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The Moderating Effects of Pubertal Timing on the Longitudinal Associations Between Parent-Child Relationship Quality and Adolescent Substance Use

Katherine H. Shelton, PhD. and

School of Psychology, Cardiff University, Tower Building, Park Place, Cardiff, Wales, UK, CF10 3AT. Sheltonkh1@cardiff.ac.uk, Tel: +44 2920 876093

Marianne B.M. van den Bree, PhD.

Department of Psychological Medicine, Cardiff University, Cardiff, Wales, UK. CF14 4XN. vandenbreemb@cardiff.ac.uk

Abstract

This prospective, longitudinal study investigated the moderating role of pubertal timing on reciprocal links between adolescent appraisals of parent-child relationship quality and girls' (N=1335) and boys' (N=1203) cigarette and alcohol use across a twelve-month period. Reciprocal effects were found between parent-child relations and on-time maturing boys and girls' cigarette and alcohol use, after estimating stability in these constructs across time. Parent-child relationship quality was associated with increased alcohol use twelve months later for early maturing girls. Cigarette and alcohol use were associated with increased problems in the parent-child relationship for late maturing girls. No off-time effects were observed for off-time maturing boys in the pathways between parent-child relationship quality and substance use. Pubertal timing moderated the pathway linking parent-child relationship quality with cigarette use one year later such that the association was stronger for late maturing girls compared to early and on-time maturing girls. The findings indicate interplay between the psychosocial aspects of maturation, family relationships and adolescent substance use and highlight possible gender-specific influences.

Early initiation of substance use has been associated with a more rapid progression to heavier use and abuse (Dick, Rose, Viken & Kaprio, 2000; Spear, 2000), has short- and long-term health implications (van den Bree, 2005) and can impact on individual and others' welfare through associations with increased risky behaviour (e.g. sexual, criminal; Patton et al., 2004). Research has shown that the quality of the parent-child relationship and the timing of pubertal maturation relative to one's peers are risk factors for substance use in adolescence. The interplay between these two risk factors in influencing the use of cigarettes and alcohol in early to mid-adolescence is less well understood.

Parent-Child Relations, Cigarette and Alcohol Use

Children from homes characterised by poor family functioning are at increased risk of drug initiation and drug use (Hawkins, Catalano & Miller, 1992). Parent-to-child hostility and an absence of warmth are associated with increased cigarette and alcohol use (Brody & Forehand, 1993; Melby et al. 1993; Shelton et al., 2008). Substance use is argued to offer a means of coping with poor family functioning, but may also reflect increased affiliation with peers (who may themselves experiment with and use substances) to gain social support and a sense of belonging (Brody & Forehand, 1993; Melby et al., 1993). Parent-child relationships that are non-supportive or characterised by conflict can also undermine adolescents' ability to regulate their behaviour in a goal-oriented way, with self-regulation linked in turn to levels of alcohol use (Brody & Ge, 2001).

Children influence the parenting they receive, yet little research captures the operation of bi-directional processes operating between family members (O'Connor, 2002). Adolescents who smoke or drink regularly may incur parents' disapproval that in turn is linked to decreased expressions of warmth and affection by parents and increased family conflict (Shelton et al., 2008). More generally, negative behaviour by adolescents such as poor self-regulation and antisocial behaviour elicits negativity from parents, with implications in turn for psychological functioning (Brody & Ge, 2001; O'Connor, Deater-Deckard, Fulker, Rutter & Plomin, 1998). In the adolescent years, therefore, the associations between parent-child relationship quality and adolescent substance use are likely to unfold in a complex, transactional fashion.

The Role of Pubertal Timing

Puberty is regarded as a critical maturational process that can profoundly affect young people's lives (Caspi & Moffitt, 1991). The timing of the pubertal transition in particular (compared to same-sex, same-age peers) is argued to be an important determinant of the relationship between pubertal maturation and psychopathology (Graber, Lewinsohn, Seeley & Brooks-Gunn, 1997). The early timing hypothesis proposes that early maturing adolescents are more prone to experiencing difficulties because they are less well prepared for pubertal change (Peskin, 1973). Early maturation curtails the time available to individuals to acquire and assimilate skills that allow them to successfully adapt to stressful experiences (Ge et al., 2003; Graber et al., 1997). Research shows that early pubertal timing is associated with the increased use as well as abuse of substances by girls (Dick et al., 2000; Graber et al., 1997; Lanza & Collins, 2002; Magnusson, Stattin & Allen, 1985) and boys (Orr & Ingersoll, 1995; Lall, Singhi, Gurnani, Singhi & Garg, 1980; Graber et al., 1997; Michaud, Suris & Deppen, 2006). Evidence suggests that early maturing adolescents affiliate with an older peer group, and in doing so, engage in behaviours such as experimental substance use that are age-normative for the group but not for them (Stattin & Magnusson, 1990). Coupled with the relative lack of psychological preparedness for social challenges that early maturing adolescents are theorised to contend with, exposure to pressures to conform to peer norms may render them vulnerable to use cigarettes and alcohol. Other studies, however, have also found that late-maturing males begin to drink earlier than on-time maturing males, are more likely to abuse alcohol in early adulthood (Andersson & Magnusson, 1990; Graber et al., 1997) and to smoke more (Bratberg, Nilsen, Holmen & Vatten, 2007). Late maturing boys may use substances in adolescence as a device to gain peer approval and popularity (e.g. Bratberg et al., 2007) while problem drinking in early adulthood acts in a compensatory way for low social status among peers in the adolescent years (Andersson & Magnusson, 1990).

Evidence that early (among girls) and late maturation (among boys) is associated with increased use and abuse of substances in adolescence and early adulthood lends support for the off-time or deviance hypothesis. The deviance hypothesis predicts that adolescents whose maturational timing is most at odds with the normal timing of socially accepted life sequences are more at risk of emotional and behavioural problems (Ge, Conger & Elder, 1996; Petersen & Taylor, 1980). Adolescents who mature on-time in relation to the peer group are therefore not hypothesised to be at risk. Recent work that used the Add Health data, however, showed that males and female's early pubertal timing was associated with higher alcohol user and heavy drinking trajectories with effects persisting into early adulthood (Biehl, Natsuaki & Ge, 2007). The differences across studies indicating that early maturing males and females and/or late maturing males are most at risk has been linked to variation in the measurement of alcohol use across studies and to the age of the sample studied (Biehl et al., 2007). However, the relative consistent support for the early timing hypothesis in relation to substance use concurs with the view that different models of

pubertal timing effects may vary in their ability to explain or characterise different domains of adolescent behaviour and psychological functioning (Weichold et al., 2003).

The timing of puberty can impact negatively on the quality of parent-child interactions. In families of early maturing girls, it is suggested that a more pronounced discrepancy can exist between the early maturing adolescents' striving for individuation and autonomy and parents' aged based expectations about autonomous behaviour (Weichold, Büttig & Silbereisen, 2003). While pubertal maturation has been associated with negative emotions among adolescents, this emotionality may be partly attributed to parents who are not perceived to be sensitive to the adolescent's needs (Paikoff & Brooks-Gunn, 1991). Consistent with this interpretation, research shows that the parent-child relationship in the families of early maturing boys and girls is characterised by more conflict and is associated with decreased closeness in the early and middle adolescent years to a greater extent than in other family types (see Weichold, Silbereisen, & Schmitt-Rodermund, 2003; Huddleston & Ge, 2003). It is suggested, however, that late maturation is also associated with problematic parent-child relationships because while late maturing girls strive for individuation too, the mothers of this group of adolescents are less accepting of such attempts (Weichold et al., 2003). Findings for boys suggest an interaction between timing and age such that early maturing males experience increased family conflict in early adolescence (11-13 years) while late maturers experience this increase in mid-adolescence (15 years; Simmons & Blyth, 1987). Collectively, these findings indicate that families with off-time maturing boys and girls may be most likely to experience disparities between parent and adolescent expectations about the timing of developmental tasks. This suggests that pubertal timing may moderate links between parent-child relationship quality and adolescent substance use.

In moving beyond establishing the main effects of pubertal timing on substance use and family functioning, the contextual amplification hypothesis proposes an interplay between social processes (e.g. parenting behaviour; neighbourhood) and the pubertal transition that heightens risk for adjustment problems (Ge, Brody, Conger, Simons, & McBride, 2002). Specifically, previous research has shown that pubertal timing and contextual influences (parenting practises; disadvantaged neighbourhoods) interact to place early maturing children at increased risk of deviant peer affiliation and externalising problems (Ge et al., 2002; Ge, Conger & Elder, 1996). In the context of family relations, early maturation has been hypothesised to sensitise children to variations in parent mood and behaviour. For example, the effects of father-child hostility on psychological distress were more evident for early maturing girls relative to on-time and late-maturing girls (Ge et al., 1996). Similarly, early maturing children who experienced harsh and inconsistent parental discipline were more likely to affiliate with deviant peers and to exhibit externalising problems (Ge et al., 2002).

The Present Study

It has been argued that the directionality of links between family functioning and substance use among adolescents is problematic to determine because adolescent substance use may influence, as well as be influenced by, interactions between parent and child (Ennett et al., 2008). Mindful that reciprocal links are plausible, such that substance use by adolescents may negatively affect parent-child interactions while poor parent-child relations can engender the increased use of cigarettes and alcohol, the present study used autoregressive, cross-lagged models to examine the interplay between these behaviours across a twelve-month period. A primary aim was to investigate whether longitudinal associations between the quality of parent-child relations and girls' and boys' cigarette and alcohol use would vary as a function of pubertal timing. While previous research has identified early maturation and parent-child relationship quality as risk factors for adolescent substance use,

it is not clear how domains of family functioning might interact with the timing of pubertal development to influence use of cigarettes and alcohol.

Based on previous findings by Biehl et al., (2007) we hypothesised that earlier pubertal timing would be associated with increased cigarette and alcohol use. We regarded tests of the relationship between pubertal timing and parent-child relationship quality as exploratory based on inconsistent findings supportive of either early timing or off-time effects on adolescents experience of relationship quality with parents. Second, we hypothesised that there would be reciprocal links between poor parent-child relationship quality and cigarette and alcohol use over and above stability in these constructs across time. Following the contextual amplification hypothesis (Ge et al., 2002), our third hypothesis was that the relationship between poor parent-child relationship quality and later cigarette and alcohol use would be significantly stronger for early maturing children. Thirdly, we were also interested to examine the possibility of gender differences in the pattern of relations between parent-child relations, pubertal timing and substance use. Given that previous work does not support directional hypotheses of different associations for boys and girls, we regarded tests of the moderating role of child gender as exploratory.

In addition to the interplay between pubertal timing, parent-child relations and adolescent substance use, other influences on the relationships of interest were plausible. First, it is argued that the increased prevalence of obesity in the preadolescent population may play a role in the notion that puberty is starting earlier in Western countries (Fechner, 2003). Adolescent reports of secondary sex characteristics may reflect pubertal development, being overweight or obese or some combined effect of the two. Second, parent alcohol use and smoking behavior can be regarded as a risk factor for adolescent substance use with evidence of genetic effects and modelling effects (Hawkins et al., 1992; Fowler et al., 2007). The effects of Body Mass Index and maternal substance use were therefore considered as part of the analyses.

Method

Sample and Procedures

The sample used in this study derives from Wave 1 and Wave 2 (separated by twelve months) of the National Longitudinal Study of Adolescent Health (Add Health; Resnick et al., 1997). The Add Health study was established to determine the causes of health-related behaviours of adolescents and their outcomes in young adulthood. A sample of 80 high schools and 52 middle schools from the US was selected with unequal probability of selection. Incorporating systematic sampling methods and implicit stratification into the Add Health study design ensured this sample is representative of US schools with respect to region of country, urbanicity, school size, school type, and ethnicity (Resnick et al., 1997). Adolescents were randomly selected to take part in in-home interviews at two time points separated by twelve months (1995 response rate, 78.9% & 1996 response rate, 88.2%). Data were collected using computer assisted interview which yields higher reported prevalence of risk-taking behaviour than regular interviews (Resnick et al., 1997). Sensitive questions, including those on pubertal development and substance use were given via headphones. Audio presentation of items relating to risk-taking behaviour has also been associated with a reduction in an under-reporting bias (Turner et al., 1998). Detailed information about the design, sampling and data instruments is available in Bearman, Jones and Udry (1998).

The present study used data from 2538 adolescents (1335 girls, 1203 boys) in Grade 7 or 8 at Time 1 who lived with a mother and father to whom they were biologically related and for whom mother reports of smoking and alcohol use were available. Participants were aged 11 to 14 years at Time 1 (Mean = 13.91 years; *SD* = 0.66). Participants in the present sample

were approximately 75% White, 15% African American, 12% Hispanic, 7% Asian or Pacific Islander, 4% American Indian and 7% other. Categories were not mutually exclusive. Based on guidance provided by Widaman (2006), Multiple Imputation using the Expectation Maximisation (EM) algorithm was used to treat missing data (the amount of missing data across the study constructs ranged from 1% to 15.5% which can be regarded as moderate).

Measures

Parent-Child Relations—Adolescent appraisals of the quality of the parent-child relationship were assessed using five questions for mothers and fathers. Three questions asked adolescents how much they agreed with statements about their mother and father. These questions were: ‘Most of the time, your mother/father is warm and loving toward you’; ‘You are satisfied with the way your mother/father and you communicate with each other’; ‘Overall, you are satisfied with your relationship with your mother’. Response options ranged from 1 “Strongly agree” to 5 “Strongly disagree”. Two further questions assessed closeness and caring as ‘How close do you feel to your mother/father’ and ‘How much do you think she/he cares about you’, where response options ranged from 1 “Not at all” to 5 “Very much”. Items were coded so that higher scores reflected poorer parent-child relationship quality. The measure had good internal consistency in the present sample (Time 1, $\alpha = .87$; Time 2, $\alpha = .87$).

Cigarette Use—Cigarette use was assessed using three items indexing frequency and quantity of use: (i) ‘Have you ever smoked regularly, that is, at least 1 cigarette every day for 30 days?’ Response options were 1 “Yes” and 0 “No”, (ii) ‘During the past 30 days, on how many days did you smoke cigarettes?’ Response options ranged from 0 “No days” to 30 “thirty days”, (iii) During the past 30 days, on the days you smoked, how many cigarettes did you smoke each day? Items were standardized before they were combined to provide an overall index of cigarette use. The measure had good internal consistency at each time point (Time 1, $\alpha = .83$; Time 2, $\alpha = .85$).

Alcohol Use—Alcohol use was assessed with five items that indexed frequency and quantity of alcohol consumption: (i) ‘Do you ever drink beer, wine, or liquor when you are not with your parents or other adults in your family?’ Response options were 0 “No” and 1 “Yes”, (ii) ‘Think of all the times you have had a drink in the past 12 months. How many drinks did you usually have each time? (A ‘drink’ is a glass of wine, a can of beer, a wine cooler, a shot glass of liquor, or a mixed drink).’ (iii) ‘During the past 12 months, on how many days did you drink alcohol?’ (iv) ‘Over the past 12 months, on how many days did you drink five or more drinks in a row?’ (v) Over the past 12 months, on how many days have you gotten drunk or “very, very high” on alcohol?’ Response options for questions (iii) to (v) ranged from 1 “Every day or almost every day” to 7 “Never” and were recoded to assign higher scores to more frequent alcohol use. Items were standardized before they were combined to provide an overall index of alcohol use which had good internal consistency in the present sample (Time 1, $\alpha = .85$; Time 2, $\alpha = .93$).

It should be noted that the greater proportion of non-users relative to users, who scored a ‘0’ across all items may have contributed to the high estimates of internal consistency for cigarette use and alcohol use. Questions that assessed ‘ever use’ revealed that 60.5% of respondents had never smoked at Time 1 and 64.7% had not had an alcoholic drink (not just a taste). Alcohol use and cigarette use at Time 1 and Time 2 were positively skewed and kurtotic. The non-normal distributions of the measures of cigarette use and alcohol use were addressed using a logarithmic transformation that produced a reduction in both the skew and kurtosis value. Before transforming the variables, the skewness values ranged from 1.66 to

4.37. The kurtosis values ranged from 3.07 to 23.22. After transforming the data the skewness values ranged from 0.70 to 3.00 and the kurtosis ranged from 0.69 to 9.72. Although cigarette use (Time 1, 2) still had a comparatively high skew and kurtosis value, the sample size of 2538 suggested that the deviation would be unlikely to make a substantive difference to the pattern of results (Tabachnik & Fidell, 2001).

Pubertal Timing—While pubertal status refers to degree of physical maturation, pubertal timing is a relative concept indicating whether development occurs early, at the same time as, or later than the individuals' same-age, same-sex peers (Graber, Petersen, & Brooks-Gunn, 1996). Following previous conceptualisation and measurement approaches, pubertal timing was assessed using multiple items with an adjustment for sex and age (e.g. Ge et al., 2002; Ge, Natsuaki, Neiderhiser, & Reiss, 2007).

Females' pubertal status was assessed using four items: (i) 'As people reach adolescence, their bodies begin to change. As a girl grows up her breasts develop and get bigger. Which sentence best describes you?' Response options ranged from 1. "My breasts are about the same size as when I was in grade school" to 5. "My breasts are a whole lot bigger than when I was in grade school, they are as developed as a grown woman's breasts" (In the USA, children attend grade school between the ages of 6-10 years). (ii) 'As a girl grows up her body becomes more curved. Which sentence best describes you?' Response options ranged from 1. "My body is about as curvy as when I was in grade school", to 5. "My body is a whole lot more curvy than when I was in grade school". (iii) Females responded to a question which asked if they had ever had a menstrual period. If they answered "yes" to this question they were asked the follow-up question: 'How old were you when you had your first menstrual period?' Participants who had their first menstruation before they were age 12 years were categorised as 'early maturing' (3), those who began menstruating between 12 and 13 years were regarded as 'on-time' (2) and those who had their first period after age 13 years were categorised as 'late maturing' (1). (iv) 'How advanced is your physical development compared to other girls your age?' Response options ranged from 1 "I look younger than most" to 5 "I look older than most".

These four questions were assessed with different response formats and were standardized and summed to provide an overall index of pubertal status (Ge et al., 2007). The internal consistency of the pubertal timing measure was .61. The relatively low internal consistency of the female index of pubertal timing may reflect the varying pace of development of different features of pubertal maturation (Ge et al., 2007). The question relating to onset of menses was not strongly associated with the other indices of development (excluding this item gave an internal consistency estimate of .66). Girls (especially older girls) may also find precise recall of their age of first menses difficult. Nevertheless, age of menses is the primary index of maturation status and was retained as part of the measure.

Male pubertal status was assessed using four questions: (i) 'As people reach adolescence, their bodies begin to change. How much hair is under your arms now? Which sentence best describes you? Response options ranged from 1. 'I have no hair at all' to 5. 'I have a whole lot of hair that is very thick, as much hair as a grown man'. (ii) 'Is your voice lower now than it was when you were in grade school? Response options ranged from 1. 'No, it is about the same as when I was in grade school' to 5. 'Yes, it is a whole lot lower than when I was in grade school; it is as low as an adult man's voice'. (iii) 'How thick is the hair on your face'. Response options ranged from 1 "I have a few scattered hairs, but the growth is not thick" to 4 "The hair is very thick, like a grown man's facial hair" (iv) 'How advanced is your physical development compared to other boys your age?' Response options ranged from 1 "I look younger than most" to 5 "I look older than most". These four questions were

standardized and summed to give a composite of males' pubertal status. The internal consistency of the pubertal timing measure for males was .73.

In order to create an index of pubertal timing, the pubertal status scores for males and for females were standardized by age to provide an index of the timing of physical maturation compared to same-age same-sex peers (Ge et al., 2007). Standardizing within age (11, 12, 13, 14 years) and gender produces a pubertal timing variable with a mean of 0 and standard deviation of 1. Pubertal timing groups were created whereby adolescents who scored within one standard deviation of the mean were classed as on-time. Those who scored more than one standard deviation above the mean were classed as early maturers and adolescents who scored more than one standard deviation below the mean were classed as late maturers.

Body Mass Index—Body Mass Index (BMI) is defined as weight divided by the square of height and was calculated using imperial units as the adolescent's weight in pounds multiplied by 703 and divided by the square of their height in inches.

Maternal Substance Use—In the Add Health study, a parent, preferably the resident mother of each adolescent respondent interviewed in Wave I, completed an interviewer-assisted questionnaire (Resnick et al., 1997). Maternal reports of her substance use were assessed using two questions. Smoking behaviour was assessed as 'Do you smoke?' which had two response options, 0 'No' and 1 'Yes'. Frequency of alcohol use was assessed as 'How often do you drink alcohol?' The six response options ranged from 1 'Never' to 6 'Nearly every day'.

Statistical Analysis—Analyses showed small positive associations between adolescent and maternal substance use (assessed using maternal report of smoking status and frequency of alcohol consumption at Time 1; $r = .10$ & $.08$, $p < .01$, for cigarette use at Time 1 & Time 2; $r = .11$ & $.15$, $p < .01$, for alcohol use at Time 1 & Time 2) The effects of maternal smoking and drinking were partialled out of adolescent substance use scores using regression. In addition, the potential confounding effect of Body Mass Index (BMI) on pubertal timing scores ($r = .08$, $p < .01$), was also addressed by partialing out BMI scores prior to the creation of pubertal timing groups.

Curvilinear relationships between the continuously assessed index of pubertal timing and later substance use and parent-child relationship quality were tested using the curve fit procedure and examined using plots. For boys and girls, a linear relationship characterised the pattern of associations with the exception of the relationship between boys' pubertal timing and alcohol use at Time 2 where a quadratic trend was significant after controlling for a linear effect (linear, $\beta = .18$, $p < .01$; quadratic, $\beta = -.11$, $p < .01$). Analysis followed guidance by Ping (1998) for examining interaction and quadratic variables using stacked procedures in structural equation modelling (SEM). Models were estimated using maximum likelihood estimation in LISREL 8.50 (Jöreskog & Sörbom, 1996). The sample was split according to pubertal timing (early; on-time; late). Constraining the model coefficients to be equal between subgroups provides a chi-square statistic which, if significant, indicates a difference in the magnitude of the coefficient between the groups. Subgroup comparison tests using stacked modelling procedures were also employed to consider whether the magnitude of parameter estimates in each model were significantly different for boys and girls. Samples of 100 cases per subgroup are regarded as a minimum sample size for such tests and these criteria were met (Ping, 1998).

Results

Means, standard deviations and correlations are presented separately for girls and boys in Table 1. Parent-child relationship quality at Time 1 was associated within and across time with cigarette and alcohol use ($r = .10$ to $.32$, $p < .01$). Cigarette and alcohol use at Time 1 was also associated with parent-child relationship quality twelve months later ($r = .13$ to $.23$, $p < .01$). Comparing levels of substance use between boys and girls revealed no differences at Time 1 or Time 2 ($t = -0.47$ to 0.33 , $p > .10$; see Table 1 for means and standard deviations by gender). Girls reported poorer quality of parent-child relations at Time 1 ($t = -6.52$, $p < .001$) and at Time 2 ($t = -6.03$, $p < .001$) compared to boys.

Multivariate analysis of variance was used to test whether pubertal timing was associated with levels of substance use and reports of parent-child relationship quality for girls and boys, respectively. Several differences were found in levels of substance use as a function of pubertal timing (see Table 2 for means and standard errors by group). Simple effects tests using the Bonferroni correction indicated that early maturing boys and girls had higher rates of cigarette and alcohol use at Time 1 compared to their on-time and late maturing counterparts (boys: $F(2, 1200) = 14.90$ & 14.04 , $p < .05$, partial $\eta^2 = .02$ for cigarette and alcohol use respectively; girls: $F(2, 1331) = 7.93$ & 14.41 , $p < .05$, partial $\eta^2 = .01$ & $.02$ for cigarette and alcohol use respectively). At Time 2, differences were also found among the groups for levels of substance use (boys cigarette use: $F(2, 1200) = 3.60$, $p < .05$, partial $\eta^2 = .01$; alcohol use: 6.50 , $p < .01$, partial $\eta^2 = .01$; girls cigarette use: $F(2, 1331) = 5.15$, $p < .01$, partial $\eta^2 = .01$; alcohol use: 8.77 , $p < .05$, partial $\eta^2 = .01$). Early maturing boys and girls had higher rates of cigarette and alcohol use than their late maturing peers. Early maturing girls also had higher rates of alcohol use than on-time maturing girls. Boys who matured on-time had higher rates of alcohol use than their late maturing peers. Examining whether levels of parent-child relationship quality differed across pubertal timing groups revealed that early maturing girls reported poorer relationship quality with their parents compared to on-time maturing girls at Time 1 ($F(2, 1331) = 5.34$, $p < .01$, partial $\eta^2 = .01$) but not at Time 2 ($F(2, 1331) = 1.02$, $p > .10$, partial $\eta^2 = .00$). No differences were observed for boys at Time 1 ($F(2, 1200) = 2.69$, $p > .10$, partial $\eta^2 = .00$) or Time 2 ($F(2, 1200) = 0.27$, $p > .10$, partial $\eta^2 = .00$).

Structural Equation Modelling

The results of the model tests are presented for girls in Figure 1 and for boys in Figure 2. The models were fully saturated with no degrees of freedom; therefore, the fit to the data was perfect. Parent-child relationship quality appeared relatively stable across time ($\beta = .53$ to $.70$, $p < .01$) as did substance use (cigarette use $\beta = .44$ to $.68$, $p < .01$; alcohol use $\beta = .49$ to $.62$, $p < .01$).

For on-time maturing girls, reciprocal links were found between parent-child relationship quality and cigarette use and alcohol use, such that poor parent-child relationship quality at Time 1 was associated with increased substance use at Time 2 ($\beta = .06$ & $.09$, $p < .05$, for cigarette and alcohol use respectively) while substance use at Time 1 was linked with poor parent-child relationship quality twelve months later ($\beta = .10$, $p < .01$ & $.06$, $p < .05$, for cigarette and alcohol use respectively). For early maturing girls, parent-child relationship quality predicted alcohol use twelve months later ($\beta = .16$, $p < .05$). No other effects were observed over and above stability in study constructs across time. For late maturing girls, reciprocal effects were found between parent-child relationship quality and cigarette use ($\beta = .25$ & $.12$, $p < .05$). In addition, Time 1 alcohol use was associated with poor parent-child relationship quality at Time 2 in this group ($\beta = .18$, $p < .05$). Parent-child relationship quality at Time 1 was not associated with late maturing girls' alcohol use at Time 2 ($\beta = .00$, $p > .10$).

Stacked model comparisons revealed two significant differences in the magnitude of effects as well as two trends. The relationship between Time 1 parent-child relationship quality and cigarette use at Time 2 was significantly stronger for late maturing girls compared to early maturing girls (late, $\beta = .25, p < .05$; early, $\beta = .03, p > .10$; $\Delta\chi^2_1 = 4.13, p < .05$) and to girls who matured on time (on-time, $\beta = .06, p < .05$; $\Delta\chi^2_1 = 4.38, p < .05$). There was a trend such that the path between Time 1 alcohol use and parent-child relationship quality at Time 2 was stronger for late maturing girls compared to early (late, $\beta = .18, p < .05$; early, $\beta = .04, p > .10$; $\Delta\chi^2_1 = 3.52, p < .06$) and on-time maturing girls time (on-time, $\beta = .06, p < .05$; $\Delta\chi^2_1 = 3.83, p = .05$).

For on-time maturing boys, reciprocal effects were observed between parent-child relationship quality and substance use across the twelve month period ($\beta = .06$ to $.09, p > .10$). For off-time maturing boys (early & late) the reciprocal paths linking parent-child relationship quality with cigarette and alcohol use were non-significant ($\beta = -.04$ to $.04, p > .10$). There were no differences in the magnitude of parameter estimates for boys as a function of pubertal timing.

Gender Differences

Stacked model comparisons by gender for each pubertal timing group revealed two differences in the magnitude of effects (see Figure 1 & 2). For late maturing adolescents, parent-child relationships was associated with girls' but not boys' increased cigarette use twelve months later (girls, $\beta = .25, p < .01$; boys, $\beta = .00, p > .10$; $\Delta\chi^2_1 = 4.78, p < .05$). Also, alcohol use was associated with increased problems in the parent-child relationship one year later for late maturing girls but not late maturing boys (girls, $\beta = .18, p < .01$; boys, $\beta = .04, p > .10$; $\Delta\chi^2_1 = 6.55, p < .01$).

Discussion

The present study examined the transactional nature of links between parent-child relationship quality and cigarette and alcohol use in the early adolescent years. By highlighting variability in the nature of the link between parent-child relationship quality and substance use as a function of adolescents' psychosocial experience of maturation, the findings of the present study point to differences in individual vulnerabilities for the use of cigarettes and alcohol in early adolescence.

Support was found for the hypothesis of reciprocal relationships operating between parent-child relationship quality and adolescent cigarette and alcohol use for girls and on-time maturing boys. These effects operated in the context of relatively high stability in both appraisals of parent-child relationship quality and cigarette and alcohol use. For adolescents whose pubertal timing can be characterised as on-time, a reciprocal pattern of effects linked parent-child relationship quality with cigarette and alcohol use across a twelve-month period. For boys whose pubertal timing was off-time (early or late), parent-child relationship quality and substance use were not associated in a reciprocal fashion. Similarly, with the exception of the path linking parent-child relationship quality with increased alcohol use, reciprocal effects were not observed for early maturing girls.

Overall, the pattern of associations indicates that parent-child relationship quality is associated with increased cigarette use and alcohol use in adolescence which is consistent with previous research showing that emotional distance and a non-supportive relationship between parent and child is associated with increased use of alcohol (Brody & Ge, 2001). Conversely, frequent and heavy use of cigarettes and alcohol also appears to disrupt the closeness of the parent-child relationship, particularly for on-time and late maturing adolescents. This finding may reflect an increase in the time adolescents spend away from

the home with [substance-using] peers as well as the difficulties of managing a close parent-child relationship in the context of adolescent substance use.

Somewhat at odds with existing research (e.g. Biehl et al., 2007) a curvilinear relationship was identified between a continuous measure of boys' pubertal timing and alcohol use at Time 2 after controlling for linear effects. The findings are consistent with an off-time/deviance perspective (Petersen & Taylor, 1990) in suggesting that adolescents whose development is most deviant from the usual timing of socially accepted life sequences are more at risk of adjustment problems. The results also converge with those of a series of empirical studies conducted in the 1990s (e.g. Andersson & Magnusson, 1990; Orr & Ingersoll, 1995) in which both early and late maturing boys had elevated rates of alcohol use and problem use (e.g. drunkenness) and have been interpreted in the context of social processes and efforts to achieve prestige in the peer group (Weichold et al., 2003). Overall, the results highlight the importance of continuing to undertake nationally representative, longitudinal research to chart the use of cigarettes and alcohol in relation to pubertal timing as well as, having obtained this data, testing for non-linear associations.

Support was found for the hypothesis that substance use would be elevated among early maturing girls (e.g. Biehl et al., 2007; Chung et al., 2005; Lanza & Collins, 2002). Late maturing girls had lower levels of substance use than early maturing girls and early maturing girls reported poorer quality relationships with their parents. However, the findings of the present study suggest that late maturing girls' substance use and parent-child relationship quality are related in interesting ways over time that was not evident for the other groups to the same extent. Specifically, parent-child relationship quality was more strongly associated with increased cigarette use among late maturing girls. In addition, a trend-like effect was noted whereby the relationship between alcohol use and parent-child relationship quality assessed twelve months later was stronger for late maturing girls. Such a finding possibly reflects parent expectations about late maturing girls' behaviour in relation to their physical appearance.

Previous research suggests that some alcohol use in the early adolescent period may be regarded as normative and that initiation of use is modestly associated with progression to heavier use and problem use (e.g. binge drinking; Fowler et al. 2007). Our findings suggest that the view of alcohol use as age normative may be qualified by pubertal timing. The early adolescent years are considered a sensitive period for parents, during which they must learn to facilitate appropriate levels of autonomy, relinquish some control and remain supportive; the extent of their success may influence adolescent adjustment and behaviour (Galambos, Barker & Almeida, 2003). The use of alcohol by late maturing girls may be problematic for parents because there is a greater conflict of interest between girls' increased need for autonomy (linked to their chronological age and comparison with same-age peers) on the one hand and parents' vigilance and control (linked to their daughter's physical maturity) on the other. In other words, late maturing girls' relative stage of maturation is incongruent with the increased autonomy that characterises their behaviour, including substance use.

In addition, it appears that the late maturing girls' experiences in the home with regard to decreased closeness and satisfaction in relations with their parents has a stronger association with their cigarette use than is observed with on-time or early maturing girls. This may be because late maturing females remain concerned and involved in family relationships and interactions for a longer period of time compared to other girls and that smoking cigarettes is used as a means to cope with unhappiness and conflict in the parent-child relationship. This interpretation is consistent with a research literature showing that adolescent girls, particularly those with a strong interpersonal orientation, show elevated levels of psychological distress in response to family conflict compared to boys (e.g. Davies &

Lindsay, 2004; Gore, Aseltine & Colten, 1993) and with work documenting a link between parenting characterised by low warmth and high hostility with smoking behaviour over and above peer influence and parent substance use (Melby et al., 1993).

Further research is required to investigate the mechanisms of effect linking family functioning, pubertal timing and adolescence substance use. For example, overlapping genetic influences have been identified between adolescent appraisals of negativity in the parent-child relationship and substance use (e.g. Shelton et al., 2008) as well as behaviour problems (e.g. Burt, Krueger, McGue & Iacono, 2003). In addition, problems in the parent-child relationship can lead to increased affiliation with peers which brings with it an increased likelihood of exposure to substances (Kandel & Andrews, 1987). Generally however, it would be optimal to assess these constructs at an earlier age to enable the unfolding links between experimentation with substances and quality of family relationships to be charted over a longer period of time that includes early pubertal development. Capturing the interplay between social contexts to explain initiation and progression of adolescent substance use is an important avenue for research (e.g. Ennett et al., 2008) while the results of the present study also underscore the potential role played by the psychosocial component of maturation as a moderator of these relationships.

Limitations

How adolescents perceive themselves and their level of development can be argued to be particularly important in understanding the interplay between markers of maturity, family-level stress and substance use. Self-ratings using a questionnaire index of pubertal development can be preferable for use with non-clinical samples (Hayward, 2003) while adolescents' social cognitions about family relationships operate as a mechanism through which family stress effects psychological adjustment (Harold & Conger, 1997). Adolescents are also likely to be the best reporters of their own substance use. However, a reliance on self report may have inflated the observed associations between study constructs.

The first wave of the Add Health study sampled adolescents when they were in 7th grade (12-13 years old). To be in a stronger position to speculate about the temporal nature of the associations between parent-child relationships and substance use, it would have been preferable to have assessments of these behaviours and indices of pubertal timing at an earlier age. This would give a clearer impression of whether the increased conflict and control that has been identified as characterising relationships between parents and early maturing girls (e.g. Weichold et al., 2003) is partly a response to girls' behaviour (e.g. affiliation with an older peer group; substance use) and/or a concern by parents about the prospect of such behaviour occurring.

The importance of early and repeated assessments of pubertal maturation is also relevant to consideration of the relatively low internal consistency of the measure of pubertal timing for girls. The phrasing of some of the questions assessing pubertal maturation and physical development asked respondents to compare their physical development to when they were in grade school (up to 10 years old). Recent estimates indicate that the mean age of onset of breast development in the United States is now approximately 10 years in Caucasian girls and less than 9 years in African American girls (Herman-Giddens et al., 1997). Thus, while the mean age of menarche remains approximately 12 years old, many girls in the present study likely experienced the development of other pubertal characteristics in grade school. Variation in the pace of development of different features of pubertal maturation may have affected the reliability of the pubertal timing measure (Ge et al., 2007).

The present study advances understanding of the interplay between parent-child relationships quality, substance use and pubertal timing in the early adolescent years. Risk

taking, including some forms of experimentation with substances, is regarded as a normal part of adolescence, representing developmentally appropriate behaviour (Spear, 2000). Yet, understanding the risk factors and mechanisms that lead some adolescents to earlier initiation and heavier use of substances is arguably central to reducing the existing public health burden presented by frequent and/or excessive drinking and smoking. These findings indicate that parent-child relationship quality and the use of cigarettes and alcohol are reciprocally linked over and above stability in these constructs across a twelve-month period. Poor parent-child relationship quality appears to be particularly problematic for levels of cigarette use among late maturing girls. Intervention and education programs may be enhanced by an awareness and understanding of the interplay between pubertal timing and substance use in exacerbating negative experiences of parent-child relationship quality in early adolescence.

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Figure 1.
Panel A: Maximum likelihood estimation of the relationship between parent-child relationship quality and adolescent girls' cigarette use; $*p < .05$, $**p < .01$. *Panel B:* Maximum likelihood estimation of the relationship between parent-child relationship quality and adolescent girls' alcohol use; $*p < .05$, $**p < .01$. Values appear in sequence for early ($N = 183$), on-time ($N = 1003$) and late ($N = 143$) maturing girls. † denotes magnitude of effect differs between pubertal timing groups.

Figure 2.

Panel A: Maximum likelihood estimation of the relationship between parent-child relationship quality and adolescent boys' cigarette use; $*p < .05$, $**p < .01$. *Panel B:* Maximum likelihood estimation of the relationship between parent-child relationship quality and adolescent boys' alcohol use; $*p < .05$, $**p < .01$. Values appear in sequence for early ($N = 144$), on-time ($N = 899$) and late ($N = 160$) maturing boys.

Table 1

Correlations Among Study Variables, Means and Standard Deviations For Girls (below diagonal, N=1335) and Boys (above diagonal, N=1203)

	1	2	3	4	5	6	Mean	SD
<u>Time 1</u>								
1. Parent-Child Relationship Quality	--	.26**	.20**	.62**	.23**	.16**	14.07	4.44
2. Cigarette Use	.21**	--	.53**	.20**	.62**	.30**	0.76	0.12
3. Alcohol Use	.32**	.51**	--	.16**	.44**	.54**	0.72	0.21
<u>Time 2</u>								
4. Parent-Child Relationship Quality	.64**	.21**	.26**	--	.22**	.19**	15.38	4.47
5. Cigarette Use	.21**	.67**	.45**	.27**	--	.44**	0.76	0.13
6. Alcohol Use	.27**	.38**	.58**	.27**	.47**	--	0.70	0.25
Mean	15.35	0.76	0.72	16.58	0.75	0.69		
Standard Deviation	5.45	0.11	0.20	5.56	0.13	0.26		

Note:

*
 $p < .05$;**
 $p < .01$.

Table 2
Means and Standard Errors For Levels of Cigarette and Alcohol Use at Time 1 and Time 2 by Pubertal Timing Group

	Boys			<i>F</i>	<i>p</i>
	Early Mean (<i>SE</i>)	On-time Mean (<i>SE</i>)	Late Mean (<i>SE</i>)		
<u>Time 1</u>					
Parent-Child Relations	14.55 (0.37)	13.90 (0.15)	14.61 (0.35)	2.69	0.07
Cigarette use	0.81 (0.01) ^a	0.75 (0.00) ^b	0.74 (0.01) ^b	14.90	0.00
Alcohol use	0.80 (0.02) ^a	0.71 (0.01) ^b	0.68 (0.02) ^b	14.04	0.00
<u>Time 2</u>					
Parent-Child Relations	15.62 (0.37)	15.33 (0.15)	15.44 (0.35)	0.27	0.76
Cigarette use	0.78 (0.01) ^a	0.75 (0.00) ^b	0.74 (0.01) ^b	3.60	0.03
Alcohol use	0.74 (0.02) ^a	0.70 (0.01) ^b	0.64 (0.02) ^c	6.50	0.00
	Girls				
	Early Mean (<i>SE</i>)	On-time Mean (<i>SE</i>)	Late Mean (<i>SE</i>)		
<u>Time 1</u>					
Parent-Child Relations	16.57 (0.40) ^a	15.16 (0.17) ^b	15.14 (0.45)	5.34	0.01
Cigarette use	0.78 (0.01) ^a	0.76 (0.00) ^b	0.73 (0.01) ^b	7.93	0.00
Alcohol use	0.79 (0.02) ^a	0.72 (0.01) ^b	0.67 (0.02) ^b	14.41	0.00
<u>Time 2</u>					
Parent-Child Relations	16.88 (0.41)	16.47 (0.18)	17.06 (0.47)	1.02	0.36
Cigarette use	0.78 (0.01) ^a	0.75 (0.00) ^{a, b}	0.73 (0.01) ^b	5.15	0.01
Alcohol use	0.76 (0.02) ^a	0.69 (0.01) ^b	0.64 (0.02) ^b	8.77	0.00

Note: Means in the same row with different superscripts differ significantly at $p < .05$.