2004b). Verbal fluency deficits in Parkinson's disease: A meta-analysis. *Journal of the International Neuropsychological Society, 10*(4), 608-622.

Henry, J.D., & Phillips, L.H. (2006). Covariates of production and perseveration on tests of phonemic, semantic and alternating fluency in normal aging. *Aging Neuropsychology and Cognition, 13*(3-4), 529-551.

HermanGiddens, M.E., Slora, E.J., Wasserman, R.C., Bourdony, C.J., Bhapkar, M.V., Koch, G.G., et al. (1997). Secondary sexual characteristics and menses in young girls seen in office practice: A study from the pediatric research in office settings network. *Pediatrics, 99*(4), 505-512.

Hicks, M.M., Rogers, R., & Cashel, M. (2000). Predictions of violent and total infractions among institutionalized male juvenile offenders. *Journal of the American Academy of Psychiatry and the Law, 28*(2), 183-190.

Higgins, D.M., Peterson, J.B., Pihl, R.O., & Lee, A.G.M. (2007). Prefrontal cognitive ability, intelligence, Big Five personality, and the prediction of advanced academic and workplace performance. *Journal of Personality and Social Psychology, 93*(2), 298-319.

Hill, J.P. (1982). Special issue: Early adolescence. *Child Development, 53*(6).

Hill, J.P. (1988). The role of conflict in familial adaptation to biological change. In M. Gunnar & W. A. Collins (Eds.), *Minnesota symposia on child development* (Vol. 21, pp. 43-77). Hillsdale, NJ: Erlbaum.

Hill, J.P., Holmbeck, G.N., Marlow, L., Green, T.M., & Lynch, M.E. (1985). Menarcheal status and parent-child relations in families of seventh-grade girls. *Journal of Youth and Adolescence, 14*, 301-316.

Hindelang, M., Hirschi, T., & Weis, J. (1981). *Measuring Delinquency*. Beverley Hills, CA: Sage Publications.

Hinshaw, S.P., & Zupan, B.A. (1997). Assessment of antisocial behavior in children and adolescents. In D. M. Stoff, J. Breiling & J. D. Maser (Eds.), *Handbook of antisocial behavior* (pp. 36-50). Hoboken, NJ: John Wiley & Sons.

Hirsch, M., Lunenfeld, B., Modan, M., Ovadia, J., & Shemesh, J. (1985). Spermarche: The age of onset of sperm emission. *Journal of Adolescent Health, 6*(1), 35-39.

Hirschi, T., & Gottfredson, M. (1983). Age and the Explanation of Crime. *American Journal of Sociology, 89*(3), 552-584.

Hirschi, T., Hindelang, M.J., & Weis, J. (1982). On the use of self-report data to determine the class distribution of criminal and delinquent behaviour: A reply. *American Sociological Review, 47*(3), 433-435.

Hood, R., & Sparks, R. (1970). *Key issues in criminology*. New York
McGraw-Hill.

Hooper, C.J., Luciana, M., Conklin, H.M., & Yarger, R.S. (2004). Adolescents' performance on the Iowa Gambling Task: Implications for the development of decision making and ventromedial prefrontal cortex. *Developmental Psychology, 40*(6), 1148-1158.

Hua, J., Baker, J., & Poynton, S. (2006). Generation Y and crime: A longitudinal study of contact with NSW criminal courts before the age of 21. *NSW Bureau of crime statistics and research Crime and Justice Bulletin*(96).

Hua, J., & Fitzgerald, J. (2006). Matching court records to measure reoffending. *NSW Bureau of crime statistics and research Crime and Justice Bulletin*(95).

Hubbard, D.J., & Pratt, T.C. (2002). A meta-analysis of the predictors of delinquency among girls. *Journal of Offender Rehabilitation, 34*(3), 1-13.

Huttenlocher, P.R. (1979). Synaptic density in human frontal cortex – developmental changes and effects of aging. *Brain Research, 163*, 195–205.

Jacob Arriola, K.R. (2002). Antisocial Behavior. In L. Breslow (Ed.), *Encyclopedia of Public Health*. New York: Thomson Gale.

Janowsky, J.S., Shimamura, A.P., Kritchevsky, M., & Squire, L.R. (1989). Cognitive impairment following frontal -lobe damage and its relevance to human amnesia. *Behavioral Neuroscience, 103*(3), 548-560.

Jones, F.L., & McMillan, J. (2001). Scoring occupational categories for social research: A review of current practice, with Australian examples. *Work, Employment & Society, 15*(3), 539-563.

Jones, R.G. (2001). Identifying Higher Education Students from Low Socio-Economic Status Backgrounds and Regional and Remote Areas [Electronic Version]. *Australian Government: Department of Education, Science, and Training (DEST), Quantitative Evaluation and Design (QED) Pty Ltd* from http://www.dest.gov.au/sectors/higher_education/publications_resources/profiles/higher_education_students_from_low_socio_economic_status.htm

Jonides, J., & Smith, E.E. (Eds.). (1997). *The architecture of working memory.* Cambridge, MA: The MIT Press.

Kaiser, J., & Gruzelier, J.H. (1999). The Adolescence Scale (AS-ICSM): A tool for the retrospective assessment of puberty milestones. *Acta Paediatrica, 88*, 64-68.

Kakarla, N., & Bradshaw, K.D. (2003). Disorders of pubertal development: Precocious puberty. *Seminars in Reproductive Medicine, 21*(4), 339-351.

Kaltiala-Heino, R., Kosunen, E., & Rimpela, M. (2003). Pubertal timing, sexual behaviour and self-reported depression in middle adolescence. *Journal of Adolescence, 26*(5), 531-545.

Kaltiala-Heino, R., Marttunen, M., Rantanen, P., & Rimpela, M. (2003). Early puberty is associated with mental health problems in middle adolescence. *Social Science & Medicine, 57*(6), 1055-1064.

Kanazawa, S. (2001). Why father absence might precipitate early menarche: The role of polygyny. *Evolution and Human Behavior, 22*(5), 329-334.

Kazdin, A.E., & Esveldt-Dawson, K. (1986). The interview for antisocial behavior: Psychometric characteristics and concurrent validity with child psychiatric inpatients. *Journal of Psychopathology and Behavioral Assessment, 8*, 289-303.

Kenny, D.K., & Lennings, C.J. (2007). The relationship between head injury and violent offending in juvenile detainees. *Crime and Justice Bulletin: NSW Bureau of Crime Statistics and Research, 107.*

Kimberg, D.Y., D'Esposito, M., & Farah, M.J. (1997). Effects of bromocriptine on human subjects depend on working memory capacity. *NeuroReport, 6*, 3581–3585.

Klein, M. (1989). Watch out for that last variable. In T. S. Mednick & S. A. S. Moffitt (Eds.), *The causes of crime: New biological approaches* (pp. 25-41). Cambridge, England: Cambridge University Press.

Kopalle, P.K., & Lehmann, D.R. (1997). Alpha inflation? The impact of eliminating scale items on Cronbach's alpha *Organizational Behavior and Human Decision Processes, 70*(3), 189 -197.

Kosson, D.S., Cyterski, T.D., Steuerwald, B.L., Neumann, C.S., & Walker-Matthews, S. (2002). The reliability and validity of the Psychopathy Checklist : Youth Version (PCL : YV) in nonincarcerated adolescent males. *Psychological Assessment, 14*(1), 97-109.

Kuhn, D. (2006). Do cognitive changes accompany developments in the adolescent brain? *Perspectives on Psychological Science, 1*(1), 59-67.

Kulik, J.A., Stein, K.B., & Sarbin, T.R. (1968). Dimensions and patterns of adolescent antisocial behavior. *Journal of Consulting and Clinical Psychology, 32*, 375-382.

Kulin, H.E., Frontera, M.A., Demers, L.M., Bartholomew, M.J., & Lloyd, T.A. (1989). The onset of sperm production in pubertal boys- Relationship to gonadotrophin excretion. *American Journal of Diseases of Children, 143*(2), 190-193.

Lahey, B.B., & Loeber, R. (1997). Attention-deficit/hyperactivity disorder, oppositional defiant disorder, conduct disorder, and adult antisocial behavior: A life span perspective. In D. M. Stoff, J. Breiling & J. D. Maser (Eds.), *Handbook of antisocial behavior* (pp. 51-59). Hoboken, NJ: John Wiley & Sons.

Lassiter, K.S., Bell, N.L., Hutchinson, M.B., & Matthews, T.D. (2001). College student performance on the General Ability Measure for Adults and the Wechsler Intelligence Scale for Adults--Third Edition. *Psychology in the Schools, 38*(1), 1-10.

Leblanc, M., Cote, G., & Loeber, R. (1991). Temporal paths in delinquency: Stability, regression, and progression analyzed with panel data from an adolescent and a delinquent male sample. *Canadian Journal of Criminology-Revue Canadienne De Criminologie, 33*(1), 23-44.

Leblanc, M., & Frechette, M. (1989). *Male criminal activity from childhood through youth: Multilevel and developmental perspectives.* New York, NY: Springer-Verlag.

Lehto, J. (1996a). Are executive function tests dependent on working memory capacity? *The Quarterly Journal of Experimental Psychology A: Human Experimental Psychology. Special Issue: Working Memory 49A*(1), 29-50.

Lehto, J. (1996b). Working memory capacity and summarizing skills in ninth-graders. *Scandinavian Journal of Psychology, 37*(1), 84-92.

Lehto, J.E., Juujarvi, P., Kooistra, L., & Pulkkinen, L. (2003). Dimensions of executive functioning: Evidence from children. *British Journal of Developmental Psychology, 21*, 59-80.

Leon-Carrion, J., Garcia-Orza, J., & Perez-Santamaria, F.J. (2004). Development of the inhibitory component of the executive functions in children and adolescents. *International Journal of Neuroscience, 114*(10), 1291-1311.

Leon-Carrion, J., Javier, F., & Ramos, C. (2003). Blows to the head during development can predispose to violent criminal behaviour: rehabilitation of consequences of head injury is a measure for crime prevention. *Brain Injury, 17*(3), 207-216.

Lerner, R.M., & Foch, T.T. (Eds.). (1987). *Biological-psychosocial interactions in early adolescence:A life span perspective*. Hillsdale, NJ: Erlbaum.

Levin, H.S., Culhane, K.A., Hartmann, J., Evankovich, K., Mattson, A.J., Harward, H., et al. (1991). Developmental-changes in performance on tests of purported frontal-lobe functioning. *Developmental Neuropsychology, 7*(3), 377-395.

Lewinsohn, P.M., Rohde, P., & Farrington, D.P. (2000). The OADP-CDS: A brief screener for adolescent conduct disorder. *Journal of the American Academy of Child and Adolescent Psychiatry, 39*(7), 888-895.

Lewis, M. (2001a). Continuity and change: A reply. *Psychological Inquiry, 12*(2), 110-112.

Lewis, M. (2001b). Issues in the study of personality development. *Psychological Inquiry, 12*(2), 67-83.

Liss, M., Fein, D., Allen, D., Dunn, M., Feinstein, C., Morris, R., et al. (2001). Executive functioning in high-functioning children with autism. *Journal of Child Psychology and Psychiatry and Allied Disciplines, 42*(2), 261-270.

Loeber, R., & Farrington, D.P. (1997). Strategies and yields of longitudinal studies on antisocial behavior. In D. M. Stoff, J. Breiling & J. D. Maser (Eds.), *Handbook of antisocial behavior* (pp. 125-139). Hoboken, NJ: John Wiley & Sons.

Loeber, R., & Farrington, D.P. (2000). Young children who commit crime: Epidemiology, developmental origins, risk factors, early interventions, and policy implications. *Development and Psychopathology, 12*(4), 737-762.

Loeber, R., Farrington, D.P., Stouthamer-Loeber, M., Moffitt, T.E., & Caspi, A. (1998). The development of male offending: Key findings from the first decade of the Pittsburgh Youth Study. *Studies on Crime & Crime Prevention, 7*(2), 141-171.

Loeber, R., Keenan, K., Lahey, B.B., Green, S.M., & Thomas, C. (1993). Evidence for developmentally based diagnoses of oppositional defiant disorder and conduct disorder. *Journal of Abnormal Child Psychology., 21*(4), 377-410.

Loza, W., & Loza-Fanous, A. (2001). The effectiveness of the self-appraisal questionnaire in predicting offenders' postrelease outcome: A comparison study. *Criminal Justice and Behavior, 28*, 105-121.

Luciana, M., Conklin, H.M., Hooper, C.J., & Yarger, R.S. (2005). The development of nonverbal working memory and executive control processes in adolescents. *Child Development, 76*(3), 697-712.

Lueger, R.J., & Gill, K.J. (1990). Frontal-lobe cognitive dysfunction in conduct disorder adolescents. *Journal of Clinical Psychology, 46*(6), 696-706.

Luna, B., Garver, K.E., Urban, T.A., Lazar, N.A., & Sweeney, J.A. (2004). Maturation of cognitive processes from late childhood to adulthood. *Child Development, 75*(5), 1357-1372.

Lynam, D.R. (1996). Early identification of chronic offenders: Who is the fledgling psychopath? *Psychological Bulletin, 120*(2), 209-234.

Lynam, D.R. (1997). Pursuing the psychopath: Capturing the fledgling psychopath in a nomological net. *Journal of Abnormal Psychology, 106*(3), 425-438.

Lynam, D.R. (1998). Early identification of the fledgling psychopath: Locating the psychopathic child in the current nomenclature. *Journal of Abnormal Psychology, 107*(4), 566-575.

Lynam, D.R. (2002). Fledgling psychopathy: A view from personality theory. *Law and Human Behavior, 26*(2), 255-259.

Lynam, D.R., Caspi, A., Moffitt, T.E., Loeber, R., & Stouthamer-Loeber, M. (2007). Longitudinal evidence that psychopathy scores in early adolescence predict adult psychopathy. *Journal of Abnormal Psychology, 116*(1), 155-165.

Lynam, D.R., & Gudonis, L. (2005). The development of psychopathy. *Annual Review of Clinical Psychology, 1*(1), 381-407.

MacLeod, C.M. (1991). Half a century of research on the Stroop effect: An integrative review. *Psychological Bulletin, 109, 109*, 1163–1210.

Macmillan, M.B. (1986). A wonderful journey through skull and brains: The travels of Mr. Gage's tamping iron. *Brain and Cognition, 5*(1), 67-107.

Mak, A.S. (1993). A self-report delinquency scale for Australian adolescents. *Australian Journal of Psychology, 45*(2), 75-79.

Marczyk, G.R., Heilbrun, K., Lander, T., & DeMatteo, D. (2003). Predicting juvenile recidivism with the PCL:YV, MAYSI, and YLS/CMI. *International Journal of Forensic Mental Health., 2*(1), 7-18.

Marczyk, G.R., Heilbrun, K., Lander, T., & DeMatteo, D. (2005). Juvenile decertification - Developing a model for classification prediction. *Criminal Justice and Behavior, 32*(3), 278-301.

Markey, C.N., Markey, P.M., & Tinsley, B.J. (2003). Personality, puberty, and preadolescent girls' risky behaviors: Examining the predictive value of the Five-Factor Model of personality. *Journal of Research in Personality, 37*(5), 405-419.

Marsee, M.A., Silverthorn, P., & Frick, P.J. (2005). The association of psychopathic traits with aggression and delinquency in non-referred boys and girls. *Behavioral Sciences & the Law, 23*(6), 803-817.

Martin, C.A., Kelly, T.H., Rayens, M.K., Brogli, B.R., Brenzel, A., Smith, W.J., et al. (2002). Sensation seeking, puberty, and nicotine, alcohol, and marijuana use in adolescence. *Journal of the American Academy of Child and Adolescent Psychiatry, 41*(12), 1495-1502.

McCaghy, C.H., Giordano, P.C., & Knicely Henson, T. (1977). Auto theft: Offender and offense characteristics. *Criminology, 15*(3), 367-385.

McCandless, S., & O'Laughlin, L. (2007). The clinical utility of the Behavior Rating Inventory of Executive Function (BRIEF) in the diagnosis of ADHD. *Journal of Attention Disorders, 10*(4), 381-389.

McGivern, R.F., Andersen, J., Byrd, D., Mutter, K.L., & Reilly, J. (2002). Cognitive efficiency on a match to sample task decreases at the onset of puberty in children. *Brain and Cognition, 50*(1), 73-89.

Miller, G.M., & Chapman, J.P. (2001). Misunderstanding analysis of covariance. *Journal of Abnormal Psychology, 110*(1), 40-48.

Mills, J.F., & Kroner, D.G. (2006). Impression Management and Self-Report Among Violent Offenders. *Journal of Interpersonal Violence, 21*(2), 178-192.

Miyake, A., Friedman, N.P., Emerson, M.J., Witzki, A.H., Howerter, A., & Wager, T.D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology, 41*(1), 49-100.

Miyake, A., & Shah, P. (2003). Toward Unified Theories of Working Memory. In P. Shah & A. Miyake (Eds.), *Models of working memory* (2nd ed., pp. 442-481). Cambridge, UK: Cambridge University Press.

Moffitt, T.E. (1993). Adolescence-limited and life-course-persistent antisocial-behavior: A development taxonomy. *Psychological Review, 100*(4), 674-701.

Moffitt, T.E., & Caspi, A. (2001). Childhood predictors differentiate life-course persistent and adolescence-limited antisocial pathways among males and females. *Development and Psychopathology, 13*(2), 355-375.

Moffitt, T.E., Caspi, A., Harrington, H., & Milne, B.J. (2002). Males on the life-course-persistent and adolescence-limited antisocial pathways: Follow-up at age 26 years. *Development and Psychopathology, 14*(1), 179-207.

Moffitt, T.E., & Henry, B. (1989). Neuropsychological assessment of executive functions in self-reported delinquents. *Development and Psychopathology, 1*(2), 105-118.

Monsell, S. (1996). Control of mental processes. In V. Bruce (Ed.), *Unsolved mysteries of the mind: Tutorial essays in cognition* (pp. 93–148). Hove, UK: Erlbaum.

Morgan, A.B., & Lilienfeld, S.O. (2000). A meta-analytic review of the relation between antisocial behavior and neuropsychological measures of executive function. *Clinical Psychology Review, 20*(1), 113-156.

Morgan, F., & Gardner, J. (1992). *Juvenile Justice I*. Adelaide.

Morse, J.K., Scheff, S.W., & DeKosky, S.T. (1986). Gonadal steroids influence axon sprouting in the hippocampal dentate gyrus: a sexually dimorphic response. *Experimental Neurology, 94*(3), 649–658.

Mountain, M.A., & Snow, W.G. (1993). Wisconsin Card Sorting Test as a measure of frontal pathology: A review. *The Clinical Neuropsychologist, 7*, 108-118.

Mukherjee, S.K. (1986). Youth crime in Australia: Conclusions. *The Bulletin of the National Clearinghouse for Youth Studies, 5*, 2-8.

Murrie, D.C., & Cornell, D.G. (2002). Psychopathy screening of incarcerated juveniles: A comparison of measures. *Psychological Assessment, 14*(4), 390-396.

Nee, C. (1993). Car theft: The offender's perspective. In *Research Findings No.3, Home Office Research and Statistics Department*. London.

New South Wales Bureau of Crime Statistics and Research (2000). from http://www.bocsar.nsw.gov.au/lawlink/bocsar/ll_bocsar.nsf/pages/bocsar_offenders_stats

Nielsen, C.T., Skakkebaek, N.E., Richardson, D.W., Darling, J.A.B., Hunter, W.M., Jorgensen, M., et al. (1986). Onset of the release of spermatozoa (spermarche) boys in relation to age, testicular growth, pubic hair, and height. *Journal of Clinical Endocrinology and Metabolism, 62*(3), 532-535.

Norman, D.A., & Shallice, T. (1986). Attention to action: Willed and automatic control of behavior. In R. J. Davidson, G. E. Schwartz & D. Shapiro (Eds.), *Consciousness and self-regulation: Advances in research and theory* (Vol. 4, pp. 1–18). New York, NY: Plenum.

Nottelmann, E.D., Susman, E.J., Blue, J., Inoffgermain, G., Dorn, L.D., Loriaux, D.L., et al. (1987). Gonadal and adrenal hormone correlates of adjustment in early adolescence. In R. M. Lerner & T. T. Foch (Eds.), *Bioological-psychosocial interactions in early adolescence* (pp. 303-323). Hillsdale, NJ: Erlbaum.

Nottelmann, E.D., Susman, E.J., Dorn, L.D., Inoffgermain, G., Loriaux, D.L., Cutler, G.B., et al. (1987). Developmental processes in early adolescence: I. Relations among chronologic age, pubertal stage, height, weight, serum levels of gonadotropins, sex steroids, and adrenal androgens. *Journal of Adolescent Health Care, 8*, 246-260.

Nottelmann, E.D., Susman, E.J., Inoffgermain, G., Cutler, G.B., Loriaux, D.L., & Chrousos, G.P. (1987). Developmental problems in early adolescence: Relations between adolescent adjustment problems and chronological age, pubertal stage, and puberty-related serum hormone levels. *Journal of Pediatrics, 110*, 473-480.

Obeidallah, D., Brennan, R.T., Brooks-Gunn, J., & Earls, F. (2004). Links between pubertal timing and neighborhood contexts: Implications for girls' violent behavior. *Journal of the American Academy of Child and Adolescent Psychiatry, 43*(12), 1460-1468.

Ogloff, J.R., Wong, S., & Greenwood, A. Treating criminal psychopaths in a Therapeutic Community program. *Behavioral Sciences & the Law, 8*(2), 181-190.

Paikoff, R.L., & Brooksgunn, J. (1991). Do parent child relationships change during puberty. *Psychological Bulletin, 110*(1), 47-66.

Pantelis, C., Harvey, C.A., Plant, G., Fossey, E., Maruff, P., Stuart, G.W., et al. (2004). Relationship of behavioural and symptomatic syndromes in schizophrenia to spatial working memory and attentional set-shifting ability. *Psychological Medicine, 34*(4), 693-703.

Pardini, D.A., Lochman, J.E., & Frick, P.J. (2003). Callous/unemotional traits and social-cognitive processes in adjudicated youths. *Journal of the American Academy of Child and Adolescent Psychiatry, 42*(3), 364-371.

Pennington, B.F., & Ozonoff, S. (1996). Executive functions and developmental psychopathology. *Journal of Child Psychology and Psychiatry, 37*(1), 51-87.

Petersen, A.C., & Crockett, L. (1985). Pubertal timing and grade effects on adjustment. *Journal of Youth and Adolescence. Special Issue: Time of maturation and psychosocial functioning in adolescence: I, 14*(3), 191-206.

Petersen, A.C., Crockett, L., Richards, M., & Boxer, A. (1988). A self-report measure of pubertal status: Reliability, validity, and intial norms. *Journal of Youth and Adolescence, 17*(2), 117-133.

Petersen, A.C., Sarigiani, P.A., & Kennedy, R.E. (1991). Adolescent depression: Why more girls. *Journal of Youth and Adolescence, 20*(2), 247-271.

Peterson, R.A. (1994). A Meta-Analysis of Cronbach's Coefficient Alpha. *The Journal of Consumer Research, 21*(2), 381-391.

Phan, K.L., Wager, T., Taylor, S.F., & Liberzon, I. (2002). Functional neuroanatomy of emotion: A meta-analysis of emotion activation studies in PET and fMRI. *Neuroimage, 16*(2), 331-348.

Phillips, M.L., Drevets, W.C., Rauch, S.L., & Lane, R. (2003). Neurobiology of emotion perception II: Implications for major psychiatric disorders. *Biological Psychiatry, 54*(5), 504-514.

Piquero, A.R., & Brezina, T. (2001). Testing Moffitt's account of adolescence-limited delinquency. *Criminology, 39*(2), 353-370.

Piquero, A.R., Brezina, T., & Turner, M.G. (2005). Testing moffitt's account of delinquency abstention. *Journal of Research in Crime and Delinquency, 42*(1), 27-54.

Porteus, S.D. (1950). *The Porteus Maze Test and intelligence*. Palo Alto, CA: Pacific Books.

Preacher, K.J., & Hayes, A.F. (2004). SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods, Instruments, & Computers, 36*(4), 717-731.

Prime, J., White, S., Liriano, S., & Patel, K. (2001). *Criminal Careers of those born between 1953 and 1978*. London: Home Office.

Raine, A. (2002). Biosocial studies of antisocial and violent behavior in children and adults: A review. *Journal of Abnormal Child Psychology, 30*(4), 311-326.

Raine, A., Brennan, P., & Mednick, S.A. (1994). Birth complications combined with early maternal rejection at age-1 year predispose to violent crime at age-18 years. *Archives of General Psychiatry, 51*(12), 984-988.

Raine, A., Brennan, P., & Mednick, S.A. (1997). Interaction between birth complications and early maternal rejection in predisposing individuals to adult violence: Specificity to serious, early-onset violence. *American Journal of Psychiatry, 154*(9), 1265-1271.

Raine, A., Lencz, T., Bihrle, S., LaCasse, L., & Colletti, P. (2000). Reduced prefrontal gray matter volume and reduced autonomic activity in antisocial personality disorder. *Archives of General Psychiatry, 57*(2), 119-127.

Raine, A., Moffitt, T.E., Caspi, A., Loeber, R., Stouthamer-Loeber, M., & Lynam, D. (2005). Neurocognitive impairments in boys on the life-course persistent antisocial path. *Journal of Abnormal Psychology, 114*(1), 38-49.

Raine, A., Park, S., Lencz, T., Bihrle, S., LaCasse, L., Widom, C.S., et al. (2001). Reduced right hemisphere activation in severely abused violent offenders during a working memory task: An fMRI study. *Aggressive Behavior, 27*(2), 111-129.

Raine, A., Stoddard, J., Bihrle, S., & Buchsbaum, M. (1998). Prefrontal glucose deficits in murderers lacking psychosocial deprivation. *Neuropsychiatry, Neuropsychology, and Behavioral Neurology, 11*, 1–7.

Reiss, A.L., Abrams, M.T., Singer, H.S., Ross, J.L., & Denckla, M.B. (1996). Brain development, gender and IQ in children. A volumetric imaging study. *Brain, 119*, 1763–1774.

Reitan, R.M. (1971). Trail making test results for normal and brain-damaged children. *Perceptual and motor skills, 33*(2), 575-581.

Richell, R.A., Mitchell, D.G.V., Newman, C., Leonard, A., Baron-Cohen, S., & Blair, R.J.R. (2003). Theory of mind and psychopathy: Can psychopathic individuals read the 'language of the eyes'? *Neuropsychologia. , 41*(5), 523-526.

Rierdan, J., & Koff, E. (1984). Age at menarche and cognitive-functioning. *Bulletin of the Psychonomic Society, 22*(3), 174-176.

Rogol, A.D., Roemmich, J.N., & Clark, P.A. (2002). Growth at puberty. *Journal of Adolescent Health, 31*(6), 192-200.

Romans, S.E., Martin, J.M., Gendall, K., & Herbison, G.P. (2003). Age of menarche: The role of some psychosocial factors. *Psychological Medicine, 33*(5), 933-939.

Romeo, R.D. (2003). Puberty: A period of both organizational and activational effects of steroid hormones on neurobehavioural development. *Journal of Neuroendocrinology, 15*(12), 1185-1192.

Rosenthal, R. (1991). Meta-analysis: A review. *Psychosomatic Medicine, 53*(3), 247-271.

Rubia, K., Overmeyer, S., Taylor, E., Brammer, M., Williams, S.C.R., Simmons, A., et al. (2000). Functional frontalisation with age: mapping neurodevelopmental trajectories with fMRI. *Neuroscience and Biobehavioral Reviews, 24*(1), 13-19.

Rutter, M. (1997). Antisocial behavior: Developmental psychopathology perspectives. In D. M. Stoff, J. Breiling & J. D. Maser (Eds.), *Handbook of antisocial behavior.* (pp. 115-124). New York, NY: Wiley.

Rutter, M. (2005). Commentary: What is the meaning and utility of the psychopathy concept? *Journal of Abnormal Child Psychology, 33*(4), 499-503.

Salekin, R.T. (2002). Psychopathy and therapeutic pessimism: Clinical lore or clinical reality? *Clinical Psychology Review, 22*(1), 79-112.

Salmelainen, P. (1995). The correlates of offending frequency: A study of juvenile theft offenders in detention. *NSW Bureau of crime statistics and research Crime and Justice Bulletin.*

Sanders, B., & Soares, M.P. (1986). Sexual Maturation and spatial ability in college students. *Developmental Psychology, 22*(2), 199-203.

Seagrave, D., & Grisso, T. (2002). Adolescent development and the measurement of juvenile psychopathy. *Law and Human Behavior, 26*(2), 219-239.

Seguin, J.R., & Zelazo, P.D. (2005). Executive Function in Early Physical Aggression. In R. E. Tremblay, W. W. Hartup & J. Archer (Eds.), *Developmental origins of aggression* (pp. pp. 307-329). New York: Guilford Press.

Shallice, T. (1988). *From neuropsychology to mental structure.* New York:, NY: Cambridge University Press.

Shallice, T., & Burgess, P.W. (1991). Deficits in strategy application following frontal-lobe damage in man. *Brain, 114*, 727-741.

Sholl, S.A., & Kim, K.L. (1989). Estrogen receptors in the rhesus monkey brain during fetal development. *Brain Research: Devopmental Brain Research, 50*(2), 189–196.

Silbereisen, R.K., & Kracke, B.r. (1997). Self-reported maturational timing and adaptation in adolescence. In J. Schulenberg, J. L. Maggs & K. Hurrelmann (Eds.), *Health risks and developmental transitions during adolescence* (pp. 85-109). New York, NY: Cambridge University Press.

Simmons, R.G., & Blyth, D.A. (1987). *Moving into adolescence: The impact of pubertal change and school context.* New York: Aldine.

Skeem, J.L., & Cauffman, E. (2003). Views of the downward extension: Comparing the youth version of the psychopathy checklist with the youth psychopathic traits inventory. *Behavioral Sciences & the Law, 21*(6), 737-770.

Skrzypiec, G., & Wundersitz, J. (2005). *Young People Born 1984 Extent of Involvement with the Juvenile Justice System*. Office of Crime Statistics and Research, Adelaide.

Smart, D., Vassallo, S., Sanson, A., & Dussuyer, I. (2004). Patterns of antisocial behaviour from early to late adolescence. *Trends and Issues in Crime and Criminal Justice: Australian Institute of Criminology, 290.*

Sobel, M.E. (1982). Asymptotic intervals for indirect effects in structural equations models. In S. Leinhart (Ed.), *Sociological methodology* (pp. 290-312). San Francisco, CA: Jossey-Bass.

Sonis, W.A., Comite, F., Blue, J., Pescovitz, O.H., Rahn, C.W., Hench, K.D., et al. (1985). Behavior problems and social competence in girls with true precocious puberty. *Journal of Pediatrics, 106*(1), 156-160.

Sowell, E.R., Peterson, B.S., Thompson, P.M., Welcome, S.E., Henkenius, A.L., & Toga, A.W. (2003). Mapping cortical change across the life span. *Nature Neuroscience, 6*, 309–315.

Sowell, E.R., Thompson, P.M., Tessner, K.D., & Toga, A.W. (2001). Mapping continued brain growth and gray matter density reduction in dorsal frontal cortex: Inverse relationships during postadolescent brain maturation. *Journal of Neuroscience, 21*, 8819–8829.

Sowell, E.R., Trauner, D.A., Gamst, A., & Jernigan, T.L. (2002). Development of cortical and subcortical brain structures in childhood and adolescence: a structural MRI study. *Developmental Medicine and Child Neurology, 44*(1), 4-16.

Spain, S.E., Douglas, K.S., Poythress, N.G., & Epstein, M. (2004). The relationship between psychopathic features, violence and treatment outcome: The comparison of three youth measures of psychopathic features. *Behavioral Sciences & the Law, 22*(1), 85-102.

Spear, L.P. (2000a). The adolescent brain and age-related behavioral manifestations. *Neuroscience and Biobehavioral Reviews, 24*(4), 417-463.

Spear, L.P. (2000b). Neurobehavioral changes in adolescence. *Current Directions in Psychological Science, 9*(4), 111-114.

Speltz, M.L., DeKlyen, M., Calderon, R., Greenberg, M.T., & Fisher, P.A. (1999). Neuropsychological characteristics and test behaviors of boys with early onset conduct problems. *Journal of Abnormal Psychology, 108*(2), 315-325.

Stattin, H., & Magnusson, D. (1990). *Pubertal maturation in female dvelopment.* Hillsdale, NJ: Erlbaum.

Stevens, D., Charman, T., & Blair, R.J.R. (2001). Recognition of emotion in facial expressions and vocal tones in children with psychopathic tendencies. *Journal of Genetic Psychology, 162*(2), 201-211.

Stieben, J., Lewis, M.D., Granic, I., Zelazo, P.D., Segalowitz, S., & Pepler, D. (2007). Neurophysiological mechanisms of emotion regulation for subtypes of externalizing children. *Development and Psychopathology, 19*(2), 455-480.

Storvoll, E.E., & Wichstrom, L. (2002). Do the risk factors associated with conduct problems in adolescents vary according to gender? *Journal of Adolescence, 25*(2), 183-202.

Stroop, J.R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology, 18*, 643-662.

Stuss, D.T., & Gow, C.A. (1992). "Frontal dysfunction" after traumatic brain injury. . *Neuropsychology, and Behavioral Neurology, 5*, 272–282.

Susman, E.J., Inoffgermain, G., Nottelmann, E.D., Loriaux, D.L., Cutler, G.B., & Chrousos, G.P. (1987). Hormones, emotional dispositions, and aggressive attributes in young adolescents. *Child Development, 58*(4), 1114-1134.

Tabachnick, B.G., & Fidell, L.S. (2001). *Using multivariate statistics* (4th ed.). Boston: Allyn & Bacon.

Tamm, L., Menon, V., & Reiss, A.L. (2002). Maturation of brain function associated with response inhibition. *Journal of the American Academy of Child and Adolescent Psychiatry, 41*(10), 1231-1238.

Tanner, J.M. (1962). Growth at adolescence. (2nd ed.). Springfield, Ill.: Thomas

Tarling, R. (1993). *Analysing Offending, Data, Models and Interpretations*. British Home Office, London.

Taylor, S.J.C., Whincup, P.H., Hindmarsh, P.C., Lampe, F., Odoki, K., & Cook, D.G. (2001). Performance of a new pubertal self-assessment questionnaire: a preliminary study. *Paediatric and Perinatal Epidemiology, 15*(1), 88-94.

Teuber, H.L. (1972). Unity and diversity of frontal lobe functions. *Acta Neurobiologiae Experimentalis, 32*, 615–656.

Trevethan, S.D., & Walker, L.J. (1989). Hypothetical versus real-life moral reasoning among psychopathic and delinquent youth. *Development and Psychopathology, 1*(2), 91-103.

Troyer, A.K., & Moscovitch, M. (1996). Clustering and switching on verbal fluency tests: Evidence from healthy controls and patients with Alzheimer's and Parkinson's Disease. *Journal of the International Neuropsychological Society, 2*, 11.

Udry, J.R., & Talbert, L.M. (1988). Sex hormone effects on personality at puberty. *Journal of Personality and Social Psychology, 54*(2), 291-295.

Vignaendra, S., & Fitzgerald, J. (2006). Reoffending among young people cautioned by police or who participated in a youth justice conference. *NSW Bureau of crime statistics and research Crime and Justice Bulletin*(103).

Vincent, G.M., Vitacco, M.J., Grisso, T., & Corrado, R.R. (2003). Subtypes of adolescent offenders: Affective traits and antisocial behavior patterns. *Behavioral Sciences & the Law, 21*(6), 695-712.

Vitacco, M.J., Rogers, R., & Neumann, C.S. (2003). The Antisocial Process Screening Device: An examination of its construct and criterion related validity. *Assessment, 10*, 143–150.

Walker, E.F. (2002). Adolescent neurodevelopment and psychopathology. *Current Directions in Psychological Science, 11*(1), 24-28.

Wechsler, D. (1997). The Manual for the Wechsler Adult Intelligence Scale (3rd ed.). San Antonio, TX: The Psychological Corporation.

Wechsler, D. (2003). Wechsler Intelligence Scale for Children — Fourth Edition. . San Antonio, TX: The Psychological Corporation.

Weyandt, L.L., & Willis, W.G. (1994). Executive functions in school-aged children: Potential efficacy of tasks in discriminating clinical groups. *Developmental Neuropsychology, 10*(1), 27-38.

Wichstrom, L. (2001). The impact of pubertal timing on adolescents' alcohol use. *Journal of Research on Adolescence, 11*(2), 131-150.

Williams, B.R., Ponesse, J.S., Schachar, R.J., Logan, G.D., & Tannock, R. (1999). Development of inhibitory control across the life span. *Developmental Psychology, 35*(1), 205-213.

Williams, J.M., & Dunlop, L.C. (1999). Pubertal timing and self-reported delinquency among male adolescents. *Journal of Adolescence, 22*(1), 157-171.

Winterdyk, J.A. (2000). *Issues and Perspectives on Young Offenders in Canada*. Toronto, ON: Harcourt Canada.

Wolfgang, M.E., Figlio, R.M., & Sellin, T. (1972). *Delinqency In a Birth Cohort.* Chicago: University of Chicago Press.

Woo, T.U., Pucak, M.L., Kye, C.H., Matus, C.V., & Lewis, D.A. (1997). Peripubertal refinement of the intrinsic and associational circuitry in monkey prefrontal cortex. *Neuroscience, 80*, 1149–1158.

Youngstrom, E., Loeber, R., & Stouthamer-Loeber, M. (2000). Patterns and correlates of agreement between parent, teacher, and male adolescent ratings of externalizing and internalizing problems. *Journal of Consulting and Clinical Psychology, 68*(6), 1038-1050.

Zecevic, N., & Rakic, P. (2001). Development of layer 1 neurons in the primate cerebral cortex. *Journal of*
Neuroscience, 21, 5607–5619.

Zelazo, P.D., Carter, A., Reznick, J.S., & Frye, D. (1997). Early development of executive function: A problem-solving framework. *Review of General Psychology, 1*(2), 198-226.

Zuckerman, M., Eyesenck, S., & Eyesenck, H. (1978). Sensation seeking in England and America: Cross-cultural, age, and sex comparisons. *Journal of Consulting and Clinical Psychology, 46*, 139-149.

Appendices

APPENDIX 3.1

(A) Please answer the following questions for ALL three stages of development:

Compared to others, I would describe myself as being.....	Before pubertal development		After pubertal development		As an Adult	
1. anxious	More than others	Less than others	More than others	Less than others	More than others	Less than others
2. confident	More than others	Less than others	More than others	Less than others	More than others	Less than others
3. shy	More than others	Less than others	More than others	Less than others	More than others	Less than others
4. depressed	More than others	Less than others	More than others	Less than others	More than others	Less than others
5. impatient	More than others	Less than others	More than others	Less than others	More than others	Less than others
6. aggressive	More than others	Less than others	More than others	Less than others	More than others	Less than others
7. impulsive	More than others	Less than others	More than others	Less than others	More than others	Less than others
8. causing trouble	More than others	Less than others	More than others	Less than others	More than others	Less than others

(B) How would you describe the financial sitation of your parents during your first 10 years of life?

0	1	2	3	4	5	6
very poor	poor	poorer than avg	average	richer than avg	rich	very rich

(C) The following questions require you to recall events related to timing of your pubertal development.

Males and Females

	Age e.g. *12.5*	How sure are you that you have remembered correctly?				
When do you recall beginning puberty?		0%	25%	50%	75%	100%

Females Only How old were you when: Age: *How sure are you?*

you started menstruating (periods)?		0%	25%	50%	75%	100%
you first noticed breast development?		0%	25%	50%	75%	100%

Males Only How old were you when: Age: *How sure are you?*

your voice "broke" (i.e. sounded like		0%	25%	50%	75%	100%
you experienced your first		0%	25%	50%	75%	100%

How would you describe your pubertal timing in relation to your (same-age, same-sex) peers? *(please circle)*

1. Earlier than my peers
2. With my peers
3. Later than my peers

(D) Thinking back on your childhood, which of the following events occurred?

	If this happened more than once, please provide AGES for all occurrences					
My parents got divorced *(if YES, at*	YES	NO	Age:	Age:	Age:	Age:
I lived in a single-parent family	YES	NO	___ to ___	___ to ___	___ to ___	___ to ___
Step-father or significant male other	YES	NO	___ to ___	___ to ___	___ to ___	___ to ___

APPENDIX 3.2

INSTRUCTIONS

Please circle the number that best describes you or how you feel for each question. Zero means it doesn't describe you at all, 1 means it sometimes or somewhat applies to you, 2 means it often applies to you, and 3 means it describes you very well or applies to you most of the time.

Please be as honest as possible.
Your name will not be on this form and no one will know how you answered.

	Doesn't apply at all	Sometimes or somewhat applies	Often applies	Applies most of the time or very well
1. I am bored with most things that I have to do	0	1	2	3
2. Most of my relationships last less than one year, and include a number of "one-night stands".	0	1	2	3
3. People tell me to talk about how I feel and to describe my feelings more.	0	1	2	3
4. I like to spend a lot of time talking about myself.	0	1	2	3
5. I like doing risky things or things I shouldn't do.	0	1	2	3
6. People are often telling me to act more responsibly.	0	1	2	3
7. I yell or get angry when someone tells me I did something wrong.	0	1	2	3
8. It doesn't matter to me if someone finds out that I told them a lie.	0	1	2	3
9. I can usually get other people to give me what I want.	0	1	2	3
10. I really care about doing chores and returning things I have borrowed	0	1	2	3
11. I don't feel really bothered (or guilty) if I do something wrong.	0	1	2	3
12. I think I am better than most people.	0	1	2	3
13. I am able to describe my feelings easily and like to talk about how I feel.	0	1	2	3
14. I do what I feel like doing in the moment, rather than spend much time thinking about it.	0	1	2	3
15. I don't really worry about hurting other people's feelings.	0	1	2	3
16. My romantic relationships can be described as volatile; my partners are often angry at me.	0	1	2	3
17. I like to maintain more than one romantic/sexual relationship at one time.	0	1	2	3

Please turn over the page to complete this survey

Please circle the number that best describes you or how you feel for each question. Zero means it doesn't describe you at all, 1 means it sometimes or somewhat applies to you, 2 means it often applies to you, and 3 means it describes you very well or applies to you most of the time.

Please be as honest as possible.
Your name will not be on this form and no one will know how you answered.

	Doesn't apply at all	Sometimes or somewhat applies	Often applies	Applies most of the time or very well
18. If I want something from someone, I keep asking for it even if they say they can't or won't give it to me.	0	1	2	3
20. I am not very good at fooling others or telling lies.	0	1	2	3
21. I guess people are bothered by some of the things I do, but I can't worry about it, I've got problems of my own.	0	1	2	3
22. I spend my time in a hobby, sport, or some type of activity class (dance, web design, photography...)	0	1	2	3
23. Sometimes, even though I know it is not a good idea to do something, I can't stop myself from doing it.	0	1	2	3
24. What I want is more important that what other people want.	0	1	2	3
25. I do what I want to without worrying about if someone doesn't like it.	0	1	2	3
26. I live day to day and don't think about the future.	0	1	2	3
27. I am often late for school or don't do my homework.	0	1	2	3
28. I would say things about myself that are not true so other people would know how important I am.	0	1	2	3
29. I like talking people into giving me things or doing things that they really don't want to do.	0	1	2	3
30. I feel like I am always being blamed for things that are not my fault.	0	1	2	3
31. I usually let other people do what needs to be done.	0	1	2	3
32. If a relationship breaks up, I don't worry about the other person, I just get on with my life.	0	1	2	3

Thank You

APPENDIX 3.3

INSTRUCTIONS

For each question, answer whether you have ever done this by circling YES or NO. If you answer YES, please circle the age you were the *FIRST* and *LAST* time you did this.

For example, if the question asked "Have you.....Lied to a friend?"

If the FIRST time you lied to a friend was when you were 8 years old, and the last time you lied to a friend was when you were 26, you would answer:

Have you.......	Ever		Please circle the age you were the *FIRST* and *LAST* time you did this:																
1. Lied to a friend?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older

OR, If you have never lied to a friend, you would answer:

Have you.......	Ever		Please circle the age you were the *FIRST* and *LAST* time you did this:																
1. Lied to a friend?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older

These questions deal with your own behaviour. PLEASE be honest, NO ONE BUT THE RESEARCHER WILL SEE THIS FORM.

Have you.......	Ever		Please circle the age you were the *FIRST* and *LAST* time you did this:																
1. Driven an unregistered car?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
2. Driven a car or a motorbike on the road without a driver's license or a learner's permit?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
3. Driven a car or a bike when drunk or over the legal alcohol limit?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
4. Raced with other vehicles while driving a car or a motorbike on the road?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
5. Taken and driven a car or a motorbike that belonged to someone else without the owner's consent?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
6. Stolen things or parts out of a car or a motorbike?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older

7. Stolen a bicycle or parts from a bicycle?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
8. Shoplifted from supermarkets, department stores or shops?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
9. Stolen money of less than $10 (in one go) from shops, school, locker rooms, home, people's milk money, etc.?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
10. Stolen money of $10 or more in one go?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
11. Broken into a house or a building with the intention of stealing something, e.g., money, exam papers, or other things?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
12. Cheated or stolen food, drinks or other goods from dispenser machines, e.g., by tilting or banging the machines, or using the "wrong" coins?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
13. Purposely messed up other people's property, e.g., turning on water taps in people's gardens, letting off firecrackers in mail boxes, burning rubbish bins, etc?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
14. Purposely damaged property by starting a fire?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
15. Purposely damaged things in public places, e.g. telephone boxes, street signs, road lamps, etc?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
16. Purposely damaged school desks, windows, or other school property, e.g., kicking holes in the wall?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
17. Put graffiti on walls, toilet doors, bus panels, or other public places?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
18. Sold or bought stolen goods?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
19. Taken part in a fistfight in which a group of people was against another group?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older

20. Purposely hurt or beaten up someone?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
21. Used a weapon of some sort, e.g., knife, stick, chains, or bottle in a fight?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
22. Used or threatened to use force to get money or things from another person?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
23. Used marijuana (also called grass, dope, or hash)?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
24. Used LSD (also called acid)?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
25. Abused barbitrates (also called barbs) by not properly following medical advice?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
26. Forced someone to do sexual things with you when that person did not want to?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
27. Tricked someone on the telephone, e.g., false restaurant booking, giving false reports of fire alarms, bombs, etc.?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
28. Taken someone's wallet or purse?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
29. Been warned by the police (but without being charged) for something that you did?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
30. Appeared in Court for something that you did?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
31. Bashed someone who didn't do anything to you?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
32. Gone to school or work drunk or high?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
33. Intentionally hurt an animal?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
34. Been convicted of a crime?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older
35. Grown or sold marijuana or other drugs?	YES	NO	9 or younger	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 or older

APPENDIX 3.4

Verbal Fluency Tests

Semantic (Category 'fruits & vegetables')	Letter-Number Switching			
Time: 60 seconds	Time: 60 seconds			
1 ____	1	A	27	A
2 ____	2	B	28	B
3 ____	3	C	29	C
4 ____	4	D	30	D
5 ____	5	E	31	E
6 ____	6	F	32	F
7 ____	7	G	33	G
8 ____	8	H	34	H
9 ____	9	I	35	I
10 ____	10	J	36	J
11 ____	11	K	37	K
12 ____	12	L	38	L
13 ____	13	M	39	M
14 ____	14	N	40	N
15 ____	15	O	41	O
16 ____	16	P	42	P
17 ____	17	Q	43	Q
18 ____	18	R	44	R
19 ____	19	S	45	S
20 ____	20	T	46	T
21 ____	21	U	47	U
22 ____	22	V	48	V
23 ____	23	W	49	W
24 ____	24	X	50	X
25 ____	25	Y	51	Y
26 ____	26	Z	52	Z
	Last number/letter spoken ____			
Total correct ____	Number correct ____			
Total incorrect ____	Number incorrect ____			
Total (correct - incorrect) ____	Total (correct - incorrect) ____			

APPENDIX 3.5

File No 315

THE UNIVERSITY OF NEW SOUTH WALES

PARTICIPANT INFORMATION STATEMENT AND CONSENT FORM

Behavioural Patterns and Cognitive Processes

Participant selection and purpose of study:

You are invited to participate in a study of *Behavioural Patterns and Cognitive Processes*. We, as researchers of the University of New South Wales, hope to learn whether early pubertal development is associated with antisocial behaviour and/or cognitive processes.

Description of study:

If you decide to participate, we will ask you to complete some brief questionnaires measuring behaviour patterns and some verbal and nonverbal cognitive tests. The cognitive tests you will be asked to complete are short, simple tasks such as tracing mazes, and memory and vocabulary tests. In one test, you will be asked to say some words that will be tape recorded for a couple of minutes.
The total amount of time needed for your participation in this study is approximately 1 hour.
We cannot and do not guarantee or promise that you will receive any benefits from this study.

Confidentiality and disclosure of information:

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or except as required by law. If you give us your permission by signing this document, we plan to publish the results in an international psychological journal. In any publication, information will be provided in such a way that you cannot be identified; only group results will be produced, not individual responses. If you have any additional questions later, please contact the experiment, Suzanne Czech at the School of Psychology (Room 1115A), University of New South Wales on 9385-1380, or Dr. Richard Kemp, School of Psychology (Room 441), University of New South Wales on 9385-1401.

Complaints may be directed to the Ethics Secretariat, The University of New South Wales, SYDNEY 2052 AUSTRALIA (phone 9385 4234, fax 9385 6648, email ethics.sec@unsw.edu.au).

Your consent:

Your decision whether or not to participate will not prejudice your future relations with The University of New South Wales, or the School of Psychology. If you decide to participate, you are free to withdraw your consent and to discontinue participation at any time without prejudice.

You will be given a copy of this form to keep.

THE UNIVERSITY OF NEW SOUTH WALES

PARTICIPANT INFORMATION STATEMENT AND CONSENT FORM (continued)

Behavioural Patterns and Cognitive Processes

You are making a decision whether or not to participate. Your signature indicates that, having read the information provided above, you have decided to participate.

....	....
Signature of Research Participant	Signature of Witness
....	....
(Please PRINT name)	(Please PRINT name)
....	....
Date	Nature of Witness

....
Signature(s) of Investigator(s)

....
Please PRINT Name

REVOCATION OF CONSENT

Behavioural Patterns and Cognitive Processes

I hereby **WITHDRAW** my consent to participate in the research proposal described above and direct that any data collected from me be destroyed.

I understand that such withdrawal **WILL NOT** jeopardise any treatment or my relationship with The University of New South Wales.

....	....
Signature	Date

....
Please PRINT Name

The section for Revocation of Consent should be forwarded to Suzanne Czech, Room 1115A, Matthews Building.

APPENDIX 3.6

THE UNIVERSITY OF NEW SOUTH WALES

DEBRIEFING

Behavioural Patterns and Cognitive Processes

The aim of this study is to investigate whether there is a relationship between *early* **pubertal development** and **antisocial behaviour** and **antisocial attitudes**, and whether there is a relationship between early pubertal development and **executive functioning**, (i.e. *working memory, inhibition, attention and switching*). Most of the cognitive tests you did were tests of executive functioning. The Letter-Number Sequencing test (put the numbers in order first and then the letters in alphabetical order) is a test of working memory. The Stroop test (say the colour of the ink not read the colour word) is a measure of inhibition (inhibit reading the word). The Trail Making Test and the Verbal Fluency/Switching tests measure attention and switching.

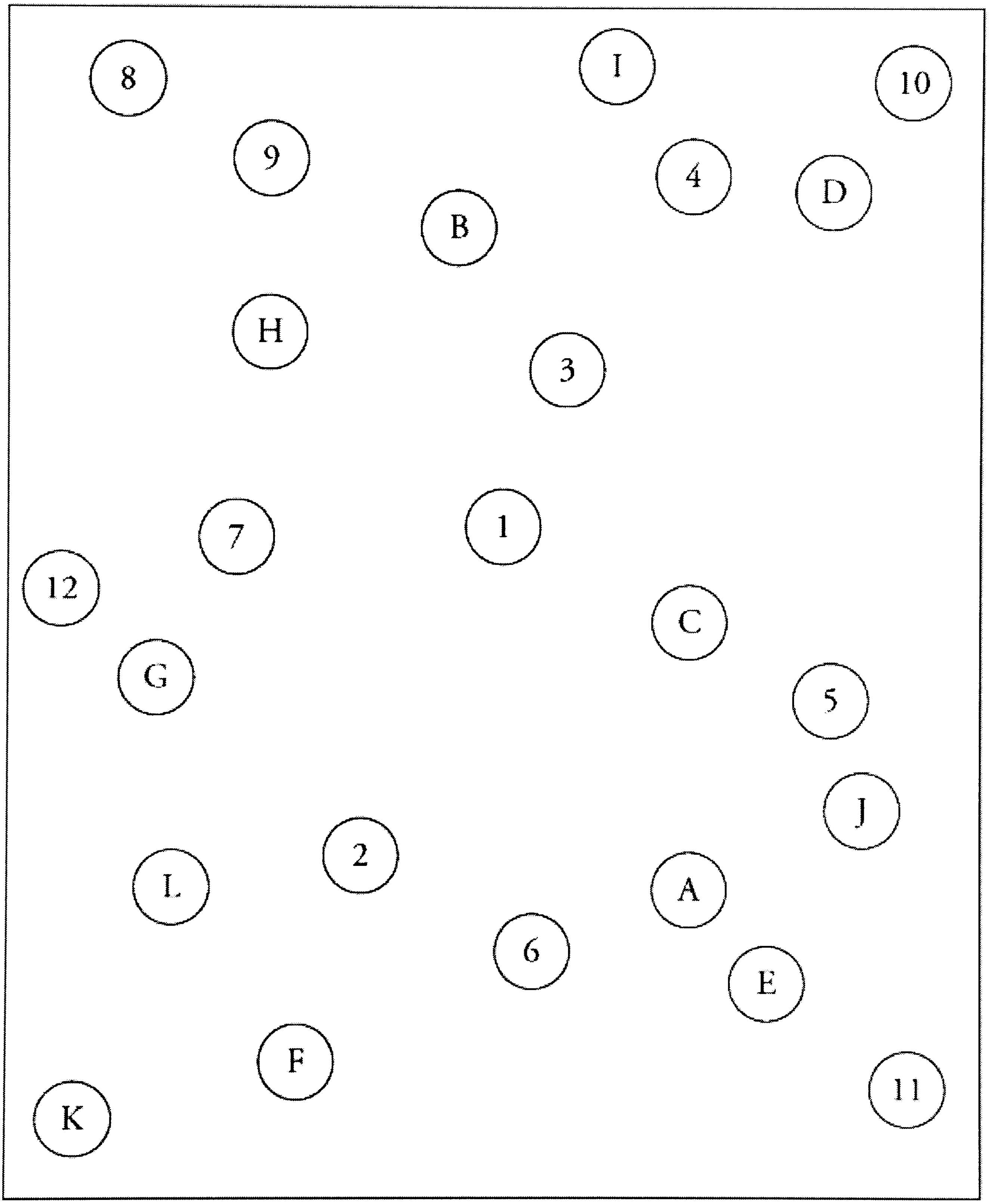
There are many other explanations for why some people participate in more antisocial behaviour than others. I needed to control for these **confounding variables** by asking you some other questions about your childhood that are *typical things that are often associated with higher rates of adolescent antisocial behaviour participation.*

The information you have provided will be combined with responses from other participants to determine whether **pubertal development timing** *(early, on-time, or late)* is associated with **adolescent antisocial participation** (*how many and how early*) and **current executive functioning and antisocial attitudes.** It is predicted that individuals who matured early will report higher levels of participation in antisocial behaviour, and earlier participation, and will score lower on executive functioning tasks than those individuals who matured later or on-time.

Thank you for your participation in this research. All of your responses will remain anonymous, as no individual responses will be reported, only group averages. In addition, to ensure confidentiality, no personal identifying information will be attached to your completed responses. If you have any questions or concerns regarding this study, please contact the investigators at the University of New South Wales, Suzanne Czech on 9385-3021, or Richard Kemp on 9385-1401. If you are interested in obtaining information regarding the results of this study please send your request by e-mail to sczech@psy.unsw.edu.au after completion of this study (June 30, 2005).

APPENDIX 4.1

Trail Making Test – Part B



APPENDIX 4.2

Verbal Fluency Tests

Semantic - Phonemic Category 'animals' and Letter 's'	Phonemic Letter 't'
Time: 60 seconds	Time: 60 seconds
1 ______	1 ______
2 ______	2 ______
3 ______	3 ______
4 ______	4 ______
5 ______	5 ______
6 ______	6 ______
7 ______	7 ______
8 ______	8 ______
9 ______	9 ______
10 ______	10 ______
11 ______	11 ______
12 ______	12 ______
13 ______	13 ______
14 ______	14 ______
15 ______	15 ______
16 ______	16 ______
17 ______	17 ______
18 ______	18 ______
19 ______	19 ______
20 ______	20 ______
21 ______	21 ______
22 ______	22 ______
23 ______	23 ______
24 ______	24 ______
25 ______	25 ______
26 ______	26 ______
Total correct ____	Number correct ____
Total incorrect ____	Number incorrect ____
Total (correct - incorrect) ____	Total (correct - incorrect) ____

PUBERTAL DEVELOPMENT MEASURE - BOYS

There is no exact age when everyone experiences puberty. This differs from person to person.
Girls can expect puberty between the ages of 8 and 17. Boys can expect puberty between the ages of 10 and 18.

APPENDIX 4.3a

Growth Spurt

A) How tall are you? __________ cm

B) If you had to choose a time that you noticed you had grown a lot taller in only a few months, how old were you at that time?
_____ Years _____ Months

C) How sure are you that this "growth spurt" occurred?
_____ 0% _____ 25% _____ 50% _____ 75% _____ 100%

D) How sure are you that you have remembered the timing correctly?
_____ 0% _____ 25% _____ 50% _____ 75% _____ 100%

Please put a tick in the box that best describes what stage you are at now

Skin Changes

A) Many people get acne or pimples during puberty.
Have you noticed any changes in your skin complexion?

- ☐ 1. No, I have not had any pimples
- ☐ 2. Yes, but I have had only the odd pimple on my face
- ☐ 3. Yes, I have pimples on my face daily
- ☐ 4. Yes, I have had pimples, but it is clearing up
- ☐ 5. Yes, but I have not had any pimples for a few weeks

B) What age were you when you first noticed pimples appearing
________ years old

C) Are you taking any mediction for acne or "problem skin"
________ Yes ________ No

PUBERTAL DEVELOPMENT MEASURE - BOYS

There is no exact age when everyone experiences puberty. This differs from person to person.
Girls can expect puberty between the ages of 8 and 17. Boys can expect puberty between the ages of 10 and 18.

Please put a tick in the box that best describes what stage you are at now

Voice Change

Is your voice lower or deeper now than it was when you were 8 years old?

	1. No, I have not noticed any big changes, it **sounds about the same**
	2. Yes, I have noticed some change, but my voice is **only starting to change**
	3. Yes, my voice has changed and it is **somewhat lower** than it used to be
	4. Yes, my voice sounds a **lot lower** than it used to; it is **almost as low as an adult man's voice**
	5. Yes, my voice sounds a **lot lower** than it used to; it is **as low as an adult man's voice**

Ejaculation

A) Have you ever had an ejaculation (includes masturbation and "wet dreams") ________ Yes ________ No

B) What age were you when you recall your first ejaculation? ________ Years ________ Months

C) How sure are you that you have remembered this date correctly?

_____ 0% _____ 25% _____ 50% _____ 75% _____ 100%

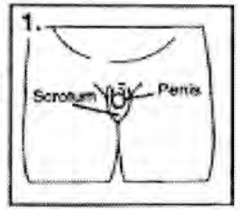
D) Please give a second guess of old you were
if you are not at least 75% sure of the start date ________ Years ________ Months

PUBERTAL DEVELOPMENT MEASURE – BOYS

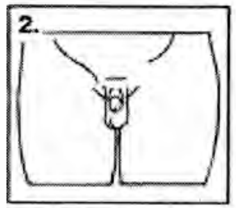
There is no exact age when eveyrone experiences puberty. This differs from person to person.
Girls can expect puberty between the ages of 8 and 17. Boys can expect puberty between the ages of 10 and 18.

Study Subject No:

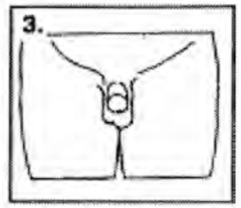
- Please look at the **Penis** and **Scrotum** only in these pictures.
- Please put a tick in the box that looks most like you now.



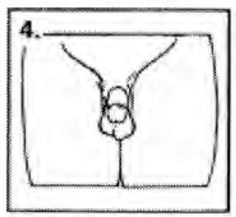
Scrotum and Penis same size as when you were younger.



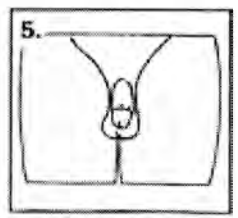
The Scrotum has lowered a bit and the Penis is a little larger.



The Penis is longer the Scrotum is larger.

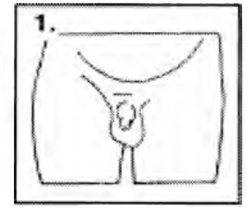


The Penis is longer and wider the Scrotum is darker and bigger than before

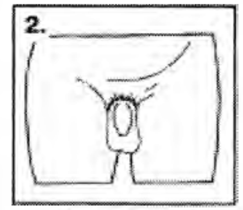


The Penis and Scrotum are the size and shape of an adult.

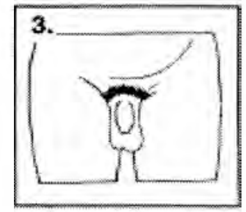
- Please look at the **Pubic Hair** only in these pictures.
- Please put a tick in the box that looks most like you now.



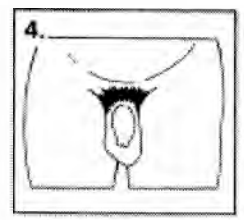
No hairs



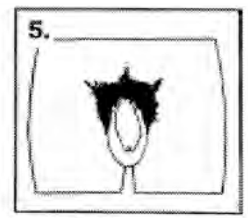
Very little hair



Quite a lot of hair



The hair has not spread over the thighs



The hair has spread over the thighs

Taylor, , Whincup, , Hindmarsh, , Lampe, , Odoki, & Cook,
Performance of a new pubertal self-assessment questionnaire: a preliminary study.
Paediatric & Perinatal Epidemiology **15** (1), 88-94.

PUBERTAL DEVELOPMENT MEASURE - GIRLS

There is no exact age when everyone experiences puberty. This differs from person to person.
Girls can expect puberty between the ages of 8 and 17. Boys can expect puberty between the ages of 10 and 18.

APPENDIX 4.3b

Growth Spurt

A) How tall are you? __________ cm

B) If you had to choose a time that you noticed you had grown a lot taller in only a few months, how old were you at that time?
_____ Years _____ Months

C) How sure are you that this "growth spurt" occurred?
_____ 0% _____ 25% _____ 50% _____ 75% _____ 100%

D) How sure are you that you have remembered the timing correctly?
_____ 0% _____ 25% _____ 50% _____ 75% _____ 100%

Please put a tick in the box that best describes what stage you are at now

Skin Changes

A) Many people get acne or pimples during puberty.
Have you noticed any changes in your skin complexion?

- ☐ 1. No, I have not had any pimples
- ☐ 2. Yes, but I have had only the odd pimple on my face
- ☐ 3. Yes, I have pimples on my face daily
- ☐ 4. Yes, I have had pimples, but it is clearing up
- ☐ 5. Yes, but I have not had any pimples for a few weeks

B) What age were you when you first noticed pimples appearing
years old

C) Are you taking any mediction for acne or "problem skin"
________ Yes ________ No

PUBERTAL DEVELOPMENT MEASURE - GIRLS

There is no exact age when everyone experiences puberty. This differs from person to person.
Girls can expect puberty between the ages of 8 and 17. Boys can expect puberty between the ages of 10 and 18.

Menstruation

A) Have you started menstruating (your period)? ______Yes ______No

B) How old were you when you started menstruating? ______Years ______Months

C) How sure are you that you have remembered the start date correctly?
______0% ______25% ______50% ______75% ______100%

D) Please give a second guess of old you were when you started
if you are not at least 75% sure of the start date ______Years ______Months

---

Hair Growth

Another normal part of puberty is called "secondary hair growth". Have you noticed hair growth in your underarms or pubic area?

Please put a tick in the box that best describes what stage you are at now

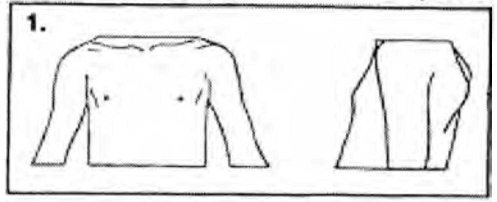
	1. No, I have not noticed any hair growth
	2. Yes, I have noticed some hair growth, but it has barely begun
	3. Yes, I noticed hair growth a short while ago (3 - 6 months)
	4. Yes, I noticed hair growth some time ago (6 - 12 months)
	5. Yes, secondary hair growth started over a year ago

PUBERTAL DEVELOPMENT MEASURE – GIRLS

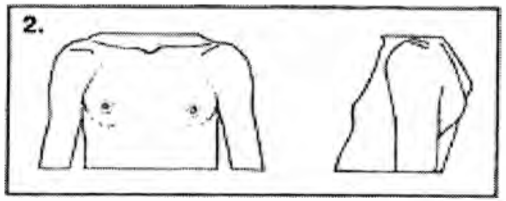
There is no exact age when eveyrone experiences puberty. This differs from person to person.
Girls can expect puberty between the ages of 8 and 17. Boys can expect puberty between the ages of 10 and 18.

Study Subject No:

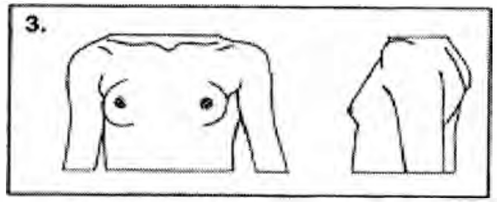
- Please put a tick in the box that looks most like you now....



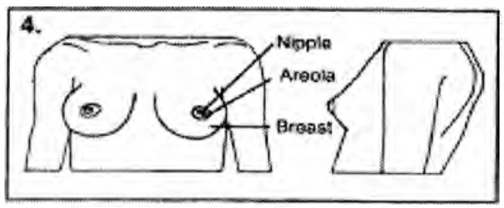
The breasts are flat.



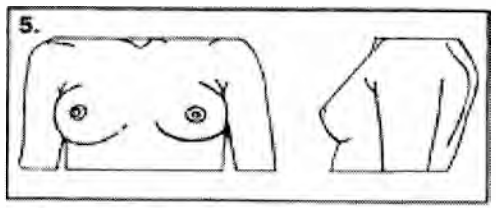
The breasts form small mounds.



The breasts form larger mounds than in 2.



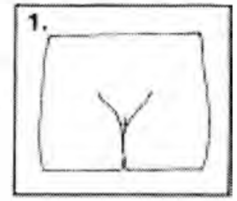
The nipple and the surrounding part *(the Areola)* make up a mound that sticks up above the breast.

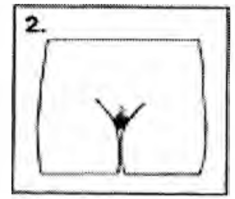


Only the nipple sticks out beyond the breast.

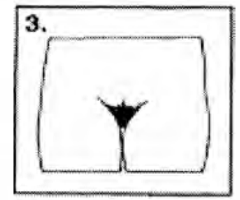
- Please put a tick in the box that looks most like you now....

No hairs

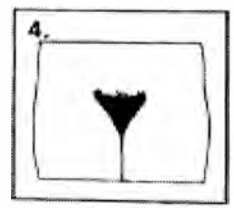




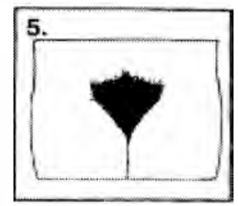
Very little hair



Quite a lot of hair



The hair has not spread over the thighs



The hair has spread over the thighs

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APPENDIX 4.4a

INSTRUCTIONS

For each question, answer whether you have ever done this by circling YES or NO, and then whether you have done this in the past 12 months by circling YES or NO. If you answer YES, please circle the age you were the FIRST time you did this.

For example, if the question asked "Have you……Lied to a friend?"

If you have lied to a friend when you were 8 years old, but not in the last 12 months you would answer:

Have you…….	Ever		In last 12 months		Age you were the first time you did this:										
1. Lied to a friend?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older

OR, If you have lied to a friend when you were 9 years old, and you lied to a friend 5 months ago you would answer:

Have you…….	Ever		In last 12 months		Age you were the first time you did this:										
1. Lied to a friend?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older

OR, If you have never lied to a friend, you would answer:

Have you…….	Ever		In last 12 months		Age you were the first time you did this:										
1. Lied to a friend?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older

These questions deal with your own behaviour. PLEASE be honest, NO ONE BUT THE RESEARCHER WILL SEE THIS FORM.

Have you.......	Ever		In last 12 months		Age you were the first time you did this:										
1. Driven an unregistered car?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
2. Driven a car or a motorbike on the road without a driver's license or a learner's permit?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
3. Driven a car or a bike when drunk or over the legal alcohol limit?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
4. Raced with other vehicles while driving a car or a motorbike on the road?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
5. Taken and driven a car or a motorbike that belonged to someone else without the owner's consent?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
6. Stolen things or parts out of a car or a motorbike?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
7. Stolen a bicycle or parts from a bicycle?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
8. Gone to see a film in a cinema without being of recommended viewing age?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
9. Failed to keep a promise?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
10. Bought beer, wine, spirits or other kinds of liquor?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
11. Drunk alcohol in a public place, e.g. a disco, pub, hotel, bar or club?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
12. Got onto a bus or into a cinema, swimming pool, disco, etc., without paying the proper fee?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older

Have you.......	Ever		In last 12 months		Age you were the first time you did this:										
13. Not attended classes or jigged school?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
14. Run away from home (at least overnight?)	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
15. Shoplifted from supermarkets, department stores or shops?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
16. Stolen money of less than $10 (in one go) from shops, school, locker rooms, home, people's lunch money, etc.?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
17. Stolen money of $10 or more in one go?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
18. Been late for school, a meeting, an appointment, etc.?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
19. Broken into a house or a building with the intention of stealing something, e.g., money, exam papers, or other things?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
20. Cheated or stolen food, drinks or other goods from dispenser machines, e.g., by tilting or banging the machines, or using the "wrong" coins?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
21. Cheated or scammed free games from coin-operated game machines (not including reward of good performance by machines in the form of bonus games)?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
22. Purposely messed up other people's property, e.g., turning on water taps in people's gardens, letting off firecrackers in mail boxes, burning rubbish bins, etc?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
23. Purposely damaged property by starting a fire?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older

Have you.......	Ever		In last 12 months		Age you were the first time you did this:										
24. Purposely damaged things in public places, e.g. telephone boxes, street signs, road lamps, etc?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
25. Purposely damaged school desks, windows, or other school property, e.g., kicking holes in the wall?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
26. Put graffiti on walls, toilet doors, bus panels, or other public places?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
27. Done something that your parents did not want you to do?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
28. Taken part in a fistfight in which a group of people was against another group?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
29. Purposely hurt or beaten up someone?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
30. Used a weapon of some sort, e.g., knife, stick, chains, or bottle in a fight?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
31. Used or threatened to use force to get money or things from another person?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
32. Used marijuana (also called grass, dope, or hash)?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
33. Used LSD (also called acid)?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
34. Abused barbitrates (also called barbs) by not properly following medical advice?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
35. Forced someone to do sexual things with you when that person did not want to?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older

Have you.......	Ever		In last 12 months		Age you were the first time you did this:										
36. Tricked someone on the telephone, e.g., false restaurant booking, giving false reports of fire alarms, bombs, etc.?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
37. Made abusive phone calls, e.g. saying nasty or obscence things?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
38. Been warned by the police (but without being charged) for something that you did?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
39. Appeared in the Children's Court for something that you did?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
40. Told a lie to someone?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
41. Been expelled from school?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
42. Sold or bought stolen goods?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
43. Asked people on the street, mall, etc. for money, food, etc.?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
44. Taken someone's wallet or purse?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
45. Threatened to hurt your parent or teacher?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
46. Hit your parent or teacher?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
47. Bashed someone who didn't do anything to you?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
48. Smoked cigarettes?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older

Have you.......	Ever		In last 12 months		Age you were the first time you did this:										
49. Gone to school drunk or high?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
50. Intentionally hurt an animal?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
51. Been convicted of a crime?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
52. Grown or sold marijuana or other drugs?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
53. Had sex with someone?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older
54. Had to live away from home (for misbehaving)?	YES	NO	YES	NO	8 or younger	9	10	11	12	13	14	15	16	17	18 or older

APPENDIX 4.4b

These questions deal with your own behaviour. PLEASE be honest, NO ONE BUT THE RESEARCHER WILL SEE THIS FORM.

For each question, answer whether you have ever done this by circling YES or NO.

Have you.......	Ever	
1. Stolen things or parts out of a car or a motorbike?	YES	NO
2. Stolen a bicycle or parts from a bicycle?	YES	NO
3. Gone to see an R film in a cinema?	YES	NO
4. Failed to keep a promise?	YES	NO
5. Got onto a bus or into a cinema, swimming pool, disco, etc. without paying the proper fee?	YES	NO
6. Not attended classes or jigged school?	YES	NO
7. Run away from home (at least overnight?)	YES	NO
8. Shoplifted from supermarkets, department stores or shops?	YES	NO
9. Stolen money of less than $10 (in one go) from shops, school, locker rooms, home, people's milk money, etc.?	YES	NO
10. Stolen money of $10 or more in one go?	YES	NO
11. Been late for school, a meeting, an appointment, etc.?	YES	NO
12. Cheated or stolen food, drinks or other goods from dispenser machines, e.g., by tilting or banging the machines, or using the "wrong" coins?	YES	NO
13. Cheated or scammed free games from coin-operated game machines (not including reward of good performance by machines in the form of bonus games)?	YES	NO
14. Purposely messed up other people's property, e.g., turning on water taps in people's gardens, letting off firecrackers in mail boxes, burning rubbish bins, etc?	YES	NO
15. Purposely damaged property by starting a fire?	YES	NO
16. Purposely damaged things in public places, e.g. telephone boxes, street signs, road lamps, etc?	YES	NO
17. Purposely damaged school desks, windows, or other school property, e.g., kicking holes in the wall?	YES	NO
18. Put graffiti on walls, toilet doors, bus panels, or other public places?	YES	NO
19. Done something that your parents did not want you to do?	YES	NO
20. Taken part in a fistfight in which a group of people was against another group?	YES	NO
21. Purposely hurt or beaten up someone?	YES	NO
22. Used a weapon of some sort, e.g., knife, stick, chains, or bottle in a fight?	YES	NO
23. Used or threatened to use force to get money or things from another person?	YES	NO
24. Used marijuana (also called grass, dope, or hash)?	YES	NO

These questions deal with your own behaviour. PLEASE be honest, NO ONE BUT THE RESEARCHER WILL SEE THIS FORM.

For each question, answer whether you have ever done this by circling YES or NO.

Have you.......	**Ever**	
25. Tricked someone on the telephone, e.g., false restaurant booking, giving false reports of fire alarms, bombs, etc.?	YES	NO
26. Made abusive phone calls, e.g. saying nasty or obscene things?	YES	NO
27. Been warned by the police (but without being charged) for something that you did?	YES	NO
28. Appeared in the Children's Court for something that you did?	YES	NO
29. Told a lie to someone?	YES	NO
30. Been expelled from school?	YES	NO
31. Sold or bought stolen goods?	YES	NO
32. Asked people on the street, mall, etc. for money, food, etc.?	YES	NO
33. Taken someone's wallet or purse?	YES	NO
34. Threatened to hurt your parent or teacher?	YES	NO
35. Hit your parent or teacher?	YES	NO
36. Bashed someone who didn't do anything to you?	YES	NO
37. Smoked cigarettes?	YES	NO
38. Intentionally hurt an animal?	YES	NO
39. Had sex with someone?	YES	NO
40. Had to live away from home (for misbehaving)?	YES	NO

APPENDIX 4.5

UNSW Approval No *04-3004*
SERAP Number: 04.129

Attention: Principal

[redacted]

Dear Principal:

The General Manager of Planning and Innovation with the Department of Education and Training has granted us permission to ask if your school would be prepared to assist with an important research project undertaken by the School of Psychology at The University of New South Wales (please see attached approval letter). We appreciate that, as school Principal, a primary objective is to avoid unnecessary disruption to your school curriculum and all students and teachers of the school. As we have expressed to the Department of Education, we are more than willing to accommodate our study to suit the schedule and wishes of your school and the teachers involved.

In brief, students in Years 7 through 12 would be asked to obtain parental consent to participate in a 1.25 interview session during school hours. If interview sessions held during school hours is not a feasible option for your school, we would appreciate the opportunity to discuss alternative options with you. For example, we could arrange with parents to conduct interviews after school hours, either in a room provided by the school or, at the University of New South Wales. We expect that the "show bag" incentive we are offering to students will attract a suitable number of students to complete the interview sessions consisting of three self-report surveys and "game-type" cognitive tests.

This study is concerned with examining the associations between adolescent development, cognitive functioning, and behaviour. As you will be aware, the prevalence of teenage antisocial behaviour is a major concern for the community and for those involved in the care and education of young people. It is speculated by some researchers that, during puberty, adolescents are struggling to cope with temporary impairment to their ability to deal with the cognitive demands of organizing their thought processes. It is possible that the lack of organization in thought impacts on their behaviour, in both their social interactions with others, as well as their academic development.

It is the aim of this study to identify whether there is an association between pubertal development and antisocial behaviour, and whether this is mediated by developmental changes in cognitive functioning. Therefore, we would ask students to complete some measures of cognitive functioning that measure their ability to attend to and remember information, and their ability to implement planning and organization skills. For example, students will be asked to trace mazes, put picture cards in order to tell a sensible story, remember and re-sequence numbers and letters, and name the colour of the ink a word is printed in, (rather than read the name of the word itself).

The results from Phase 1 of this research project are very promising. A large sample of first year university students (17 – 19 years) have participated in an identical study to the one proposed. The results have supported the existence of a relationship between pubertal onset and antisocial behaviour: participants provided retrospective reports of age in participation of typical adolescent rule-breaking behaviour that was significantly correlated with the time they recalled puberty onset. Participants were administered all cognitive functioning measures that are proposed for the current study. Thus, all measures have been tested for administration ease as well as statistically tested for construct validity measuring what we think we are measuring). However, the effect of cognitive functioning on antisocial behaviour was very small as only a small number of participants were "late developers".

Therefore, the success of this study depends largely on the availability of a large sample of children and adolescents that represent pre-pubertal, pubertal, and post-pubertal stages of development. To encourage youth to participate in this beneficial study we are collaborating with local organizations to offer an incentive to students in the form of a "show bag" containing vouchers for products actively sought by young people (see attached brochure to be sent home with Participant Information Statement and Consent Form). A number of these organizations have already expressed their willingness to support this study (e.g. [redacted] Cinemas, Randwick [redacted], Randwick [redacted]). The offer by these local organizations and the proximity of [redacted] High School to the University of New South Wales, emphasizes the value of [redacted] High School's participation in this study.

Although this study is of obvious benefit to all organizations working with children and to the larger community, we recognize that your involvement will mean some disruption to [redacted] High School's regular school curriculum. It is expected that the data collection period will take between one to two months to complete. If you are willing to participate, students in Years 7 through 12 will bring home information sheets and consent forms to their parents to participate in a 1.25-hour individual session in which students will complete surveys regarding behaviour and developmental status, and tests of vocabulary, memory and attention.

This research is being conducted as part of a university doctoral thesis (supervised by Dr. Richard Kemp), and has received ethics approval by the ethics committee of both UNSW and the Department of Education and Training. The results of this study are expected to advance our understanding of the relationship between pubertal development changes in adolescents and delinquent behaviour. In approaching [redacted] High School for partnership in this study, we recognize and appreciate your contribution and commitment to the community. We would very much appreciate the opportunity to meet with you to review the materials and protocol associated with the study and to answer any questions you may have. Thank you very much for your time and willingness to consider our request, and we look forward to hearing from you.

Sincerely,

Suzanne Czech
Doctoral Candidate - Forensic Psychology
School of Psychology, University of New South Wales
Sydney 2052
Ph: +61 (02) 9385 1380
email: sczech@psy.unsw.edu.au

Dr. Richard Kemp
School of Psychology, University of New South Wales
Sydney 2052
Ph: +61 (2) 9385 1401
Fax: +61 (2) 9385 3641
email: richard.kemp@unsw.edu.au

APPENDIX 4.6

Your child is invited to participate in an important research project entitled:

Developmental and Behavioural Patterns in Children and Adolescents

This project has been approved by the ethics committees of both the School of Psychology of the University of New South Wales, and the NSW Department of Education & Training.

About the Project

We are investigating how pubertal development affects the way children think and behave. Participation in this study involves completing some cognitive tasks (e.g. tracing mazes, reading names of colours written in different coloured ink), surveys about attitudes and behaviour, and a pubertal development survey; this will take approximately 1 hour. The school Principal has arranged for these interviews to be held in two 1/2-hour sessions during regular school hours. If your child would like to participate in this study with your approval, please read the attached information sheet together with your child, sign the consent form, and have your child return the forms to the school office. We would also greatly appreciate if you would complete the attached demographic information sheet and return this with the signed consent.

Community Support

Local retailers have expressed their interest in supporting this project and have kindly offered donations as a thank you gift to young people who participate in this project. If your child participates in this study, he or she will receive a gesture of our appreciation for their help with this project. If your child participates in this study, he or she will receive a Free new release voucher from Randwick [redacted] and a voucher from Randwick [redacted].

If you would like your child to participate in this study, please read the attached participant information sheet and sign the accompanying consent form. To help us describe general characteristics about participants, we would appreciate it if you also complete the attached short demographic information sheet. Please have your child return the signed consent form, and demographic information sheet to his teacher within next few days.

(Note: You do not need to complete the demographic sheet for your child to participate)

Thank You

APPENDIX 4.7

Approval No *04-3004*

THE UNIVERSITY OF NEW SOUTH WALES
PARTICIPANT INFORMATION STATEMENT

Developmental and Behavioural Patterns in Children and Adolescents

Why we are asking your child to help with this study:
Your child is invited to participate in a study being conducted by the University of New South Wales. We hope to learn whether people think and do different things when they are adolescents (teenagers), compared to when they are children or adults. We are asking your child to participate in this study because your child is between the ages of 9 to 18 years old. We expect to find out that people do more things that get them into trouble when they are adolescents than when they are children or adults because of the changes that happen during puberty.

What this study is about:
If you allow your child to participate in this study, we will ask your child to fill out three forms. Two of the forms will ask questions about whether your child has done certain types of things (e.g. "Have you ever jigged school?"), and what your child thinks about doing certain types of things (e.g. "I am bored with most things I have to do"). The other form has questions about the stage of physical development your child is at now. In order to answer these questions, your child will only need to know about some changes in his or her own body he or she may have noticed lately. For example, your child will be asked if they have noticed growing a lot taller lately. The game-type tasks your child will be asked to do are short, easy tasks such as tracing mazes and telling stories using pictures. Your child will fill out the forms and do all tasks individually (not as a group), which will take just over an hour (1.25 hours). This study is not about helping your child or teaching your child anything. However, your child might learn some things about him or herself that he or she didn't already know. The school counselor knows about all the forms and tasks in this study and your child can talk to the counselor if he or she has any questions about any of the forms or tasks in this study.

What happens to the information your child gives:
All information your child gives in this study will be kept confidential. Information will be disclosed only with your permission or except as required by law. No one will be allowed to see your child's completed forms, including parents and teachers. Your child's answers will also be kept anonymous; your child's name will not be on any of the forms, which means your child's answers cannot be identified. Your child's name will only be on this consent form, which will be kept in a separate file folder from the forms with your child's answers. When your child finishes each part of the study, he or she will put the forms into a secret ballot box, which will only be opened at the university. Any publications arising from this study will report only group results; individual responses cannot be identified.

If you have any questions, please contact the experimenter, Suzanne Czech, at the School of Psychology, University of New South Wales on 9385-1380, or Dr. Richard Kemp, School of Psychology, University of New South Wales on 9385-1401. Complaints may be directed to the Ethics Secretariat, The University of New South Wales, SYDNEY 2052 AUSTRALIA (phone 9385 4234, fax 9385 6648, email ethics.sec@unsw.edu.au).

Your consent:
Your decision whether or not to allow your child to participate in helping us with this study will not affect your relationship with the University of New South Wales, or your school. If your child decides to participate with your consent, your child will receive a small thank you gift for his or her time (see attached invitation sheet). If your child decides to participate in this study with your consent, you may withdraw your child, or your child may withdraw, at any time without jeopardizing your relationship with the school, or the University of New South Wales.

If your child would like to participate in this study, please have your child sign the attached form, and sign your consent.

THE UNIVERSITY OF NEW SOUTH WALES

PARENT CONSENT AND MINOR (CHILD) ASSENT FORM

Developmental and Behavioural Patterns in Children and Adolescents

Note to parent: Please read over the information statement (page 1) with your child. If your child would like to participate in this study, please have your child sign and print his or her name below.

If you give your consent for your child to participate in this study, please sign and complete the parent information below your child's assent.

Thank you.

CHILD (MINOR):
You are making a decision whether or not you would like to participate in helping with this study. By signing this form, you are agreeing that you would like to participate.

....

Signature of Minor (child) Participant (Please PRINT name)

PARENT (LEGAL GUARDIAN):
You are making a decision whether or not to allow your child to participate in this study. Your signature indicates that, having read the information provided above, you have decided to allow your child to participate.

....

Signature of Parent or Legal Guardian Nature of Relationship

....

(Please PRINT name) Date

INVESTIGATOR:

....

Signature of Experimenter

....

(Please PRINT name) Date

THE UNIVERSITY OF NEW SOUTH WALES

REVOCATION OF CONSENT

Developmental and Behavioural Patterns in Children and Adolescents

Please keep this form.

A copy of this form will also be available to your child at the time of the interview.

If at any time you or child decides you do not wish to participate in this study, please sign and date this form and give to the experimenter.

PARENT (LEGAL GUARDIAN):
I hereby wish to **WITHDRAW** my consent for my child to participate in the research study described above and understand that such withdrawal **WILL NOT** jeopardise any treatment or my relationship with The University of New South Wales, the NSW Department of Education, or the school.

....
Signature Date

....
Please PRINT Name

Please forward revocation of consent to:

Suzanne Czech
School of Psychology
The University of New South Wales
Sydney 2052

CHILD (MINOR):
I have decided I do not want to participate in helping with this study. I understand that I can withdraw (quit) from this study at any time without any consequences from my school, my parents, or the University of New South Wales.

....
Signature Date

THE UNIVERSITY OF NEW SOUTH WALES

DEBRIEFING

Developmental and Behavioural Patterns in Children and Adolescents

Thank you for participating in this research experiment. Your name will not be on any of the forms you completed, or on any of the answers you gave. The information you gave can only be identified by a number on the research forms, and will be entered into a computer file.

This means that we will not be looking at the information you gave us to find out information about you, but rather to find out some information about young people your age.

We are interested in finding out whether young people are more likely to feel like misbehaving during certain times of childhood or adolescence, and if this change in behaviour is because at certain ages young people find it harder to control their behaviour.

As we are still conducting this study at your child's school, we cannot reveal the full details of our hypotheses at this time. However, we will provide a more detailed debriefing for students to bring home to parents at the conclusion of this study at your child's school (approximately 30 June 2006).

If you have any questions about this research experiment, please contact the experimenters at the University of New South Wales, Suzanne Czech on 9385-3021, or Richard Kemp on 9385-1401. If you are interested in the results of this study, please e-mail sczech@psy.unsw.edu.au, and we will send you a summary of what we found as soon as one it is available.

APPENDIX 4.8

Approval No *04-3004* Identification No

THE UNIVERSITY OF NEW SOUTH WALES

Developmental and Behavioural Patterns in Children and Adolescents

DEMOGRAPHIC INFORMATION

All the information collected from your child for the purposes of this study will remain anonymous and confidential. However, we need to report some information about the average age, etc of the participants so that the results can be compared to results from other studies. All information will be recorded in such a way that you cannot be identified; only group results will be produced, not individual responses. **Your responses will remain completely confidential; no one other than the researcher will see this form, and this information will not be shared with anyone else.**

----------Please answer all of the questions------------

1. How old is your child/ward? __________years _________months
2. Is the child **male** or **female**? *(please circle)*
3. Has your child ever been diagnosed with *(please circle)*:
   a) autistim b) learning disability c) attention deficit (hyperactivity) disorder ?
4. Which of the following ethnic or cultural groups describes the child's background?
   a. Aboriginal/Torres Strait Islander
   b. Asian
   c. Arabic
   d. Australian of European origin
   e. Australian of other origin *(please specify)*____________________
   f. European/North American
   g. Other *(please specify)*__________________
5. How would you describe your household?
   a. Is child living with mother? *(please circle)*..YES NO
   b. Is child living with father? *(please circle)* ....YES NO
   c. Is child living with another adult other than mother or father? *(please circle)*... YES NO
      If YES, is other adult? *(please circle)*……………..MALE or FEMALE
6. What is your current occupation?

   Parent 1:_________________ **Parent 2:______________________**

THANK YOU: PLEASE CHECK THAT YOU HAVE ANSWERED ALL OF THE QUESTIONS

WHEN COMPLETE, PLEASE **PUT THIS SURVEY IN ENVELOPE PROVIDED AND SEAL** AND RETURN TO SCHOOL WITH YOUR CHILD

The information you have provided will not be shared with your child's school, or any other person or organisation!

APPENDIX 4.9

THE UNIVERSITY OF NEW SOUTH WALES

DEBRIEFING

Developmental and Behavioural Patterns in Children and Adolescents

Thank you for participating in this research experiment. Your name will not be on any of the forms you completed, or on any of the answers you gave. The information you gave can only be identified by a number on the research forms, and will be entered into a computer file.

This means that we will not be looking at the information you gave us to find out information about you, but rather to find out some information about young people your age.

We are interested in finding out whether young people are more likely to feel like misbehaving during certain times of childhood or adolescence, and if this change in behaviour is because at certain ages young people find it harder to control their behaviour.

As we are still conducting this study at your child's school, we cannot reveal the full details of our hypotheses at this time. However, we will provide a more detailed debriefing for students to bring home to parents at the conclusion of this study at your child's school (approximately 30 June 2006).

If you have any questions about this research experiment, please contact the experimenters at the University of New South Wales, Suzanne Czech on 9385-3021, or Richard Kemp on 9385-1401. If you are interested in the results of this study, please e-mail sczech@psy.unsw.edu.au, and we will send you a summary of what we found as soon as one it is available.

APPENDIX 4.10

Approval No *05-3011*

PARTICIPANT DEBRIEFING INFORMATION

Developmental and Behavioural Patterns in Children & Adolescents

It is widely accepted that 90% of adolescents who get into trouble during their teenage years, grow up to be law-abiding adults. What remains unknown is why adolescents take part in troublesome behaviour and adopt an "I don't care" attitude. This study is investigating whether biology plays a part in the behaviour of our adolescents. During puberty, certain hormones are released. Previous research findings have resulted in the suggestion that the hormonal changes related to puberty, and the concurrent restructuring of the adolescent brain may be having an affect on adolescents' decision-making ability. (Please see the attached newspaper clipping for more information on recent American research findings).

The aim of this study is to investigate whether there is a relationship between the onset of pubertal development and the temporary development of antisocial attitudes and participation in antisocial behaviour, and whether this relationship can be explained by a relationship between the onset of pubertal development and a "dip" in executive functioning. Executive functioning is a technical term used to describe decision-making ability. This is our ability to organize and plan our actions and behaviours, and our ability to inhibit certain actions appropriately. The major components of executive functioning are working memory, inhibition, and planning (ability to pay attention to and switch between tasks).

Most of the cognitive tests administered to students who participated in this study were tests of executive functioning. The *Letter-Number Sequencing* test requires the participant to listen to a random list of numbers and letters, and then put them in numerical, and then alphabetical order. For example, the combination C-7-2-S-K is read out, and the participant must work with his or her memory and repeat back 2-7-C-K-S. The *Stroop* test was administered to participants to assess their ability to inhibit the automatic tendency to read the word, and instead name the colour of the ink that the word is printed in. For example, the word RED is written in BLUE ink, and the participant must say BLUE. Most people find both of these tests rather challenging, but it is hypothesized in this study that adolescents who are at or near the onset of puberty will find the tasks even more challenging than their same age peers who are not at or near the onset of puberty.

Two additional tests of executive functioning were administered to assess the participant's ability to pay attention to and switch between tasks. The *Trail Making Test* requires participants to make a trail connecting circles in order switching between numbers and letters, e.g. 1-A-2-B-3-C. The *verbal fluency* and *verbal switching* tasks requires participants to say as many words as they can in 60 seconds by switching between words from a certain category and words that begin with a certain letter. For example, the category "animals" and the letter "s" is given to the participant, and they are required to respond with something like "lion, sofa, bear, soft…". Participants were also administered a vocabulary test as a measure of general knowledge so we can conclude that differences on the executive functioning tests are not due to differences in general abilities.

All participants also completed three self-report questionnaires to measure the stage of pubertal development, and endorsement of antisocial attitudes and antisocial behaviours. Parents of teenage children may have noticed that their children seem to lose sensitivity toward the feelings of others, and act more selfishly. They experience sudden changes in mood, getting angry for no reason, and they seem insensitive to punishment: It doesn't matter what you threaten or implement as consequences for their antisocial behaviour, they do want they want to do anyway. Participants were asked to rate themselves on a scale of 0 = "Not at all" to 3 = "Very well" on a number of attitudes such as "People are often telling me to act more responsibly" and "I usually let other people do what needs to be done".

Participants also reported on whether they had ever participated in a range of antisocial behaviours, and the age they were the first time they had done it (only high school students reported on first age, younger students simply answered "yes" or "no"). Behaviours self-reported on include jigging school, writing graffiti, theft, bullying, and alcohol use. It is hypothesized that age of participation in antisocial behaviour and endorsement on antisocial attitudes will be highly correlated with the onset of puberty.

I would like to thank all the children and adolescents, and their parents for agreeing to participate in this study. I hope to find that children who have not experienced many of the physical changes related to puberty are also not experiencing problems with making appropriate decisions regarding their attitudes and behaviour, but that older children who have experienced these changes are experiencing decision-making problems, and this is the reason they are doing some of the things they wouldn't ordinarily do. I hope to find that regardless of age, it is children who are currently in the developmental stage of puberty who may be experiencing these troublesome behaviours, and that this relationship can be explained by a temporary "dip" in executive functioning.

I would like to remind you that all data will be kept strictly confidential and anonymous; individual results are identifiable by identification number only. No one will have access to these files except the principal researchers. Parents, schools, and the participants themselves **will not** have access to these files. All results will be reported as group averages; no individual results will be available. As I am currently still collecting data in other local schools, the results of this study will not be available for another few months. However, I will make available the results of this study to your child's school as soon as they are available.

Kind Regards,

Suzanne Czech
Doctoral Candidate - Forensic Psychology
School of Psychology, University of New South Wales
Sydney 2052
Ph: +61 (02) 9385 3021
email: sczech@psy.unsw.edu.au

APPENDIX 4.11

[redacted]

[redacted]

[redacted]

I wish to thank you and the participating students of South Sydney High School for your assistance with the research project, *Developmental and Behavioural Patterns in Children & Adolescents,* I am completing as part of my doctoral thesis at the University of New South Wales, in the School of Psychology.

I have enclosed a letter for each of the participating students (copy for you attached), which provides a detailed debriefing of which measures were used during the interviews with students, and what I hope to find when I analyse the information collected.

I have completed the data collection phase for this research project, and I am currently analyzing the data. I will be providing South Sydney High School with a summary of the findings upon completion of this research project. Prior to completion of my doctoral thesis, I will be presenting the preliminary findings at the ***Young People's Health: what's it going to take?*** **YOUTH HEALTH 2006 Conference on 15 November 2006 at Southee Centre Sydney Showground Olympic Park – Sydney Australia.** If you are interested in the details regarding this conference, please visit their website at www.youthhealth2006.org.

Thank you for your valuable support in this important research.

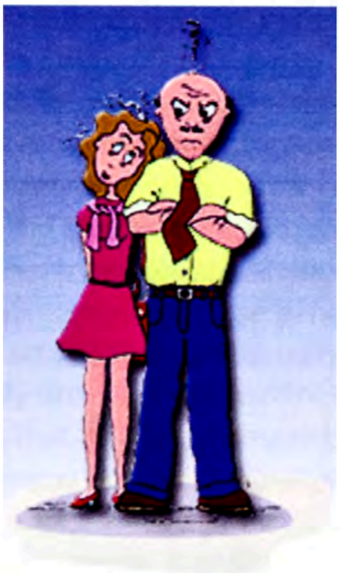
Kind Regards,

Suzanne Czech
Doctoral Candidate - Forensic Psychology
School of Psychology, University of New South Wales
Sydney 2052
Ph: +61 (02) 9385 3063
email: sczech@psy.unsw.edu.au

31 July 2006

APPENDIX 4.12

Explanations for antisocial behaviour in adolescents: the role of pubertal development on cognitive processes



OR

'Dude who stole my brain?'

Suzanne Czech
School of Psychology
University of New South Wales
sczech@psy.unsw.edu.au

BACKGROUND

Antisocial behaviour (ASB) is any behaviour that is contrary to the standards of the society we live in. This includes criminal behaviour, but is also any behaviour that ignores the rights of others and acting in a self interested fashion. Although a small percentage of individuals display this type of behaviour throughout their lifetime, for the majority of individuals any participation in ASB is limited to the period of adolescence.

Communities often believe that adolescent ASB is a serious problem, and each generation believe that adolescent behaviour is 'worse' than the generation before. In fact, this problem of high ASB during adolescence has existed for centuries. In the past couple of decades, research has found that the temporary rise in ASB is not attributable to a few adolescents who are engaging in more problem behaviour, but that a very large number of adolescents are engaging in a small number of these behaviours for a few years during adolescence. We now know that among those adolescents who come into contact with the law, on average, approximately only 10% will continue this pattern of criminal behaviour as an adult; this means that 90% of adolescents grow out of their antisocial behaviour, even if it was serious enough to get themselves involved with the law.

One explanation for this temporary increase in antisocial behaviour during adolescence is that the release of hormones during puberty disrupts the cognitive processes responsible for monitoring and controlling behaviour. Recent research has found evidence that adolescents' participation in ASB is positively correlated with the age of puberty onset, rather than a particular age. Furthermore, neuropsychologists have found that the release of pubertal hormones causes a temporary deficit in executive functioning and consequently behavioural control. Executive functioning is commonly referred to as our 'higher order brain functions', and is the term used to describe the complex cognitive processes responsible for planning, organizing, and ordering behaviour, and for deciding which behaviours are appropriate in a given situation. This includes our ability to control our impulses, take risks, think through to the consequences of our behaviour, and make appropriate decisions.

This research investigates the possibility that during puberty, adolescents experience disruption to executive functioning, and that this 'dip' in executive functioning explains the increase in antisocial behaviour during adolescence. For example, as an adult, if I see that someone has left their car keys in the ignition, I might think it would be fun to take the car for a ride around town, but then I consider the possible consequences, and inhibit this initial impulse In contrast, an adolescent with diminished executive functioning might not foresee that they may get caught, and what the possible consequences of that may be, or even consider that someone may be distressed to find their car gone missing, and therefore acts on the initial impulse.

This research investigated whether the timing of adolescent antisocial behaviour is actually associated with the onset of puberty, rather than a particular age, and whether adolescents experience temporary disruption to their normal pattern of executive functioning development during puberty.

METHOD

Self-report data on pubertal development stage and antisocial attitudes and behaviours was collected from 323 boys and girls (9 – 17 years) in local NSW public schools. Executive functioning (working memory, response inhibition, organizing, planning, and behavioural control) was subsequently measured in a 30-minute individual interview.

The executive functioning tests examined adolescents' ability to process information quickly and accurately and to control their responses. These measures included:

1) the ability to inhibit their responses, (e.g. say the colour of ink a word is printed in rather than read the colour-name word, i.e. required to say 'red' for the word BLUE written in red ink),

2) attend to, remember, and process information (e.g. memorize a string of numbers and letters read out in random order, put them in number order first, and then alphabetical order, and repeat back to the interviewer), and

3) to switch between information-processing tasks (e.g. say as many words as possible in 60 seconds, from the category 'animals', and words beginning with the letter 's', alternating between the two without repeating any words already spoken).

Participants were also administered a vocabulary test as a non-executive functioning test (to control for individual differences in general IQ).

For the purpose of this research, antisocial attitudes were those attitudes indicative of changes in how adolescents process emotional information. On 28 items, adolescents were asked to rate how well each statement described them: 'not at all'; 'somewhat'; 'quite a bit'; or 'very well'. Adolescents rated themselves on their tendency to take risks or act impulsively, as well as on self-serving attitudes such as willingness to manipulate others, or to dodge their responsibilities.

A wide range of antisocial behaviours were investigated. Children and adolescents responded 'Yes' or "No" to between 40 and 60 items which included:

- naughty behaviours such as nuisance phone calls,
- rule-breaking behaviour such as wagging school,
- drug taking behaviours including smoking cigarettes, and under-age drinking,
- a wide range of criminal behaviours including vandalism, and theft,
- aggressive behaviours including use of weapons or participation in gang fights.

High school-aged adolescents also indicated whether they had participated in the behaviour in the past 12 months, and what age they were the first time they had participated in the behaviour.

FINDINGS

Preliminary findings of this research were presented on 15 November, at the 5th Australian and New Zealand Adolescent Health Conference, sponsored by Westmead Children's Hospital, The analyses were designed to assess whether changes in cognitive processes which occur during pubertal development are associated with an increase in ASB. Preliminary analyses suggests that compared to pre-pubertal or post-pubertal adolescents, those adolescents who reported being in a mid-pubertal stage scored lower on tests of executive functioning, and reported higher levels of antisocial attitudes and behaviours.

As expected, executive functioning (EF) skills and antisocial behaviour increased with age (i.e. older adolescents reported more ASB and performed better on tests of executive functioning). However, when I performed analyses that controlled for age (i.e. adjusted for the age of the adolescent), the results revealed that adolescents who had not yet reached puberty, performed better on tests of EF than those adolescents who were in a mid-pubertal stage. Correspondingly, those adolescents who had progressed to a late pubertal stage (i.e. mid-puberty occurred between one to two years ago) performed better than those mid-puberty. Results also revealed that when self-reported levels of current antisocial behaviour and current antisocial attitudes were adjusted for age, mid-pubertal adolescents reported higher levels than pre- or late pubertal adolescents.

For those adolescents who had reached a mid-pubertal stage (i.e. excludes only pre-pubertal adolescents), the peak age of initial participation in antisocial behaviour was significantly positively correlated with the age of puberty onset, for both boys and girls. That is, those adolescents reporting an age of puberty onset as age 13, for example, were significantly more likely to report that their initial peak ASB participation was at or near age 13. This is despite the fact that the range for both of these phenomena occurred anywhere between the ages of 9 and 16.

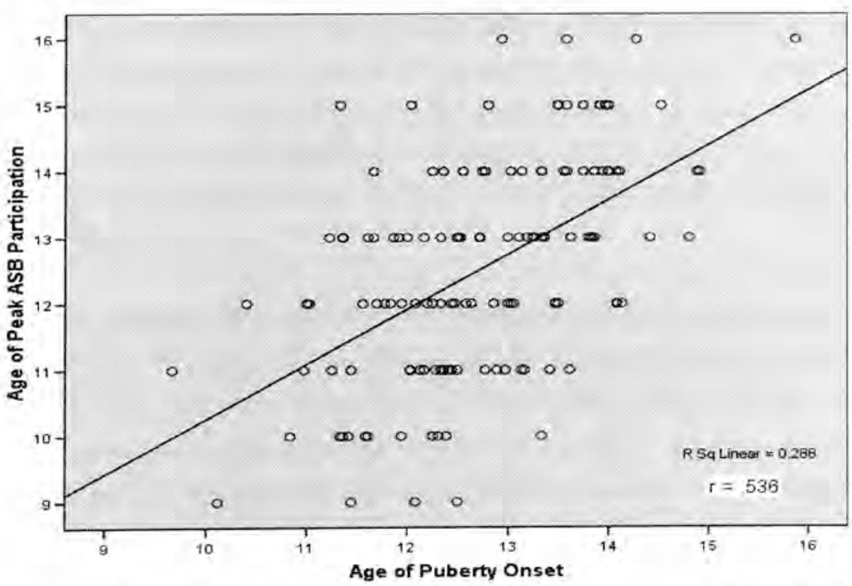


Figure 1: Correlation between Puberty onset age and peak ASB participation age for boys and girls.

DISCUSSION: IMPLICATIONS & APPLICATIONS

These research findings are only preliminary, and my research is continuing to investigate the associations between pubertal development, cognitive functioning, and antisocial behaviour and attitudes in adolescents. Some patterns are identifiable, however, closer examination of the data is required to delineate the relationships between specific types of executive functioning and antisocial behaviours, and to determine specific effects of gender, particularly in regard to pubertal development progression. I am currently also investigating the effects of pubertal timing on executive functioning and antisocial behaviour. It is expected that those adolescents who mature earlier than their peers may be more at risk for experiencing the effects of the proposed relationship between executive functioning and antisocial behaviour.

This research is important to anyone who has a relationship or guidance role with adolescents including parents, educators, youth workers, counselors, and legal authorities. These preliminary findings provide another piece of the puzzle and help us to understand and explain adolescent antisocial behaviour. Ultimately, we may be able to prevent a number of negative experiences in the community, as well as potential negative consequences to adolescents themselves, by teaching skills of 'prevention and protection'.

Parenting strategies may be influenced by the final outcomes of this research, and by future related research. For example, parents may focus on helping their adolescents avoid situations in which they may be vulnerable or find themselves at risk. One way parents can do this is to establish and enforce firm boundaries not only to teach children the importance of following rules, but also to protect them from the serious consequences of making inappropriate decisions in risky situations. Parents can also discuss potential decision-making scenarios their child may encounter, and practice appropriate decision-making skills with them, so that adolescents are better prepared.

This research has important implications for how we educate our adolescents as well. We may be able to prevent some poor achievements on school projects by monitoring student's progress on long-term assessment projects. Rather than expecting adolescents to have the ability to plan and organize their study habits over a two-month period, we can set short-term markers along the way to support those adolescents who may be experiencing difficulties with planning, ordering, and understanding the consequences of their behaviour.

We can provide information to adolescents to become aware of the fact that they may experience this potentially critical developmental period of puberty. With this awareness, adolescents can better prepare for the challenges of the adolescent years. Finally, we can all support adolescents to question and evaluate their own behaviours, and assist them to implement strategies for developing strong decision-making skills.
The full results from this research will be available in approximately six months time. If you would like a copy of the final paper, please contact Suzanne Czech anytime after June 1, 2007 at sczech@psy.unsw.edu.au.[°]

[°] This is PhD research being conducted in the School of Psychology at the University of New South Wales under the supervision of Dr Richard Kemp

APPENDIX 3.0.1

Australian Government
Department of Education, Science, & Trading
http://www.dest.gov.au/archive/highered/eippubs/eip02_4/appendix_02.htm

Identifying Higher Education Students from Low Socio-Economic Status Backgrounds and Regional and Remote Areas
Appendix 2: Grouping of ANU4 occupational status categories and scores

Table A2.1 ANU4 occupation categories and scores

ANU4 Code	Indicative occupational title	Score	Rank
19	Medical practitioners	100	1
29	Legal professionals	96.03	2
25	University teachers	95.66	3
21	Other health professionals (a)	94.49	4
24	Secondary school teachers	89.72	5
9	Natural science professionals	86.15	6
23	Primary school teachers	84.52	7
26	Other education professionals (a)	84.31	8
11	Engineers	83.77	9
10	Architects and related professionals	83.63	10
12	Other science and engineering professionals	83.37	11
13	Accountants and related professionals	81.42	12
22	Other health professionals (b)	80.14	13
6	Other specialist managers	79.98	14
18	Other business professionals	79.38	15
15	Computing professionals	78.45	16
17	Business and organisation analysts	76.43	17
20	Nursing professionals	75.32	18
30	Other professionals (a)	74.84	19
27	Other education professionals (b)	74.52	20
1	General Manager	73.43	21
28	Social welfare professionals	73.21	22
3	Resource managers	73.1	23
4	Engineering and process managers	63.2	24
34	Finance associate professionals	63.19	25
31	Other professionals (b)	63.05	26
5	Sales and marketing managers	63	27
16	Human resource professionals	62.37	28
14	Sales and related professionals	62.02	29
36	Other business associate professionals	58.88	30
33	Building associate professionals	56.25	31
32	Medical and science technical officers	56.06	32
7	Managers n.e.c.	55.24	33
38	Computing support technicians	54.58	34
44	Health and welfare associate professionals	51.22	35
2	Other generalist managers	49.95	36
46	Other associate professionals	49.54	37
37	Real estate associate professionals	49.22	38
45	Police officers	48.51	39
43	Other sales and service managing supervisors	48.45	40
69	Other advanced clerical workers	47.78	41
79	Other intermediate clerical workers	46.74	42
35	Office managers	46.55	43

ANU4 Code	Indicative occupational title	Score	Rank
8	Farmers and farm managers	46.33	44
88	Other intermediate service workers (a)	44.14	45
48	Other mechanical engineering tradespersons	43.1	46
52	Electricians	42.84	47
73	Accounting clerks	41.5	48
65	Other tradespersons (a)	41.2	49
80	Sales representatives	41.16	50
78	Inquiry and admissions clerks	41.08	51
39	Shop managers	40.99	52
53	Other electrical tradespersons	40.6	53
42	Other hospitality managers	40.55	54
56	Plumbers	40.43	55
47	Metal fitters and machinists	39.94	56
40	Restaurant and catering managers	39.61	57
68	Bookkeepers	39.54	58
54	Carpenters and joiners	39.51	59
75	Other numerical clerks	39.11	60
55	Painters and decorators	37.31	61
87	Waiters	36.37	62
70	General clerks	36.15	63
57	Other construction tradespersons	35.89	64
84	Special care workers	35.51	65
77	Other recording and despatching clerks	35.49	66
74	Bank workers	35.45	67
83	Children's care workers	35.39	68
62	Printing tradespersons	35	69
67	Secretaries and personal assistants	34.88	70
103	Elementary clerks	34.7	71
106	Other elementary sales workers	33.69	72
50	Motor mechanics	32.99	73
64	Hairdressers	32.8	74
99	Car and delivery drivers	32.21	75
71	Keyboard operators	32.16	76
41	Chefs	32.05	77
89	Other intermediate service workers (b)	31.87	78
76	Stock and purchasing clerks	31.76	79
51	Other automotive tradespersons	31.75	80
82	Education aides	31.55	81
63	Wood tradespersons	31.5	82
49	Fabrication engineering tradespersons	31.31	83
72	Receptionists	30.1	84
66	Other tradespersons (b)	29.95	85
60	Skilled agricultural workers (a)	28.45	86
61	Other horticultural workers (b)	28.32	87
107	Guards and security officers	27.58	88
104	Sales assistants	27.4	89
102	Other intermediate production & transport workers	27.33	90
98	Bus, tram and train drivers	27.2	91
86	Bar attendants	26.67	92
92	Intermediate stationary plant operators	26.22	93
85	Personal care and nursing assistants	25.87	94
81	Other intermediate sales workers	24.85	95
108	Other elementary service workers	24.81	96
105	Checkout operators and cashiers	24.53	97
59	Other food tradespersons	24.1	98
117	Miscellaneous labourers	22.73	99
96	Miscellaneous intermediate machine operators	21.46	100
94	Intermediate machine operators n.e.c.	21	101

ANU4 Code	Indicative occupational title	Score	Rank
116	Kitchenhands	19.54	102
101	Storepersons	19.01	103
110	Cleaners	18.34	104
100	Other transport drivers	17.8	105
58	Cooks	17.67	106
113	Mining, construction and related labourers (a)	17.06	107
90	Mobile construction plant operators	16.32	108
93	Other intermediate plant operators	14.7	109
97	Truck drivers	14.01	110
111	Factory labourers	12.35	111
112	Product packagers	9.64	112
95	Intermediate textile machine operators	8.51	113
114	Mining, construction and related labourers (b)	7.64	114
91	Forklift drivers	7.19	115
109	Labourers n.e.c.	5.13	116
115	Agricultural and related labourers	0	117

Table A2.2 Eight occupation classes and component ANU4 occupation categories

Occupation Class	Class title	ANU4 category codes	Mean ANU4 Score
1	Health, Education, Legal, Science, Building & Engineering qualified Professionals	9,10,11,12,19,21,23,24, 25,26,29	88.63
2	Nurses/therapists; Social, Business, Computing, Media & Air/sea transport qualified Professionals	13,15,17,18,20, 22,27,28,30	76.65
3	Elected & appointed officials; Senior management - public sector & large organisations	1,3,4,5,6,7,34,36	66.54
4	Artists; Associates/technicians; Police/ADF officers (non-commissioned); Sportspeople; & Business specialists	2,14,16,31,32,33,37,38,43, 44,45,46	53.51
5	Farm, shop, office & hospitality Managers; Specialised clerks, sales & service workers; Mechanical engineering, electrical & communications Tradespeople	8,35,39,40,42,47,48,52, 53,68, 69,73,78,79,80, 88	42.84
6	Building/auto/arts/miscellaneous Tradespeople; Secretaries; Clerks; & Care workers	41,50,51,54,55, 56,57,62,	35.48
7	Transport & service workers; Metal/textile/glass/ wood/agriculture Tradespeople; Stationary plant operators; Skilled forestry/waterside/mining/ construction workers; & Defence Forces (lower ranks)	49,60,61,63,66, 72,81,85, 86,87,89,92,98, 99,102, 104,105,107	28.64
8	Other service workers; Other machine operators; Factory/farm hands; & Labourers	58,59,90,91,93, 94,95,96,97, 100,101,108, 109,110,111, 112,113, 114,115,116, 117	

APPENDIX 6.1

Self-Reported Behaviour Scale

These questions deal with your own behaviour. PLEASE be honest, NO ONE BUT THE RESEARCHER WILL SEE THIS FORM.

HAVE YOU, IN THE PAST 12 MONTHS:

	YES	NO
1. Driven an unregistered car?		
2. Driven a car or a motor bike on the road without a driver's license or a learner's permit?		
3. Driven a car or a bike when drunk or over the legal alcohol limit?		
4. Raced with other vehicles while driving a car or a motor bike on the road?		
5. Taken and driven a car or a motor bike that belonged to someone else without the owner's consent?		
6. Stolen things or parts out of a car or a motor bike?		
7. Stolen a bicycle or parts from a bicycle?		
8. Gone to see an R film in a cinema?		
9. Failed to keep a promise?		
10. Bought beer, wine, spirits or other kinds of liquor?		
11. Drunk alcohol in a public place, e.g. a disco, pub, tavern or bistro?		
12. Got onto a bus or into a cinema, swimming pool, disco, etc., without paying the proper fee?		
13. Not attended classes or wagged school?		
14. Run away from home (at least overnight)?		
15. Shoplifted from supermarkets, department stores or shops?		
16. Stolen money of less than $10 (in one go) from shops, school, locker rooms, home, people's milk money, etc?		
17. Stolen money of $10 or more in one go?		
18. Been late for school, a meeting, an appointment, etc.?		
19. Broken into a house or a building with the intention of stealing something, e.g., money, exam papers, or other things?		
20. Cheated or stolen food, drinks or other goods from dispenser machines, e.g., by tilting or banging the machines, or using the "wrong" coins?		

	YES	NO
21. Obtained free games from coin-operated space invaders or other game machines (not including reward of good performance by machines in the form of bonus games)?		
22. Purposely messed up other people's property, e.g., turning on water taps in people's gardens, letting off fire-crackers in mail boxes, burning rubbish bins, etc?		
23. Purposely damaged property by starting a fire?		
24. Purposely damaged things in public places, e.g., telephone boxes, street signs, road lamps, etc?		
25. Purposely damaged school desks, windows, or other school property, e.g., kicking holes in the wall?		
26. Put graffiti on walls, toilet doors, bus panels, or other public places?		
27. Done something that your parents did not want you to do?		
28. Taken part in a fistfight in which a group of people was against another group?		
29. Purposely hurt or beaten up someone?		
30. Used a weapon of some sort, e.g., knife, stick, chains, or bottle in a fight?		
31. Used or threatened to use force to get money or things from another person?		
32. Used marijuana (also called grass, dope, or hash)?		
33. Used LSD (also called acid)?		
34. Abused barbiturates (also called barbs) by not properly following medical advice?		
35. Forced someone to do sexual things with you when that person did not want to?		
36. Tricked someone on the telephone e.g., false restaurant booking, giving false reports of fire alarm, bombs, etc?		
37. Made abusive phone calls, e.g., saying nasty or obscene things?		
38. Been warned by the police (but without being charged) for something that you did?		
39. Appeared in the Children's Court for something that you did?		
40. Told a lie to someone?		

Scoring the Self-Reported Delinquency Scale

Scores for the total scale, lie scale, and 9 subscales can be calculated.

- Total scale: Add all the items marked as a yes. Do not include items 9, 18, 27, 38, 39, 40. Higher scores on the total scale indicate a greater variety of delinquent activities engaged in by the respondent.

- Lie scale: Add items 9, 18, 27, 40. High scores on the lie scale indicate a lower tendency towards social desirability.

- Cheat subscale: Add items 12, 20, 21.

- Status subscale: Add items 10, 11, 13.

- Fight subscale: Add items 28, 30.

- Vehicles subscale: Add items 6, 7.

- Drugs subscale: Add items 33, 34.

- Theft subscale: Add items 15, 16, 17.

- Harm subscale: Add items 29, 31.

- Driving subscale: Add items 1, 2, 3, 4, 5.

- Disturb subscale: Add items 24, 25, 26, 36, 37.

APPENDIX 6.2a: ASA Scale Item Intercorrelations-Boys

	Shallow1	Narcist1	Lying1	Manip1	Remorse1	Impress1	Empathy1	Shallow2	Narcist2	Lying2	Manip2	Remorse2	Impress2	Empathy2
Shallow1	1.000	.164	-.073	.090	.116	.025	.117	.090	.123	-.075	.219	.159	.131	.260
Narcist1	.164	1.000	.184	.183	.101	.378	.260	-.013	.171	-.159	.146	.099	.218	.167
Lying1	-.073	.184	1.000	.094	.191	.167	.405	.085	.211	.023	.276	.214	.261	.258
Manip1	.090	.183	.094	1.000	.087	.283	.079	-.117	.095	.184	.211	.136	.069	.027
Remorse1	.116	.101	.191	.087	1.000	.119	.292	-.032	.172	-.067	.170	.265	.129	.063
Impress1	.025	.378	.167	.283	.119	1.000	.120	-.008	.324	-.071	.287	.103	.254	.200
Empathy1	.117	.260	.405	.079	.292	.120	1.000	.067	.166	-.002	.344	.426	.351	.269
Shallow2	.090	-.013	.085	-.117	-.032	-.008	.067	1.000	.092	-.019	.084	.097	.083	.100
Narcist2	.123	.171	.211	.095	.172	.324	.166	.092	1.000	-.082	.278	.357	.275	.303
Lying2	-.075	-.159	.023	.184	-.067	-.071	-.002	-.019	-.082	1.000	.120	-.030	-.011	-.159
Manip2	.219	.146	.276	.211	.170	.287	.344	.084	.278	.120	1.000	.386	.449	.231
Remorse2	.159	.099	.214	.136	.265	.103	.426	.097	.357	-.030	.386	1.000	.212	.350
Impress2	.131	.218	.261	.069	.129	.254	.351	.083	.275	-.011	.449	.212	1.000	.252
Empathy2	.260	.167	.258	.027	.063	.200	.269	.100	.303	-.159	.231	.350	.252	1.000

	Stim1	Stim2	Resp1	Anger1	Irres1	Impulse1	Parasit1	Anger2	Goals1	Impulse2	Goals2	Irresp2	Resp2	Parasit2
Stim1	1.000	.134	.135	.158	.076	-.024	-.087	.430	.128	.302	.047	.249	-.155	-.144
Stim2	.134	1.000	.127	.414	.369	.085	.049	.348	.083	.267	.241	.204	.123	-.081
Resp1	.135	.127	1.000	.296	.178	-.065	.515	.321	.176	.416	.114	.247	.237	.180
Anger1	.158	.414	.296	1.000	.105	-.132	.216	.292	.046	.090	.201	.211	.051	-.039
Irres1	.076	.369	.178	.105	1.000	-.042	.107	.004	.365	.021	.354	.128	-.149	-.328
Impulse1	-.024	.085	-.065	-.132	-.042	1.000	.005	.068	-.197	.236	.054	.063	.028	.101
Parasit1	-.087	.049	.515	.216	.107	.005	1.000	.055	-.232	.287	.084	.156	.155	.099
Anger2	.430	.348	.321	.292	.004	.068	.055	1.000	.185	.510	.004	.272	.263	-.033
Goals1	.128	.083	.176	.046	.365	-.197	-.232	.185	1.000	.096	.181	.013	-.071	-.021
Impulse2	.302	.267	.416	.090	.021	.236	.287	.510	.096	1.000	.350	.174	.160	.054
Goals2	.047	.241	.114	.201	.354	.054	.084	.004	.181	.350	1.000	.166	-.184	-.362
Irresp2	.249	.204	.247	.211	.128	.063	.156	.272	.013	.174	.166	1.000	.044	.058
Resp2	-.155	.123	.237	.051	-.149	.028	.155	.263	-.071	.160	-.184	.044	1.000	.258
Parasit2	-.144	-.081	.180	-.039	-.328	.101	.099	-.033	-.021	.054	-.362	.058	.258	1.000

APPENDIX 6.2b: ASA Scale Item Intercorrelations-Girls

	Shallow1	Narcist1	Lying1	Manip1	Remorse1	Impress1	Empathy1	Shallow2	Narcist2	Lying2	Manip2	Remorse2	Impress2	Empathy2
Shallow1	1.000	-.018	.091	.129	.133	.083	.109	.115	.049	.038	.034	.089	-.014	.096
Narcist1	-.018	1.000	.123	.283	.175	.501	.308	-.042	.353	.057	.381	.392	.114	.184
Lying1	.091	.123	1.000	.078	.319	.089	.059	-.090	.089	.066	-.043	.064	.072	.184
Manip1	.129	.283	.078	1.000	.187	.472	.213	.029	.343	.213	.482	.475	.225	.319
Remorse1	.133	.175	.319	.187	1.000	.261	.130	.114	.295	.185	.290	.237	.264	.289
Impress1	.083	.501	.089	.472	.261	1.000	.371	-.118	.427	.160	.331	.452	.196	.306
Empathy1	.109	.308	.059	.213	.130	.371	1.000	-.052	.255	.153	.190	.351	.053	.353
Shallow2	.115	-.042	-.090	.029	.114	-.118	-.052	1.000	.173	.135	.242	.084	.158	.051
Narcist2	.049	.353	.089	.343	.295	.427	.255	.173	1.000	.035	.338	.528	.373	.415
Lying2	.038	.057	.066	.213	.185	.160	.153	.135	.035	1.000	.171	.234	.126	.208
Manip2	.034	.381	-.043	.482	.290	.331	.190	.242	.338	.171	1.000	.491	.276	.242
Remorse2	.089	.392	.064	.475	.237	.452	.351	.084	.528	.234	.491	1.000	.268	.359
Impress2	-.014	.114	.072	.225	.264	.196	.053	.158	.373	.126	.276	.268	1.000	.354
Empathy2	.096	.184	.184	.319	.289	.306	.353	.051	.415	.208	.242	.359	.354	1.000

	Stim1	Stim2	Resp1	Anger1	Irres1	Impulse1	Parasit1	Anger2	Goals1	Impulse2	Goals2	Irresp2	Resp2	Parasit2
Stim1	1.000	.177	.469	.402	-.012	.134	.254	.255	-.067	.167	.162	.384	.226	-.051
Stim2	.177	1.000	.295	.389	.196	.341	.148	.227	.013	.524	.110	.195	.218	.088
Resp1	.469	.295	1.000	.386	.132	.275	.329	.122	-.118	.279	.189	.215	.216	-.111
Anger1	.402	.389	.386	1.000	.082	.210	.306	.392	-.092	.332	.179	.355	.287	.154
Irres1	-.012	.196	.132	.082	1.000	.167	.112	-.008	.131	.083	-.097	.103	-.130	.023
Impulse1	.134	.341	.275	.210	.167	1.000	.152	.075	-.018	.435	.190	.152	.236	.085
Parasit1	.254	.148	.329	.306	.112	.152	1.000	.159	-.023	.303	-.049	.208	.114	-.063
Anger2	.255	.227	.122	.392	-.008	.075	.159	1.000	.170	.117	.043	.073	.294	.017
Goals1	-.067	.013	-.118	-.092	.131	-.018	-.023	.170	1.000	-.030	-.157	.107	-.022	-.044
Impulse2	.167	.524	.279	.332	.083	.435	.303	.117	-.030	1.000	.020	.139	.323	.083
Goals2	.162	.110	.189	.179	-.097	.190	-.049	.043	-.157	.020	1.000	.117	.350	.167
Irresp2	.384	.195	.215	.355	.103	.152	.208	.073	.107	.139	.117	1.000	.152	.069
Resp2	.226	.218	.216	.287	-.130	.236	.114	.294	-.022	.323	.350	.152	1.000	.154
Parasit2	-.051	.088	-.111	.154	.023	.085	-.063	.017	-.044	.083	.167	.069	.154	1.000

APPENDIX 6.3: Factor Loadings for Factor 1 and Factor 2 Antisocial Attitudes Scale Items

Antisocial Attitudes Scale Item	Component 1	Component 2
Manip2	.725	-.051
Remorse2	.711	-.043
Narcist2	.649	-.190
Impulse2	.600	.009
Parasit1	.599	-.306
Empathy2	.591	.281
Resp1	.591	.217
Anger1	.586	.037
Stim2	.576	-.041
Impress1	.540	-.439
Anger2	.523	.296
Manip1	.502	-.433
Empathy1	.483	.202
Impress2	.454	.267
Remorse1	.453	-.115
Irresp2	.409	.350
Resp2	.382	.080
Narcist1	.367	-.510
Impulse1	.357	-.171
Stim1	.339	.293
Lying1	.251	.115
Goals2	.249	.143
Parasit2	.219	.118
Irres1	.194	.187
Lying2	.174	-.036
Shallow1	.164	.021
Goals1	.075	.623
Shallow2	.058	.229

Extraction Method: Principal Component Analysis.
a 2 components extracted.

APPENDIX 12.1

Appendix 12.1a.

Distribution of primary and high school girls and boys across pubertal timing groups.

Pubertal Timing Group	Girls					
	High School		Primary		Total	
	N	% of Girls	N	% of Girls	N	% of Girls
Earlier than peers	12	10.0%	11	9.2%	23	19.2%
With peers	51	42.5%	24	20.0%	75	62.5%
Later than peers	20	16.7%	2	1.7%	22	18.3%
Total	83	69.2%	37	30.8%	120	100.0%

	Boys					
	High School		Primary		Total	
	N	% of Boys	N	% of Boys	N	% of Boys
Earlier than peers	21	10.8%	20	10.3%	41	21.0%
With peers	85	43.6%	29	14.9%	114	58.5%
Later than peers	38	19.5%	2	1.0%	40	20.5%
Total	144	73.8%	51	26.2%	195	100.0%

Appendix 12.1b.

Distribution of primary and high school girls and boys across pubertal status groups.

Pubertal Status	Girls					
	High School		Primary		Total	
	N	% of Girls	N	% of Girls	N	% of Girls
Pre-pubertal	3	2.5%	24	20.0%	27	22.5%
Mid-pubertal	40	33.3%	11	9.2%	51	42.5%
Late pubertal	40	33.3%	2	1.7%	42	35.0%
Total	83	69.2%	37	30.8%	120	100.0%

	Boys					
	High School		Primary		Total	
	N	% of Boys	N	% of Boys	N	% of Boys
Pre-pubertal	6	3.1%	31	15.9%	37	19.0%
Mid-pubertal	66	33.8%	19	9.7%	85	43.6%
Late pubertal	72	36.9%	1	.5%	73	37.4%
Total	144	73.8%	51	26.2%	195	100.0%

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