Title: A longitudinal study of self-control at the transition to secondary school: considering the role of pubertal status and parenting

Authors and affiliations

Terry Ng-Knight[a*], Katherine H. Shelton[b], Lucy Riglin[a], I. C. McManus[a], Norah Frederickson[a], and Frances Rice[a]

a Department of Clinical, Educational and Health Psychology, University College London, UK.

b School of Psychology, Cardiff University, UK.

[*] Correspondence/present address:

Terry Ng-Knight, Department of Clinical, Educational and Health Psychology, University College London, 26 Bedford Way, London, WC1H OAP.

Contact: terry.ng-knight.11@ucl.ac.uk

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Abstract: Higher self-control in children and adolescents is associated with a range of positive outcomes in adulthood. However, little is known about the naturalistic development of self-control during early adolescence and the factors that affect this. We examined the role of puberty and parenting style as theoretically important influences on stability and change in self-control. A longitudinal (3 waves), multiple-informant dataset of children entering early adolescence (*M* =11 years) was used to explore longitudinal change in self-control using latent growth curve modelling. Children's self-control declined during the one-year study period and declines were associated with children's behavioural and social functioning. Associations with self-control were found for pubertal status and parental warmth and hostility, but not for parental discipline. The findings suggest that during early adolescence, when children make the transition to secondary school, self-control declines. This is particularly the case for those experiencing puberty earlier than their peers. Parent warmth influences the trajectory of self-control during this period.

Keywords: parenting, puberty, self-control, self-regulation, psychological adjustment.

Adolescence is an important period for exercising self-control, with research suggesting that many of the adverse long-term effects of low childhood self-control are mediated by poor choices made in adolescence (Moffitt et al., 2011; Steinberg, 2007). Self-control involves the ability to control attention, thoughts, impulses and emotions and to direct behaviour towards long-term goals (Tangney, Baumeister, & Boone, 2004). It is a strength that allows people to delay immediate gratification, consider consequences and take deliberate, considered action. Elucidating factors that influence childhood self-control and that could potentially be targeted in interventions is an important research aim, particularly in light of recent research that has identified childhood self-control as an important factor in later health and wealth outcomes (Israel et al., 2014; Moffitt, 2015). Self-control emerges as a trait early in childhood and shows modest stability in pre-school children (Ahadi & Rothbart, 1994). Nevertheless, as with other personality traits (Roberts & DelVecchio, 2000), naturalistic changes in self-control do occur (e.g., Moffitt et al., 2011) and commentators have highlighted the importance of understanding what factors promote naturalistic improvements in self-control (Duckworth, 2011).

One potentially important factor is puberty. Theoretical models view puberty, and adolescence more generally, as a period characterised by vulnerability to reduced self-regulation and increased risk-taking, thought to be due to the combination of an immature cognitive control system operating alongside a hyper-sensitive reward system (Ernst, Pine, & Hardin, 2006; Steinberg, 2005; Van Leijenhorst et al., 2010). In particular, changes to the limbic system which are initiated by a surge in gonadal hormones associated with the onset of puberty are believed to play a role in the increases in reward seeking observed during adolescence (Crone, 2009; Nelson, Leibenluft, McClure, & Pine, 2005; Steinberg et al., 2008). This includes an increased sensitivity to anticipated, received and uncertain rewards as well as the capacity to experience threat signals as exciting and stimulating (Spielberg, Olino, Forbes, & Dahl, 2014; Van Leijenhorst et al., 2010). Empirical research into risk-seeking and theoretical work on self-regulation during adolescence therefore indicates children's pubertal development may exert effects on their capacity for self-regulation. To date, however, there is little data demonstrating an empirical link between pubertal status and specific measures of self-control (van Duijvenvoorde et al., 2014). Taken together, these findings emphasise the importance of understanding the developmental course of self-control during early adolescence and of considering the effects of puberty on self-control in young people.

Early adolescence also coincides with important events such as children's transition from primary to secondary schooling (e.g., from elementary to middle school in the US school system). How well children adapt to their new school has potentially important ramifications for their future functioning (Felner, Ginter, & Primavera, 1982; Rutter, 1989; Seidman & French, 2004; West, Sweeting, & Young, 2010) and self-control is likely to be an important strength that assists adaptation to the new school environment and social structures where greater academic independence and organisation is expected and relationships with peers and teachers change (Bowes et al., 2013; Eccles et al., 1993). While it is well-established that there are advantages of high self-control during early adolescence, a number of basic developmental questions merit examination. First, there is little empirical evidence describing the normal development of self-control over time, particularly in samples of similarly-aged children. Second, there is still relatively little data assessing to what extent naturalistic changes in self-control are associated with children's functional outcomes such as symptoms of psychopathology, social functioning and school attainment.

A second potentially important factor influencing self-control is parenting. Self-control is thought to develop through transactions between individual characteristics and the family environment, where good self-regulation promotes positive parent-child relationships which in turn contribute to good self-control (Wills & Dishion, 2004). Both theory and evidence point to parenting characteristics such as parental warmth and non-punitive control being associated with greater competencies in children (e.g., Grolnick & Farkas, 2002; Spera, 2005), however, a number of important issues have still to be addressed. First, whilst a number of studies have shown cross-sectional associations between adolescent self-control and various parenting characteristics (e.g., Brody & Ge, 2001; Finkenauer, Engels, & Baumeister, 2005; Lengua, 2008), evidence of longitudinal associations tends to come from studies of younger children and research has not yet considered the relative association of different aspects of parenting, such as affect and discipline (Belsky, Fearon, & Bell, 2007; Cecil, Barker, Jaffee, & Viding, 2012). Second, some existing research, such as that on the General Theory of Crime, aggregates behavioural problems and self-control making specific conclusions about self-control difficult (Gottfredson & Hirschi, 1990) and where self-control has been studied specifically only a handful of previous studies have controlled for behavioural problems. This is important because behavioural problems are known to be associated with parenting and impairments in aspects of self-control are common features of behavioural problems (Fergusson, Boden, & Horwood, 2013; Krueger, Caspi, Moffitt, White, & Stouthamer-Loeber, 1996).

Previous research on the relations between parenting and longitudinal change in self-control during early adolescence are less consistent than that focusing on childhood (Kiff, Lengua, & Zalewski, 2011). For example, a longitudinal study found positive parenting characteristics (warmth and expressivity) were related to longitudinal change in children's self-control when children aged 7 to 12 years were followed up two years later at ages 9 to 14, but this pattern was not repeated when children were followed-up again a further two years later at ages 11 to 16 (Eisenberg et al., 2005). These findings underscore the potential importance of considering the broader developmental context when assessing associations between parenting and self-control. The earliest external changes associated with puberty are apparent at an average age of 11 in both boys and girls in many developed countries (Parent et al., 2003; Patton & Viner, 2007) therefore it is possible that the onset of puberty may account for some of the inconsistencies in the literature to date. Thus, there is evidence that relations between parenting and self-control during adolescence are less consistent than those in childhood and it therefore may be important to consider the moderating role of puberty.

In the current study, we examined the relations between multiple well-defined parenting dimensions and longitudinal change in children's self-control, including both negative (hostility and inconsistent discipline) and positive (warmth and inductive reasoning) aspects of parents' affect and discipline. We also examined whether individual differences in pubertal status (individual differences in pubertal development at baseline) and pubertal tempo (the speed of pubertal development) were associated with longitudinal change in children's self-control (Ellis, Shirtcliff, Boyce, Deardorff, & Essex, 2011). Next, because it has been claimed that adolescence is characterised by changes to children's relationships with their parents (e.g., increased autonomy and parent-child conflict; Larson & Richards, 1991; Steinberg & Morris, 2001) and existing findings indicate that the effects of parenting on children's self-control decrease as children approach adolescence, we examined whether individual differences in pubertal status moderate the relationship between parenting and self-control. This study was conducted during children's transition from primary to secondary school as this ecological transition coincides with the average onset of puberty. We analysed latent growth in children's self-control using a three-wave longitudinal, multiple-informant dataset collected from an ethnically and socially diverse sample of similarly-aged children who were transitioning to secondary school. We considered the following questions:

1) How does self-control develop during early adolescence and does this vary across individuals?
2) Are baseline levels and longitudinal change in self-control associated with differences in functional outcomes?
3) Are individual differences in pubertal status and pubertal tempo associated with children's self-control and longitudinal change in self-control?
4) Are dimensions of parenting associated with children's self-control and longitudinal change in self-control?
5) Are associations between parenting and children's self-control moderated by individual differences in pubertal status?

Method

Research procedure and participants

Ethical approval for the study was obtained from the University College London Research Ethics Committee. Informed consent (parents) or assent (children) was obtained from all participants. Participants were recruited from 10 secondary schools in the South East of England which were selected to be broadly representative of English secondary schools in terms of examination pass rates and the proportion of pupils with Special Educational Needs, from minority ethnic backgrounds, and from economically disadvantaged households. The selection of primary school pupils took place via the secondary schools, with secondary schools' lists of prospective pupils forming the study sampling frame. Data were collected from children on three occasions, 6 months apart. Children completed a postal questionnaire at wave 1 and completed questionnaires during the school day for waves 2 and 3. Parents completed a postal questionnaire at wave 1. Teachers completed a questionnaire about children's behaviour at wave 3.

Completed questionnaires were obtained from 750 children at wave 1, just prior to starting secondary school (35% of those invited to participate), 1712 at wave 2 (87% of those invited), and 1653 at wave 3 (85% of those invited). The first assessment was conducted when children were an average of 11 years and 3 months old (*SD* = 0.29 years). Questionnaires were also obtained from 745 parents/guardians at wave 1 and 1594 teachers at wave 3. Response rates at wave 1 were lower due to an opt-in postal questionnaire format, whereas follow-up assessments were conducted in school and used an opt-out procedure. Data collected from school records show that the full sample is broadly representative of the local population of schoolchildren from which it was drawn in terms of: indicators of socioeconomic deprivation (16% this sample vs 14% in the local population), the proportion of individuals from minority ethnic groups (40% vs 33%) but has very slightly higher attainment levels than the national average as measured by achieving level 4 at key stage 2 national curriculum levels (English 89% vs 82%; Maths 90% vs 81%) (Department for Education, 2011).

Measures

Following recommendations by Rutter, Pickles, Murray, and Eaves (2001) separate informants were used, where possible, to measure key predictor and outcome variables. All scales described here were calculated so that higher scores indicate higher levels of the behaviour or construct.

Self-control. At all three waves the 13-item Brief Self-Control Scale (BSCS; Tangney et al., 2004) was used to measure children's self-regulatory behaviour (self-report) in four domains: thoughts, emotions, impulses and performance (e.g., 'I am good at resisting temptation'). Items are rated on a five point scale (1 = not at all; 2 = very little; 3 = somewhat; 4 = quite a bit; 5 = very much). The scale showed good internal consistency (*α's* range =.80 to .81) and has previously been used with children (e.g., Duckworth & Seligman, 2005; Finkenauer et al., 2005).

Parenting. Parenting was assessed at wave 1 with parents' reports on four subscales of the Iowa Youth and Families Project Interaction Rating Scales (Melby et al., 1993; item scale range from 1 = always to 7 = never). Two scales measured parent's positive and negative affection expressed towards their child in the past month: Warmth (six items, e.g., 'How often did you let them know you really care about them?' α =.87) and Hostility (four items, e.g., 'How often did you get angry at them?' α =.76). Two scales measured the strategies parents' use to control their child: Inconsistent Discipline (four items, e.g., 'Once a punishment has been decided, how often can they get out of it?' α =.71) and Inductive Reasoning (four items, e.g., 'How often do you give reasons to this child for your decisions?' α =.79). These questionnaire scales have been widely used to assess parenting behaviours (e.g., Brody et al., 2005; Dogan, Conger, Kee Jeong, & Masyn, 2007).

Pubertal status. At all three waves individual differences in children's pubertal status was assessed using the nine-item Puberty Development Scale (PDS; Petersen, Crockett, Richards, & Boxer, 1988) which shows good validity in comparison to physician ratings (Brooks-Gunn, Warren, Rosso, & Gargiulo, 1987). Items asked pupils (i.e., self-report) whether there had been no development, a little development or a lot of development in five areas. All children were asked about body hair, skin and increased speed of growing. Boys were additionally asked about 'voice breaking' and facial hair. Girls were additionally asked about breast development and menarche. The scale also asked whether physical development in these areas was complete (like that of an adult). Scores for each characteristic (1 = no development; 2 = a little; 3 = a lot; 4 = complete or like that of an adult) were summed to produce a continuous puberty scale (range: 5-20, α =.65 and .60 for girls and boys, respectively). PDS scores were used to assess both pubertal status and pubertal tempo (see statistical analysis section).

Functional outcomes. Teachers completed five subscales of the Strengths and Difficulties Questionnaire (SDQ) at wave 3: emotional symptoms; conduct problems; hyperactivity; peer problems; and pro-social behaviour (*α's* range =.75 to .85). At wave 3, academic attainment data was measured using children's end of year Maths, English and Science assessments obtained from school records. To account for differences in measurement systems between schools, attainment scores were standardised within schools. Adjustment to secondary school was assessed using teacher reports on the Secondary Transition Adjustment Rating Tool (START) (Ng-Knight et al., under review; Rice et al., 2015), which comprises four items that assess the major concerns and challenges of secondary school: academic performance, social relationships with peers, social relationships with teachers and the new routine (α = .83). Higher scores indicate better post-transition adjustment.

Control variables. Statistical controls for age and behavioural problems (using the SDQ total difficulties scale) were included to adjust for their potentially confounding effects on measures of pubertal status and self-control, respectively. Age was measured in months (*M* =134.60, *SD* =3.53). Parents completed the SDQ (Goodman, 2001) at wave 1, a total difficulties score was generated from 20-items measuring children's adjustment and psychopathology (α =.83). Gender was coded as 0 = male and 1 = female (54% male). Parental education was measured with parent self-reports of the highest parental qualification obtained by either parent (0 =none, 4.8%; 1 =secondary school, 28.5%; 2 =further education, 22.2%; 3 =university undergraduate, 28.8%; 4 =university postgraduate, 15.6%).

Statistical Analysis

Analyses were conducted in Mplus version 7 (Muthén & Muthén, 2012). Latent growth curve modelling was used to investigate baseline levels and longitudinal change in children's self-control and pubertal status. Two main parameters are provided by growth curve models, the *intercept* and the *slope* for each variable of interest (Kline, 2011). For self-control, the intercept represents the level of self-control at baseline (wave 1) and the slope represents the change in self-control over the three study waves. For pubertal status, the intercept represents individual differences in pubertal status at baseline (when children were an average age of 11 years 3 months), and the slope represents pubertal 'tempo' (the speed of pubertal development) over the three study waves (Ellis et al., 2011). Full information maximum likelihood (FIML) estimation was used to treat missing data, FIML uses all of the available information for each participant rather than deleting participants or imputing values (Schafer & Graham, 2002). Analyses with this sample have shown that wave 1 respondents are a slightly more academically able subgroup (t (1594) = -3.55, p <.001) and are also higher on self-reported self-control (t (1422) = -3.56, p <.001) and have lower teacher-rated SDQ total difficulties (t (1203) = 3.10, p <.01). Thus, this dependence of missingness on observable characteristics indicates that data are more likely to be missing at random (MAR) rather than missing completely at random (MCAR), underscoring the importance of using an analytic approach which accounts for missing data (Allison, 2001; Enders & Bandalos, 2001; Graham, 2009; Schafer & Graham, 2002). FIML can provide unbiased estimates in the presence of missing data, particularly when the statistical model includes variables that correlate highly with the variables that have missing data (e.g., self-control measured at waves 2 and 3 provide additional statistical information about the missing responses to the self-control scale at wave 1; Graham, 2009).

We use the conventional 5% level (i.e., p <.05) as our threshold for statistical significance, however, we report exact p values throughout the manuscript (except where p <.001) to give a more precise indication of the statistical robustness of findings reported here (American Psychological Association, 2009; Cumming, 2014).

Research question 1 was investigated by modelling a latent growth curve of self-control. Research question 2 was investigated by testing associations between self-control and children's functioning (measured at wave 3) in a structural equation model where the intercept and slope of self-control predicted all nine functioning variables simultaneously. Research questions 3 and 4 were investigated by examining the associations between parenting measures, pubertal status and self-control in a structural equation model where baseline measures of parenting and pubertal status growth curve parameters were predictors of the intercept and slope of children's self-control. These associations were first assessed as unadjusted associations for each predictor variable (i.e., parental warmth, parental hostility, inconsistent discipline, inductive reasoning, pubertal status, pubertal tempo) and control variable (i.e., gender, age, parental education, total difficulties) separately and then simultaneously assessed in a multivariate model. Finally, to address research question 5 we tested whether the effects of parenting on children's self-control were moderated by baseline pubertal status by adding interaction terms to the multivariate model.

Results

<TABLE 1 ABOUT HERE>

RQ1. How does self-control develop during early adolescence and does this vary across individuals?

The mean level of children's self-control decreased between each wave of data collection (Table 1). A latent growth curve model fitted the data well, χ^2 (N =1815, 3) =10.35, *p* =.02, RMSEA =.04, CFI =.99, SRMR =.098. At baseline, the average score on the self-control scale was 3.78 with significant variability in these scores across individuals (*intercept variance* =.30, *p* <.001). On average, scores on the self-control scale declined by .07 between each assessment (*slope mean* = -.07, *p* <.001). Slopes showed significant variation across individuals (*slope variance* =.02, *p* =.002), suggesting that individuals changed at different rates.

RQ2. Are baseline levels and longitudinal change in self-control associated with differences in functional outcomes?

Higher levels of self-control at baseline were associated with superior functioning in a range of areas at wave 3, including: school attainment ($\beta_{English}$ =.24, *p* <.001; β_{Maths} =.21, *p* <.001; $\beta_{Science}$ =.25, *p* <.001), behaviour ($\beta_{Conduct\ Problems}$ = -.24, *p* <.001; $\beta_{Hyperactivity}$ = -.31, *p* <.001; $\beta_{Prosocial\ Behaviour}$ =.25, *p* <.001), emotional problems (β = -.08, *p* =.04), peer relationships (β = -.12, *p* =.003), and adaptation to secondary school (=.26, *p* <.001). The rate of change (slope) of self-control also predicted behavioural and social functioning and adaptation to secondary school, specifically, less decline in self-control was associated with lower levels of conduct problems (β = -.34, *p*

<.001), hyperactivity (β = -.29, p <.001), and peer problems (β = -.22, p =.01) and with higher levels of prosocial behaviour (β =.26, p =.002) and better adaptation to secondary school (β =.31, p <.001). That is, those individuals who showed less decline in self-control over the study period showed better functioning assessed at the end of the study.

RQ3. Are individual differences in pubertal status and pubertal tempo associated with children's self-control and longitudinal change in self-control?

The mean scores on the PDS increased between each wave of data collection (Table 1). A latent growth curve model fit the data well, χ^2 (N =1750, 3) =4.39, p =.22, RMSEA =.02, CFI =1.00, SRMR =.028. At baseline, the average score on the PDS was 7.60 with significant variability in these scores across individuals (*intercept variance* =3.39, p <.001), suggesting individuals were showing different levels of pubertal development. On average, PDS scores increased by .77 between each assessment (p <.001). Slopes showed significant variation across individuals (*slope variance* =.31, p <.001), suggesting that individuals were showing different rates of 'pubertal tempo'. Girls' mean PDS scores at baseline (M =8.24, *variance* =4.11) were significantly higher and more varied (both p <.001) compared to those of boys (M =7.03, *variance* =2.03), but there were no significant gender differences in the mean levels or variances of pubertal tempo (*p's* =.39 and .45, respectively).

Girls generally begin puberty earlier than boys (shown by the higher pubertal status intercept for girls) and it is therefore important to control for this mean difference between the genders when testing associations between pubertal status and self-control. After controlling for covariates (Table 2), more advanced pubertal status at baseline was also associated with lower self-control at baseline (β = -.12, p =.006) whilst also predicting faster decreases in self-control over time (β = -.23, p =.04; Figure 1). Pubertal tempo did not significantly predict the slope of self-control (β = -.18, p =.18).

<TABLE 2 ABOUT HERE>

RQ4. Are dimensions of parenting associated with children's self-control and longitudinal change in self-control?

All four parenting variables showed statistically significant unadjusted associations with the intercept and slope of children's self-control (Table 2). As expected, higher levels of parental warmth and greater use of inductive reasoning were associated with higher baseline levels of self-control (β =.32, p <.001 and β =.20, p <.001, respectively), whilst higher levels of parental hostility and greater use of inconsistent discipline were associated with lower baseline levels of self-control (β = -.49, p <.001 and β = -.32, p <.001, respectively). Slope estimates for all four parenting variables were in the opposite direction to intercepts (Table 2) indicating the effects of parenting (which was measured at wave 1) on self-control tended to attenuate over time.

After simultaneously entering all four parenting variables into the model and controlling for covariates (gender, age, parental education, children's total difficulties, and puberty), the only parenting variables associated with children's self-control were parental hostility and warmth (Table 2). The strongest parenting predictor of children's self-control was hostility, whereby higher levels of parental hostility were associated with lower self-control at baseline (β = -.23, p <.001). This effect of hostility on self-control attenuated over time (β =.39, p <.001; Figure 1). Parental warmth also remained a significant predictor of baseline levels of children's self-control (β =.10, p =.04). In contrast to the findings for parental hostility, the effects of parental warmth showed no evidence of attenuating over time (β =.08, p =.47). For example, when we compare children experiencing high levels of warmth (1 *SD* above the mean) to children experiencing low levels of warmth (1 *SD* below the mean) we find children of high warmth parents have significantly higher self-control at wave 3 (*M* [95% CI] =3.71 [3.64, 3.79]) compared to children of low warmth parents (*M* [95% CI] =3.56 [3.49, 3.63]) (Figure 1).

<FIGURE 1 ABOUT HERE>

RQ5. Are associations between parenting and children's self-control moderated by individual differences in pubertal status?

To test whether parenting has differential effects on children's self-control according to individual differences in children's pubertal status at baseline four interaction terms were computed (one for each parenting variable) and added to the multivariate model shown in Table 2. There was no evidence of pubertal status moderating the effects of warmth ($\beta_{intercept}$ = -.04, p =.41; β_{slope} = -.08, p =.46), hostility ($\beta_{intercept}$ =.004, p =.94; β_{slope} =.01, p =.92), inconsistent discipline ($\beta_{intercept}$ = -.01, p =.89; β_{slope} =.07, p =.53), or inductive reasoning ($\beta_{intercept}$ = -.04, p =.42; β_{slope} =.10, p =.34).

Finally, sensitivity analyses examined (i) whether results replicated when listwise deletion was used as opposed to FIML and (ii) potential gender differences in the development of self-control and the pattern of association with functional outcomes. The pattern of results was very similar when listwise deletion was used (results available from first author). However, listwise deletion assumes that data are MCAR (Enders, 2010) while missingness at wave 1 showed a small but significant association with academic attainment, self-control and SDQ total difficulties in this sample (see earlier). We therefore present results obtained using FIML. Potential gender differences were explored by running separate models for males and females and examining the chi square change when paths were constrained to be equal. None of the predictors of self-control differed significantly for males and females (all $\Delta \chi^2 (1) < 1.69$, all $p > .05$). Similarly, all of the associations between the slope of self-control and functional outcomes did not differ significantly across boys and girls (all $p > .05$; results available from first author).

Discussion

This study presents a number of novel contributions to the understanding of children's self-control during early adolescence. A descriptive but important finding was that self-control decreased between the ages of 11 and 12. Such basic knowledge about the developmental course of children's self-control is a key step in understanding the causes of the development of self-control (Rutter, 2007). Few studies have explicitly examined how levels of self-control tend to develop during early adolescence, though there is some empirical evidence pointing to similar decreases in self-control during this period (Yu, 2010). We also found self-control was favourably related to functional outcomes and that self-controlled children adapted better to the challenges of secondary school and showed better post-transition adjustment as rated by teachers, which is consistent with previous research (de Ridder, Lensvelt-Mulders, Finkenauer, Stok, & Baumeister, 2012; Duckworth & Seligman, 2005; Tangney et al., 2004). Importantly, we extended previous work by showing that changes over time in children's self-control were associated with levels of behavioural problems, social functioning and adaptation to secondary school as rated by children's school teachers. These findings add to a growing literature suggesting the importance of better understanding the development of self-control and how it can be promoted, with the hope that this knowledge can be translated into effective interventions for children having academic, behavioural or social difficulties (Blair & Diamond, 2008; Shields, Cicchetti, & Ryan, 1994).

Further investigation is required to understand why self-control declined over the transition to secondary school. Cognitive processes related to attention and problem solving are disrupted by anxious emotional experience (Blair, 2002; Matthews & Wells, 1999). One possible explanation, therefore, is that self-control declines due to the stressful process of school transition (Rice, Frederickson, & Seymour, 2011; Simmons & Blyth, 1987). Elias and colleagues (Elias et al., 1992) suggest children encounter a number of psychosocial challenges in the course of adapting to secondary school, including, peer-related difficulties, conflicts with authority and academic pressures all of which draw on children's self-regulatory capacities by requiring them to inhibit behaviour, regulate attention, and exercise willpower. This explanation is consistent with the strength model of self-control which suggests individuals have a limited capacity for exercising self-control (Baumeister, Vohs, & Tice, 2007). Future research should assess whether declines in self-control during this period are associated with transition-related stress.

It is also likely that the decline in self-control found here will be partly due to normative developmental changes associated with adolescence and puberty. For instance, executive functions – a group of neuropsychological skills thought to underlie self-control – show steady improvement throughout childhood but appear to plateau during early adolescence (Blakemore & Choudhury, 2006; Crone, Ridderinkhof, Worm, Somsen, & van der Molen, 2004; Somsen, 2007) and may even reduce slightly at the onset of puberty (Blakemore & Choudhury, 2006; McGivern, Andersen, Byrd, Mutter, & Reilly, 2002). This slowing in the development of executive functions occurs alongside extensive synaptic reorganisation in the frontal lobes at the onset of puberty and may explain the observed inverse association between pubertal status and children's self-control (Blakemore & Choudhury, 2006). Future research may be able to tease apart the unique contributions of pubertal development and school transition to the development of children's self-control by utilising a research design that compares a cohort of transitioning children with a cohort of non-transitioning children of equivalent age. It is important to note, however, that it would be difficult to carry out such a study in the UK given the nearly universal transition at 11 years.

We did not find evidence of an association between pubertal tempo and changes in self-control, suggesting the age of onset of puberty has a more consistent effect on children's self-control than the rate at which puberty unfolds – at least in the age period of 11-12 which was the focus of this study. Thus, individual differences in early pubertal status were associated with change in self-control over time.

Simple associations indicated that parents who expressed higher levels of warmth and lower levels of hostility towards their child and who attempted to discipline their child consistently and through reasoning tended to have children who were more self-controlled. However, after controlling for key confounders such as children's behavioural problems, only parental warmth and hostility were robustly associated with children's self-control, though in different ways. Parental warmth measured at baseline had a concurrent effect on children's self-control, and this effect did not attenuate over the one-year study period. While parental hostility had a stronger concurrent effect on self-control, this effect did attenuate over the one-year study period. Thus parental warmth, but not parental hostility, had a persistent effect on children's self-control in this one-year study in early adolescence.

The move from primary to secondary school is likely to disrupt several aspects of children's lives, including their friendships, relationships with teachers, daily routines, and academic expectations. Children tend to receive lower levels of individual support from teachers post-transition and typically have a greater number of teachers who know them less well at secondary school compared to primary school (Symonds & Galton, 2014). Therefore, good quality relationships and consistent sources of support over the transition are likely to be important resources for children trying to adapt to the new school environment (Fenzel, 2000; Jindal-Snape & Miller, 2008; Simmons & Blyth, 1987). The findings presented here show that warm parenting confers beneficial effects on self-control during the transition to secondary school indicating that warm parent-child relationships may provide children with an ‘arena of comfort’ during this time (Simmons & Blyth, 1987). Therefore, the support offered by positive relationships with parents is likely to be a valuable resource at a time when many other aspects of children’s lives are in flux.

Our results converge with previous findings that show negative parenting characteristics have stronger cross-sectional associations with self-control than positive parenting (Finkenauer et al., 2005). Hostile or rejecting parents may negatively impact children’s self-control by acting as poor role models for good self-control and also by arousing negative affect in their children which diverts children’s attention towards soothing their negative emotions and away from self-regulation strategies (Moilanen, Rasmussen, & Padilla-Walker, 2014). Research in a slightly older sample of adolescents also found that negative parenting was associated with rank-order declines in children’s self-control (Moilanen et al., 2014). However, in our study the effects of hostile parenting appeared short-lived and it was the positive parenting characteristic of parental warmth which showed evidence of more persistent effects on children’s self-control. In this respect, our results are consistent with previous theory that stresses the importance of supportive and involved parenting for facilitating children’s internalisation of their parents’ values and goals (Grolnick & Farkas, 2002). The present results also concur with studies that found parental warmth and expressivity predicts longitudinal variations in self-control during late childhood/early adolescence (Eisenberg et al., 2005) and extend understanding of this association by showing that this association exists in the context of children’s decreasing self-control during this period and that parental warmth maintains an important association with self-control that is not explained by children's behavioural problems.

As per previous research we found no support for parental discipline predicting longitudinal variations in self-control (Eisenberg et al., 2005; Lengua, 2006). It was particularly interesting to find inductive reasoning did not show a robust association with children's self-control. In line with theory that emphasises the role of adult guidance in developing children's capacity to self-regulate (Grolnick & Farkas, 2002), we might hypothesise that parents explaining their decisions and discipline would result in children learning to reflect on their own actions and behaviour and subsequently be motivated to internalise their parent's guidance. However, adolescents' impulsivity (i.e., low self-control) is not typically a reflection of inadequate cognitive abilities, but a consequence of adolescents' sensitivity to social and affective influences (Steinberg, 2005). This sensitivity may extend to the broader domain of self-control and explain why indicators of parental affect had stronger effects on children's self-control than parental discipline in this study. Other aspects of parenting not studied here may also influence children's self-control, for instance, Gottfredson and Hirschi (1990) suggest parental monitoring and punishment of deviant behaviour are key processes underlying the development of self-control in young children.

The present findings indicated that the effects of parenting on children's self-control are not affected by individual differences in pubertal status at 11 years old as shown by the absence of interactions. Thus, results suggest the influence of positive parenting on children's self-control during adolescence does not attenuate due to individual differences in early pubertal status. One possible reason that the present study did not find a moderating effect of pubertal status is the small window of pubertal development studied. Puberty is a long developmental period consisting of numerous endocrine events that continue into the early 20s (Blakemore, Burnett, & Dahl, 2010) as well as a range of biological events that have notable social and psychological meaning (e.g., menarche, growth spurts), so it remains possible that pubertal development may influence self-control during a later period. An alternative explanation is that the diminished role of parenting during adolescence has been overstated. Numerous findings point to an important protective role for parents in relation to reducing risky adolescent behaviours such as substance misuse, affiliating with deviant peers, and sexual behaviour (DeVore & Ginsburg, 2005; Hummel, Shelton, Heron, Moore, & van den Bree, 2013). More work is needed to establish whether the effects of parenting on children's self-control truly attenuate, though our findings here indicate they continue to play a role in children of 11-12 years old, many of whom have begun to show signs of pubertal development.

The limitations of this study include its reliance on questionnaire reports and the relatively short study period which meant the extent of naturalistic changes in self-control and pubertal development may be relatively low. Nonetheless, we incorporated established and reliable questionnaire measures and focused on a developmental period characterised by profound changes in risk taking and impulsivity, and importantly, found significant variation in growth models of self-control and pubertal status. Moreover, longitudinal change in self-control has been demonstrated across similar time-lags as employed in this study (Lengua et al., 2015). Additionally, given that change in self-control predicted functional outcomes the variations in children's self-control found here were functionally meaningful and not just statistically meaningful. Questionnaire measures of self-control provide the benefit of an 'aggregate judgment of behaviour across *multiple* situations' and have been found to show higher levels of convergent validity compared to tasks assessing behavioural aspects of self-control such as executive function or delay of gratification (Duckworth & Kern, 2011). Nevertheless, self-reports may reflect perceptions of self-control rather than actual behaviour and, although reliable, self-evaluations of competence are potentially prone to bias (Cole, Martin, Peeke, Seroczynski, & Fier, 1999) and may vary according to the characteristics of reference groups (Wood, Brown, Maltby, & Watkinson, 2012). Future research should therefore examine whether more objective behavioural assessments of self-control show similar declines during this period and across similar timespans. As highlighted earlier, we note that our assessments of pubertal development do not cover the full range of puberty. Instead, the present results refer to individual differences in pubertal status and tempo at an age generally considered to be the average age of onset of puberty (Dahl, 2004; Parent et al., 2003; Patton & Viner, 2007).

The general theory of crime views self-control as having a critical period of development spanning early childhood through to the pre-teen years, after which individual differences in self-control become relatively fixed (Hirschi & Gottfredson, 2000). Despite our results showing absolute levels of self-reported self-control within individuals do indeed decline over the early adolescent period they do not provide any evidence on whether the relative differences between individuals in self-control change during this period. This issue will need to be addressed in future research.

The current study draws on a conceptualisation of self-control grounded in personality theory, where self-control is viewed as a lower order trait of the broader personality trait of conscientiousness, with high self-control including the tendency to be planful and behaviourally-controlled while low self-control is characterised by impulsivity and carelessness (Caspi, Roberts, & Shiner, 2005). This perspective views personality as biologically constituted and largely consistent across domains and situations, however, it is possible that future research may benefit from disaggregating self-control across domains or behaviours. Neurobiological models generally conceptualise adolescent behaviour as containing both a motivational component and a regulatory component (Ernst et al., 2006; Van Leijenhorst et al., 2010). Crucially, individuals' motivations undergo change during adolescence and these may be the areas where self-control changes most. For instance, adolescent behaviour appears to be particularly susceptible to influence by the presence of peers (Steinberg, 2008). Additionally, early adolescence is a period where self-regulatory behaviours are more easily disrupted by negative emotional distraction (Cohen-Gilbert & Thomas, 2013). It is therefore possible that self-control would show greater declines in aspects of social relationships and emotional control compared to other domains such as cognitive and physical control.

Our study design also limited our ability to test whether the effects of parenting attenuate during adolescence. To more fully answer this question, future studies should follow children through the whole of puberty or use a design that enables comparison of pre-pubertal children and post-pubertal adolescents. Our reliance on a baseline assessment of parenting behaviour also means we were unable to assess whether longitudinal change in parenting predicts longitudinal change in self-control, a question that will need to be addressed in future research. A further limitation was the lower study participation rate at wave 1, but as participation was very high at waves 2 (87%) and 3 (85%) equivalent measures collected at later waves were incorporated into our statistical models using FIML procedures to limit potential bias due to non-response (Graham, 2009). The pattern of results also replicated when listwise deletion was used (results available from first author). The strengths of this research include its use of multiple-informants and the ability to statistically control for a number of alternative explanations such as co-occurring behavioural and emotional problems. Additionally, due to our use of a sample largely similar in age we were able to examine the effects of pubertal status relatively independent of age (Blakemore et al., 2010).

Results from this study indicate that self-control decreases across ages 11 to 12 as children in the UK (and many other countries) make the transition from primary to secondary school. This has important implications because greater decreases in self-control during this period are associated with poorer behavioural and social functioning at the end of the first year of secondary school. One risk factor for low self-control during this period is advanced pubertal status at age 11, suggesting that children experiencing puberty earlier than their peers may comprise a vulnerable group. Finally, parental affect but not parental discipline is one way through which parents influence older children's self-control. In particular, our findings suggest that parents may be able to buffer developmental declines in their children's self-control through demonstrations of warmth and affection.

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Table 1.

Means, standard deviations, and correlations for study variables.

Variable	*M*	*SD*	1.	2.	3.	4.	5.	6.	7.
1. Self-control W1	3.79	0.65	1.00						
2. Self-control W2	3.68	0.66	0.62***	1.00					
3. Self-control W3	3.63	0.66	0.54***	0.66***	1.00				
4. Puberty (PDS) W1	7.58	2.16	-0.01	-0.10**	-0.12**	1.00			
5. Puberty (PDS) W2	8.41	2.31	-0.02	-0.12***	-0.16***	0.71***	1.00		
6. Puberty (PDS) W3	9.16	2.49	-0.04	-0.05	-0.17***	0.62***	0.72***	1.00	
7. Parental warmth W1	38.05	4.57	0.25***	0.21***	0.14**	0.02	0.03	0.03	1.00
8. Parental hostility W1	10.95	3.88	-0.40***	-0.27***	-0.16***	-0.01	-0.01	0.01	-0.41***
9. Inconsistent discipline W1	10.44	4.31	-0.28***	-0.16***	-0.18***	-0.04	-0.02	-0.05	-0.27***
10. Inductive reasoning W1	24.37	3.33	0.17***	0.07	0.06	0.00	-0.03	0.02	0.51***
11. English attainment W3	-0.01	1.00	0.23***	0.17***	0.18***	0.07*	0.00	0.03	0.00
12. Maths attainment W3	-0.01	1.00	0.19***	0.15***	0.17***	0.01	-0.04	0.00	-0.03
13. Science attainment W3	-0.01	1.00	0.18***	0.20***	0.19***	0.00	-0.05	-0.02	-0.02

14. Emotional symptoms W3	1.12	1.96	-0.03	-0.05	-0.07*	-0.02	0.05	-0.01	0.01
15. Conduct problems W3	0.74	1.49	-0.04	-0.21***	-0.24***	0.00	0.08*	0.06	0.04
16. Hyperactivity W3	2.29	2.45	-0.17***	-0.24***	-0.28***	-0.09*	0.07*	0.05	0.03
17. Peer problems W3	1.17	1.74	-0.04	-0.09**	-0.13***	-0.09*	-0.02	-0.01	-0.06
18. Prosocial behaviour W3	7.81	2.29	0.10*	0.21***	0.22***	0.01	-0.01	-0.03	0.05
19. Sex (male reference)	0.46	0.50	0.17***	0.19***	0.12***	0.30***	0.23***	0.22*	-0.01
20. Age (months)	134.58	3.55	0.02	-0.03	-0.09*	0.22***	0.24***	0.16*	0.03
21. Parental education	2.13	1.18	-0.05	-0.01	0.00	-0.02	-0.09*	-0.07	-0.05
22. Total difficulties scale W1	7.56	5.61	-0.53***	-0.32***	-0.27***	-0.06	-0.05	0.01	-0.23***

Notes. W1 = wave one, W2 = wave two, W3 = wave three, *= p<.05, **= p<.01, ***= p<.001. Statistics presented here were calculated using FIML (N = 2290), these statistics may vary slightly compared to those reported in the results section due to a slightly reduced sample when covariates are not included in the model.

Table 1 continued.

Variable	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
9.	0.43***	1.00												
10.	-0.30***	-0.25***	1.00											
11.	-0.05	-0.06	0.10*	1.00										
12.	-0.07	-0.09*	0.00	0.64***	1.00									
13.	-0.06	-0.11**	0.00	0.63***	0.72***	1.00								
14.	0.06	0.13*	0.02	-0.24***	-0.22***	-0.21***	1.00							
15.	0.06	0.05	0.03	-0.23***	-0.22***	-0.24***	0.28***	1.00						
16.	0.07	0.07	0.06	-0.34***	-0.31***	-0.29***	0.32***	0.65***	1.00					
17.	0.06	0.07	-0.05	-0.20***	-0.15***	-0.17***	0.57***	0.34***	0.30***	1.00				
18.	-0.13**	-0.01	0.07	0.21***	0.16***	0.19***	-0.26***	-0.55***	-0.60***	-0.30***	1.00			
19.	-0.10**	-0.06	-0.05	0.19***	0.03	0.04	0.02	-0.16***	-0.27***	-0.10**	0.21*	1.00		
20.	-0.05	-0.02	-0.01	0.01	0.04	0.06	-0.02	-0.01	0.05	-0.07	0.02	0.02	1.00	
21.	0.04	-0.03	0.03	0.28***	0.21***	0.24***	-0.09	-0.09	-0.14**	-0.11*	0.04	-0.03	-0.02	1.00
22.	0.37***	0.34***	-0.18***	-0.35***	-0.31***	-0.30***	0.14**	0.11*	0.21***	0.20***	-0.17***	-0.14***	-0.10*	-0.10*

Table 2.

Associations between predictors and self-control (intercept and slope).

	Unadjusted models[a]		Multivariate model[b]	
Predictor variables	Intercept	Slope	Intercept	Slope
Warmth	.32***	-.21*	.10*	.08
Hostility	-.49***	.51***	-.23***	.39***
Inconsistent Discipline	-.32***	.22*	-.03	-.09
Inductive Reasoning	.20***	-.23*	-.01	-.11
Puberty				
Intercept/status	-.05	-.26**	-.12**	-.23*
Slope/tempo	-	-.18	-	-.18
Gender (male reference)	.23***	-.13	.18***	.02
Age	.02	-.22*	-.02	-.14
Parental Education	-.07	.10	-.09*	.08
Total Difficulties	-.62***	.54***	-.49***	.40***

Notes. * = p<.05, ** = p<.01, *** = p<.001. [a]Unadjusted models show the association for the intercept and slope of self-control regressed on each predictor separately (n.b. the intercept and slope of puberty are assessed simultaneously). [b]The multivariate model shows the associations for the intercept and slope of self-control regressed on all predictor variables simultaneously.

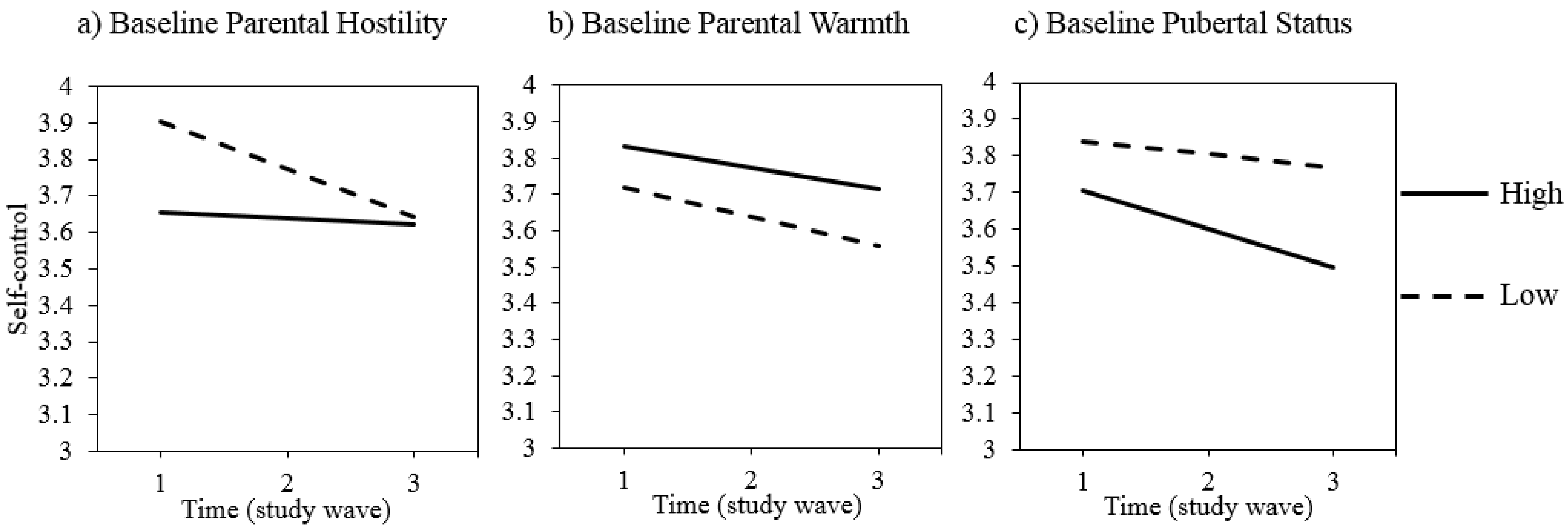

Figure 1. This figure shows the model estimated slopes of longitudinal change in self-control (covariates shown in multivariate model in table 2 are held at mean levels). Separate slopes are plotted for high (one standard deviation above the mean) and low (one standard deviation below the mean) levels of (a) baseline parental hostility (b) parental warmth (c) pubertal status.