Title: Self-control in early childhood: individual differences in sensitivity to early parenting

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Abstract

Objective: This study extends existing research on the role of infant temperament as a moderator of the association between the quality of parent-child relationships and children's self-control during the pre-school years. In particular, we focus on the potential moderating role of a dimension of early infant temperament known as behavioural inhibition. Assumptions formulated within the diathesis-stress, the vantage-sensitivity and the differential susceptibility models of individual differences in environmental sensitivity are tested. **Method:** Data are from the Millennium Cohort Study, a nationally representative birth cohort of 18,552 infants born in the UK during 2000/01. **Results:** The results show that the quality of both mother-child and father-child relationships are associated with children's development of self-control in early childhood. Additionally, individual differences in infant temperament moderate the association between mother-child conflict and children's development of self-control. Specifically, high behavioural inhibition shows a vantage-sensitivity pattern for mother-child conflict. **Conclusion:** Aspects of both mothers' and fathers' relationships with their young children independently predict variations in self-control. This study also provides an initial indication that behavioural inhibition, a temperamental trait best-known for being a risk factor for anxiety, may provide small benefits in relation to young children's self-control development.

Keywords: self-control, effortful control, vantage-sensitivity, differential susceptibility, mother/father-child relationship, temperament, behavioural inhibition.

SELF-CONTROL IN EARLY CHILDHOOD

The acquisition of good self-control during childhood is central to positive functioning throughout the life course and can be considered a core indicator of early developmental health (Kopp, 1982; Moffitt, 2015). Childhood levels of self-control are associated with a range of successful adult outcomes including financial stability and employment, better physical and mental health, and less anti-social behaviour (Daly et al., 2015; Moffitt et al., 2011). Therefore, improving understanding of the early development of self-control is an important research aim with substantial real-world implications (Eisenberg, Duckworth, Spinrad, & Valiente, 2014; Moffitt, 2015). In this study we focus on how the parent-child relationship shapes the development of self-control during early childhood, paying renewed attention to the potential moderating role of individual differences in early infant temperament.

Definitions of self-control are numerous and vary between disciplines (Nigg, 2016). Here, we use a broad definition of self-control conceptualised as "effortful regulation of the self by the self" (Duckworth, 2011; Zhou, Chen, & Main, 2012). Self-control is grounded in components of executive functioning that facilitate individuals' abilities to plan, focus and shift attention, inhibit inappropriate responses, and activate behaviour to pursue goals (Eisenberg et al., 2014; Zhou et al., 2012). Compared to their more impulsive counterparts, self-controlled individuals more competently regulate their immediate behavioural, emotional, and attentional impulses in order to achieve long-term goals (Duckworth, 2011).

Empirical studies have consistently shown that children's self-control is predicted by the affective quality of the parent-child relationship (Brody et al., 2005; Kochanska, Murray, & Harlan, 2000; Li-Grining, 2007; Slagt, Dubas, Dekovic, & van Aken, 2016) and this seems to be especially important during early childhood (Choe, Olson, & Sameroff, 2013; Ng-Knight et al., 2016). Previous research has also shown that child-level characteristics, such as a difficult temperament can moderate associations between caregiving and children's

behaviour, pointing to mutually dependent and interactive processes (Belsky & Pluess, 2009; Boyce & Ellis, 2005; Rothbart, Derryberry, & Posner, 1994). Most of this work has examined outcomes related to psychopathology (i.e., behavioural and emotional problems) and to a lesser extent cognition and social skills (Slagt et al., 2016). Self-control has been less well studied.

There is good reason to believe early infant temperament would be particularly important to the development of self-control. Yet, there is still little understanding of the specific emotions or behavioural styles that moderate the effects of parent-child interactions. Here we focus on the role of infants' behavioural inhibition, an early reactive interruption of behaviour in response to novel, ambiguous or threatening stimuli (Kagan & Snidman, 2004). In particular, we test assumptions of individual differences in environmental sensitivity, differentiating between three types of environmental sensitivity to better explain the observed patterns of sensitivity, these are: general susceptibility, vulnerability and vantage-sensitivity. This study extends previous research by 1) adding a better understanding of the role of parent-child relationship quality in shaping manifestations of self-control in early childhood, including information provided by both mothers and fathers; 2) specifying the role of infant behavioural inhibition as a moderator of the association between parent-child relationship quality and children's development of self-control; and 3) providing evidence from a large nationally representative cohort of children, moving beyond mostly small-scale studies of opportunity samples generally used in this field.

The role of the parent-child relationship in the development of self-control

To exert good self-control a child must learn which impulses to inhibit and which behaviours to activate. Because much of this is learned from parents, the quality of the parent-child relationship is believed to be instrumental in the development of self-control (Kopp, 1982;

Morris, Criss, Silk, & Houltberg, 2017). The Tripartite model of emotional regulation suggests that parental contexts influence self-regulation via three main mechanisms: modelling/social learning, parental instruction, and the emotional climate of the family (Morris, Criss, Silk, & Houltberg, 2017). In this study we focus on the importance of the emotional climate of the family. For instance, close and affectively warm parent-child relationships support learning of self-control by facilitating communication between parent and child (Darling & Steinberg, 1993; MacDonald,1992; Morris, Criss, Silk, & Houltberg, 2017). Feeling supported, safe and able to express one's emotions are also important prerequisites for self-control (Morris et al., 2017). The stable emotional base provided by safe and secure parent-child bonds allows children to express emotions freely and to explore and engage with difficult and challenging tasks. This exploration provides children with the experience and practice required to develop their own self-regulatory skills (Alessandri & Lewis, 1996). Conversely, parent-child relationships characterised by high levels of conflict and hostility arouse negative emotions in children and these negative emotions then interfere with the cognitive processes underlying self-control (Pessoa, 2009).

Previous research has shown that high quality parent-child relationships aid self-control development whilst low or poor quality parent-child relationships have detrimental effects on self-control (Brody et al., 2005; Kochanska, Murray, & Harlan, 2000; Li-Grining, 2007; Slagt, Dubas, Dekovic, & van Aken, 2016). For example, using data from over 1300 North American children and parents, Belsky and colleagues found that parenting quality (observed during parent-child laboratory tasks) predicted change in the child's response inhibition between age 4 years and their first grade of elementary school (Belsky, Fearon, & Bell, 2007). Importantly, genetically-informed research designs (e.g., from both twin and adoption studies) have shown that the parent-child relationship has effects on children's self-control over and above genetic effects (Bridgett et al., 2018; Cecil et al., 2012). For instance,

a twin-difference study of 5184 twins found that parents' negative feelings about their children predicted reductions in self-control in the early years (e.g., from age 3 to 4 years; Cecil, Barker, Jaffee, & Viding, 2012). Thus, there is good evidence from a range of study designs showing that higher quality parent-child relationships predict greater increases in self-control during early childhood. There has however, been a predominant focus on mother-child relationships and there is less evidence regarding the simultaneous role of both mothers and fathers parenting and how this interacts with children's temperament, which we discuss later.

Individual differences in environmental sensitivity

Multiple theoretical models state environmental factors such as the parent-child relationship and individual-level factors like child temperament mutually and interactively shape variations in children's adjustment (Belsky & Pluess, 2009; Boyce & Ellis, 2005; Rothbart, Derryberry, & Posner, 1994). However, these models differ in the patterns of effect they predict. First, the traditional 'diathesis-stress' model suggests children with certain temperamental characteristics are more vulnerable to adverse environmental stressors (Monroe & Simons, 1991). Conversely, the 'vantage-sensitivity' model predicts that temperamental characteristics allow some children to benefit more than others from positive environments (Pluess, 2017). Finally, encompassing both of these positions are the theories of 'differential susceptibility' (or 'sensitivity to context') which suggest that temperamentally sensitive children are more susceptible to their environments both "for better and for worse" (Belsky & Pluess, 2009; Boyce & Ellis, 2005; Pluess, 2015), meaning sensitive children suffer more in adverse environments but also prosper more under supportive conditions. Research shows that the pattern of interaction effects can differ depending on both the outcome examined (e.g., behavioural problems, emotional problems) and the aspect of

temperament measured (Slagt et al., 2016). We contribute to the current literature by examining the less-often studied outcome of self-control alongside a specific dimension of infant temperament, behavioural inhibition, which has received less attention as a potential sensitivity factor.

A moderating role for infant temperament

Temperament has been defined as "constitutionally based individual differences in reactivity and self-regulation, in the domains of affect, activity, and attention" (Rothbart & Bates, 2006, p. 100). The existing research literature provides many examples where infant temperament moderates the effects of the parental context on children's adjustment. There is however less evidence regarding early self-control (Slagt et al., 2016). Self-control has been relatively under-researched as an outcome, but there is good reason to believe early infant temperament would be particularly important to the development of self-control.

First, we note that self-control is itself believed to be substantively grounded in early temperament (Rothbart et al., 1994). Specifically, contemporary theories identify three overarching temperament factors: Negativity, Surgency and Effortful Control, where effortful control shows strong conceptual convergence with self-control as it refers to one's trait-level tendency to employ top-down control in order to self-regulate (Nigg, 2016; Rothbart & Bates, 2006; Stifter & Dollar, 2016). Distinctions between self-control and effortful control are fairly small and partly disciplinary (e.g., personality psychologists commonly refer to self-control while developmentalists typically refer to effortful-control). However, small differences can be seen in the stipulation that effortful control is a *biological* predisposition towards effective self-regulation, whilst self-control is viewed as broader personality trait that *emerges* over time, though in part from its basis in effortful control (Diamond, 2013; Ng-Knight & Schoon, 2016).

A second reason to look more closely at self-control is that aspects of temperamental *negativity* play a *regulatory* role in children. That is, both 'top-down' (effortful) processes like inhibitory- and attentional-control and 'bottom-up' (reactive) processes related to negativity underpin good self-control as part of a dynamic self-regulating system (Derryberry & Rothbart, 1997; Fox et al., 2005; Nigg, 2016). Furthermore, it has been argued that a child's reactivity style (e.g., behavioural inhibition) can shape how effortful control processes emerge (Derryberry & Rothbart, 1997; Fox et al., 2005; Nigg, 2016). These relations are important because the negativity domain of temperament is posited as the main moderator of parental context on children's development (Belsky & Pluess, 2009). However, few studies have considered how different aspects of negativity can themselves be regulatory rather than problematic. For an exception see a study by Kerr et al. (1997) who found behaviourally inhibited boys were less likely to participate in delinquency compared to their less inhibited counterparts. Thus, it is important to differentiate between bottom-up and top-down regulation as the developmental relations between these systems is likely to be more complex than is often appreciated.

The top-down regulatory processes that underpin self-control (e.g., attentional- and inhibitory-control) emerge much more slowly than the bottom-up regulatory processes (sometimes referred to as *reactive* or *passive* control) which are observable very soon after birth (Stifter & Dollar, 2016). This raises the possibility that bottom-up processes have the potential to shape the development of self-control from a much earlier age than top-down processes. Additionally, a recent meta-analysis found parental effects on children's adjustment were only consistently moderated by negativity measured during infancy (i.e., not by surgency/approach or effortful control) pointing to the importance of early individual differences in bottom-up regulatory processes (Slagt et al., 2016). Whilst much of the work in this area has examined the concepts of negativity, reactivity or 'difficult temperament'

somewhat interchangeably, recent research shows it is important to examine the specific emotions or behavioural styles that are typically combined in measures of negativity, such as anger, sadness, withdrawal and fear (Slagt et al., 2016; Stifter & Dollar, 2016).

One such regulatory trait is behavioural inhibition (BI), which describes the bottom-up (reactive) interruption of a behaviour in response to novel, ambiguous or challenging stimuli. In particular, behaviourally inhibited children tend to withdraw and show negative affect when faced with novelty (Fox et al., 2005; Kagan et al., 2007). For example, ceasing play and withdrawing to caregivers when an unfamiliar event occurs. Though correlated with other temperamental traits such as fear and shyness, BI more closely reflects an inability to handle uncertainty rather than a predisposition to fear (Kagan & Snidman, 2004). Like self-control, BI draws on inhibitory skills (Diamond, 2013) and deficits in BI have been linked to clinically relevant self-regulatory difficulties such as ADHD (Barkley, 1997). Therefore, according to the hypothesis of bottom-up reactive control (Eisenberg et al., 2004; Rothbart & Bates, 2006), we expect BI to be positively related to the development of children's self-control in early childhood.

Differential susceptibility theory argues that difficult or negative emotional temperament reflects a more sensitive nervous system on which experience such as parent-child interaction registers especially strongly (Pluess, 2015). However, the case for BI moderating self-control is more specific. BI inhibits action and redirects attention in response to novelty, uncertainty or other cues for possible harm (Kagan & Snidman, 2004; Nigg, 2016; Stifter & Dollar, 2016). Therefore children with a higher inclination towards BI are likely to be more attentive to environmental cues in general and parental cues in particular (Kochanska & Knaack, 2003; Nigg, 2016). This may be because more inhibited children have lower anxiety thresholds, making them more easily aroused by and responsive to parental feedback (Derryberry & Rothbart, 1997; Kiff, Lengua, & Zalewski, 2011; Kochanska, 1993; Nachmias

et al., 1996). Thus, children high in BI may be more sensitive to both negative and positive parental feedback.

Research has not yet tested for differential effects of parent-child relationship quality on children's self-control at different levels of BI, but previous studies on the less clearly defined construct of 'difficult' temperament points to a pattern of effects consistent with differential susceptibility theory. For instance, the association between supportive parental contexts (i.e., high mother-infant affective synchrony) when infants were 9 months old and children's self-control at 2 years old was found to be stronger for children identified as having 'difficult' temperaments (defined as a higher propensity to display fussiness and negative emotions) compared to children with 'easier' temperaments (Feldman, Greenbaum, & Yirmiya, 1999). 'Difficult temperament' as a construct has been strongly criticized in the developmental literature and is increasingly seen as an out-of-date approach to labelling children with little theoretical basis (for example see discussion by Stifter & Dollar, 2016). Thus studying more precise and empirically validated temperamental dimensions is warranted.

Research on temperament X environment interactions with fathers is less common but does exist. For instance, one study found less negative and more positive paternal parenting explained substantially more variance in inhibition for toddlers' high in negative affect versus low negative affect (Belsky, Hsieh & Crnic, 1998). However, other research has found the effect of maternal relationship quality on toddlers' self-control is moderated by infants' negative affect, but neither main effects nor interactions were found for paternal relationships (Kim & Kochanska, 2012). Given that most previous studies were based on small, convenience samples, further research on large population representative samples would have more statistical power to help clarify apparent inconsistencies. The current study takes us in this direction and also focuses on the specific temperament dimension of BI which we

hypothesise to make children more susceptible to the influence of parent-child relationship quality.

The current study

This study evaluates evidence for three possible hypotheses regarding the nature of BI-related susceptibility to parent-child relationship quality: (i) children high in BI are vulnerable to poor quality parent-child relationships only (the diathesis-stress or vulnerability model); (ii) children high in BI benefit more from high quality parent-child relationships only (the vantage-sensitivity model); (iii) children high in BI are both vulnerable to poor quality parent-child relationships and also benefit more from high quality parent-child relationships (the differential susceptibility model). No specific assumptions are made regarding the role of maternal versus paternal parenting, given the limited and inconsistent evidence base. Our hypotheses are tested in a large population representative cohort of children with statistical controls for a number of variables known to be associated with lower self-control during childhood, including male sex, low birthweight and lower socio-economic background (Ng-Knight & Schoon, 2016). Moreover, the longitudinal data enables us to assess the influence of BI and parent-child relationship on change in self-control over time.

Method

Participants and procedure

Participants are from the first three sweeps of the United Kingdom's Millennium Cohort Study (MCS), a nationally representative longitudinal study of 18,818 infants born into 18,552 families in the UK during 2000 and 2001 (Joshi & Fitzsimons, 2016). We restricted the sample to one child per family in the 266 families containing twins and triplets. The sample was stratified to ensure adequate representation of children from the four UK

countries (England, Northern Ireland, Scotland, Wales) and from disadvantaged and ethnic minority populations. Probability weights are used in all analyses to account for the stratified sample design.

At the first sweep, data were collected via parent interviews when children were approximately 9 months old. Eighty percent of these families took part again at sweep 2 and 79% took part at sweep 3 when children were approximately 3 and 5 years old respectively. At sweep 3 data from 14625 parental interviews were available (79% of baseline sample). Missing data were handled with the full information maximum likelihood procedure in Mplus. Detailed information on the study sample and procedures have been reported elsewhere (Plewis, Calderwood, Hawkes, Hughes, & Joshi, 2007) and all data used here are available to researchers from the UK Data Service (www.ukdataservice.ac.uk). The MCS received ethical approval from the South West and London Multi-Centre Research Ethics Committees (Hansen, 2006).

Measures

Self-control. At ages 3 and 5, self-control was measured by parent-reports (98.4% & 97.3% mothers at each wave) to the five-item hyperactivity/inattention subscale of the Strengths and Difficulties Questionnaire (SDQ) which shows good scale reliability (α = .71 and .76 in our sample) and has been widely validated as a screening tool for children's attention and hyperactivity problems (Goodman, 2001). Items were recoded and summed so that higher scores indicate better self-control (range 0-10). Though the SDQ subscale was originally developed to assess levels of self-regulatory difficulties it shows good face validity for measuring both the presence and absence of self-control. This is consistent with dual-systems models of self-control which suggest low self-control can come about due to strong impulses, weak restraint, or a combination of these (Carver, 2005). Similarly, the most

widely used contemporary self-control measure used with adults and older children, the Brief Self-Control Scale (Tangney, Baumeister, & Boone, 2004), has been found to tap both restraint (i.e., effortful self-control) and impulsivity domains (Maloney, Grawitch, & Barber, 2012).

The questions in the SDQ scale assess attentional control ('easily distracted, concentration wanders'), inhibitory control ('can stop and think things out before acting') and perseverance ('sees tasks through to the end, good attention span'), as well as assessing hyperactive behaviour ('restless, overactive, cannot sit still for long' and 'constantly fidgeting or squirming') which is also related to poor inhibitory control (Diamond, 2013). Attentional and inhibitory control are core components of typical definitions of self-control and effortful control, and measures of attention (e.g., stroop tasks) and inhibition (e.g., delay of gratification tasks) are frequently used to measure self-control in laboratory settings (Spinrad, Eisenberg, & Gaertner, 2007). An individual's perseverance on experimental tasks is also widely used to measure self-control (Eisenberg et al., 2009). Previous research has provided support for the convergent and discriminant validity of the SDQ hyperactivity/inattention subscale with validated measures of attentional focusing (r = .44) and inhibitory control (r = .60) (see Ng-Knight & Schoon, 2016).

Infant temperament. At sweep 1, individual differences in infant temperament were measured using parent responses (99.8% mothers) to five items selected from the Carey Infant Temperament Scale (ITS) (Carey & McDevitt, 1978), a widely used measure of temperament that has demonstrated good validity and reliability (Rothbart & Bates, 2006). In this study, we focused only on indicators of *Behavioural Inhibition* (BI) using 5 items measuring infants' tendencies to withdraw and show negative affect in response to novelty (e.g., 'for the first few minutes in a new place or situation she is fretful', 'is shy (turns away or clings to you) on meeting another child for the first time', and 'objects to being bathed in a

different place or by a different person') (α = .67). Responses were made on a five point scale (1=almost never, 2=rarely, 3=usually does not, 4=often, 5=almost always) and summed so that higher scores indicate higher BI (range 5-25).

Parent-child relationship quality. At sweep 2, mothers' and fathers' parenting was measured using their own self-reports to the Child-Parent Relationship Scale (Driscoll & Pianta, 2011). The scale consists of 7 items measuring closeness (e.g., 'I share an affectionate, warm relationship with my child', range = 7-35) and 8 items measuring conflict (e.g., 'My child and I always seem to be struggling with each other', range = 8-40) between the parent and child. Mothers and fathers were asked how far each statement currently applies to their relationship with their child on a five-point scale (1=definitely does not apply, 2=not really, 3=neutral, 4=applies sometimes, 5=definitely applies). Four scores were computed assessing mother-child closeness (α = .92), mother-child conflict (α = .86), father-child closeness (α = .76), and father-child conflict (α = .75). Complete parent-child relationship data were available for fewer fathers (82.5%; N= 12,284) than mothers (N=14,776).

Covariates. The child's birthweight in kilograms was reported by the main parental respondent. Other covariates were the child's sex (male=0 and female=1), ethnic minority status (white=0 and other ethnicity=1) and the highest level of education achieved by either parent (range 0=none to 5=postgraduate). Data were also available on whether families included two-parents or a single parent, this was used to split the sample and check for differences across family types.

Data analysis

A single path model was used to investigate the predictive roles of all four measures of parent-child relationship quality, infants' BI and their interaction term for children's self-

control at age 5 (main hypothesised paths shown in figure 1). We statistically controlled for self-control at age 3 to assess the effects of predictors on (rank-order) change in self-control over time. We also controlled for a number of child covariates that are known to be associated with early childhood self-control (sex, ethnicity, birthweight and SES). Simultaneous analysis of both mothers and fathers parenting was done for two-parent families only. Separate sensitivity analyses were run to examine possible differences in the effects of maternal parenting in two-parent (N = 15,538) versus single-mother families (N = 3,194). Sensitivity analyses did not include fathers as so few single-parent fathers were present in the dataset (N = 18).

Simple slopes were tested at high and low levels of BI (±1 *SD*) to examine the pattern of interaction effects. Two additional tests were carried out to assess whether interaction effects were consistent with differential-susceptibility, diathesis-stress or vantage-sensitivity theory (Roisman et al., 2012). First, regions of significance (RoS) were examined to check whether self-control differences between children high and low on BI were present for low quality (e.g., low closeness or high conflict) parent-child relationships only (diathesis-stress), high quality (e.g., high closeness or low conflict) only (vantage-sensitivity) or at both high and low quality (differential susceptibility). This is referred to as the RoS on X test by Roisman et al. (2012) who recommend that such differences should be observable within common values of the predictor/X variable of interest (i.e., $\pm$ 2 *SD*s). Second, because the RoS on X test is at risk of being over-interpreted as a meaningful effect in large N studies such as ours, the proportion affected (PA) index was calculated to assess what proportion of the sample lie in the "for better" region. This is calculated as the region above the interaction crossover point for parental closeness and the region below the interaction point for parental conflict. Prototypical differential susceptibility would assume 50% of cases fall in the "for better" region (and thus 50% fall in the "for worse" region). In the interest of benchmarking,

Roisman et al. suggested that at a minimum 16% of cases should fall in the "for better" region to support differential susceptibility theory (Roisman et al., 2012).

All analyses were run in Mplus version 8. The WEIGHT command was used throughout to take account of the clustered sample design and the unequal probability of being sampled. Hence, all *p* values account for clustering and all regression coefficients are weighted. Missingness for measures of self-control was 24% at both age 3 and 5 years timepoints. Missingness for mother-child closeness and conflict variables was 33% and 32% respectively. Missingness for father-child closeness (51%) and conflict (50%) variables was generally higher than for mothers, with the additional missingness due to no father being present in the household (11%) or due to survey non-response (7%). Missingness on all other variables was minimal (<3%) or 0%.

All participants were included in analyses using full information maximum likelihood estimation (FIML; Muthén & Muthén, 1998–2012) to address missingness in the data. Data in this sample were not missing completely at random (Little's MCAR χ^2 (1162) = 7182.64, df = 1162, p = .000), however FIML only assumes data are missing at random (MAR), meaning that missingness can be dependent on other variables in the dataset (Schlomer, Bauman, & Card, 2010). FIML accounts for missing data by estimating parameters based on available data and implied values of missing data given the associations between variables in the available data (Schlomer, Bauman, & Card, 2010). As a robustness check we compared results using the full sample with models run with the listwise deletion sample (results in table S4) and using the non-response weights that account for all observed sources on non-response in the data (e.g., family income, ethnicity, housing type and tenure) (Plewis, 2011). In terms of measures taken at time 1 (which have the lowest levels of missingness), children with missing data in the listwise deletion sample tended to be higher in BI, t(17660) = -11.16, p < .001, have lower birthweight, t(18484) = 15.14, p < .001, have parents with lower

education levels $t(17938) = 45.59$, $p < .001$, and were more likely to be ethnic minorities, $\chi^2(1) = 952.66$, $p < .001$. Thus, not using FIML would bias our results towards a healthier, higher educated, Caucasian sample.

Results

Descriptive statistics and correlations are shown in table 1. There was evidence of developmental increases in self-control (mean levels of self-control were higher at age 5 compared to age 3) and changes in rank-ordering of self-control over time (self-control at age 3 was moderately but not perfectly correlated with self-control at age 5). All four measures of parent-child relationship quality were correlated in the expected directions with self-control at ages 3 and 5 years. Higher BI was correlated with lower self-control at age 3 and 5, as was male sex, lower birthweight, minority ethnicity, and lower parental education.

Path model results

The path model was a good fit to the data from two-parent families, $\chi^2(4) = 7.90$, $p = .10$, RMSEA = .01, CFI = 1.00, sRMR = .004. Higher levels of mother-child ($\beta = -.09$) and father-child ($\beta = -.04$) conflict at age 3 predicted lower self-control at age 5 over and above self-control at age 3 and other covariates (table 2). Higher levels of mother-child ($\beta = .03$) closeness at age 3 predicted higher self-control at age 5 but father-child closeness did not ($p = .35$). After controlling for self-control at age 3 and other covariates, the change in R^2 attributable to parent-child relationship variables was 1.1%. Behavioural inhibition at age 9 months did not significantly predict self-control at age 5 ($p = .051$) after autoregressive controls for age 3 self-control and covariates.

The path model reveals a number of associations which inform understanding of the nomological network of BI (see table S3). First, higher BI at age 9 months predicted higher conflict and lower closeness with mothers ($\beta = .10$ and $\beta = -.04$, respectively) and more

conflict with fathers (β = .03) at age 3 years. Second, higher BI was correlated with lower parental education (β = -.07), female sex (β = .06), and minority ethnicity (vs white majority ethnicity, β = .16). Socio-economic status, measured via parental education measured when the child was age 9 months, predicted a range of key variables (see table S3). Specifically, higher parental education predicted positive changes in self-control (β = .08) and predicted higher closeness (β = .15 for mothers and β = .11 for fathers) and lower conflict with parents (β = -.05 for mothers and β = -.04 for fathers).

Moderation results

Infant BI moderated the effects of mother-child conflict (β = -.03) but not mother-child closeness, father-child conflict or father-child closeness. After controlling for self-control at age 3, demographic covariates, behavioural inhibition and parenting variables, the change in R^2 attributable to interaction terms was 0.1%. Simple slopes (plotted in figure 2) show that mother-child conflict had a stronger negative association with self-control for more behaviourally inhibited children (β = -.11, 95%CI = -.15, -.08) compared to less behaviourally inhibited children (β = -.06, 95%CI = -.09, -.03). The slope patterns in figure 2 point to a "for better or for worse" interaction where more behaviourally inhibited children had higher self-control when mother-child conflict was low but also lower self-control when mother-child conflict was high (see figure 2). However, the Region of Significance (RoS) on X test (region: 0.01, >2*SD*) shows that BI was only significantly associated with self-control in the range of low to moderate levels of conflict (shown by shaded area in figure 2) pointing to a vantage-sensitivity (i.e., "for better") relationship. Additionally, the Proportion Affected (PA) index shows that the majority (81.4%) of the sample falls below the crossover point (= 3.67) and thus within the "for better" region of mother-child conflict. Both of these tests indicate BI acts as a vantage-sensitivity factor in low mother-child conflict environments and

does not significantly distinguish children's level of self-control in high mother-child conflict environments.

To assess the most substantial effects of the interaction between mother-child conflict and BI, we estimated point estimates of self-control for children high and low in BI (+/-1SD) at the lowest levels of mother child conflict. Children high in BI had an average level of self-control of 6.71, while children low in BI had an average level of self-control of 6.39. This difference of 0.32 units (0.14 SD) was statistically significant, χ^2 (1) = 6.85, p = .009.

Sensitivity analyses

The main path model was run using listwise deletion (N = 6639) and with non-response weights, all main and interaction effects on self-control at age 5 years were very similar in terms of statistical significance and effect size (see table S4 for listwise deletion results). The path model was also run comparing maternal parenting in two-parent and one-parent families. No differences were found on the main and interaction effects of primary interest (see table S5).

Discussion

Our findings add to a growing body of work showing parent-child relationship quality is associated with longitudinal changes in self-control during early childhood (e.g., Belsky, Fearon, & Bell, 2007; Cecil, Barker, Jaffee, & Viding, 2012; Choe, Olson, & Sameroff, 2013). We extend this literature by showing that individual differences in infant temperament moderate this association for mother-child relationships, highlighting that the development of self-control is the result of complex developmental processes. We found that behaviourally inhibited children benefit slightly more from low-conflict maternal contexts, corresponding to what has been termed 'vantage-sensitivity', a proclivity to benefit more than others from positive environmental conditions (Pluess, 2017). Below we discuss the relevance of our

findings to the role of parental influences on self-control, BI as a vantage-sensitivity factor, and the role of BI in self-control development.

Young children are largely reliant on parents for guidance and assistance with regulating their inner feelings and behaviour (Kopp, 1982; Sameroff, 2009) making early parent-child relationships particularly important. Parental relationships have long-term implications for children's feelings of security and confidence (e.g., attachment, Bowlby, 1982) and provide the context in which children learn to regulate their behaviour (e.g., social learning, Bandura, 1991). Relationships that are both affectionate and low in conflict are conducive to supporting children's positive feelings and learning (Morris, Criss, Silk, & Houltberg, 2017). The current study has shown that multiple dimensions of a family's emotional climate independently predict self-control longitudinally, specifically closeness with mothers and conflict with both mothers and fathers. The relative largest effects were found for dimensions of negative parental affect (i.e., conflict) which corresponds to previous findings on parental predictors of self-control (Cecil et al., 2012; Ng-Knight et al., 2016). Keeping conflict in parent-child relationships as low as possible is likely to be an important aspect of helping children develop good self-control.

The family stress model aims to explain how socioeconomic adversity and associated strains influence children's development (Conger, Conger, & Martin, 2010) and it has been used to explain individual differences in children's self-control before (Ng-Knight & Schoon, 2016). The model suggests the negative effects of socioeconomic disadvantage on children's self-control partially act through more proximal family stress mechanisms, including parents' experience of financial and emotional strain, which in turn shape parent–child interactions. Our findings are consistent with this perspective as we found parental education level (an aspect of parental SES) was correlated with the quality of the parent-child relationship.

Alleviating parents' economic and emotional strain or supporting parental education may be possible routes to intervene and reduce socio-economic disparities in children's self-control.

Vantage-sensitivity has been described as the "bright side" of environmental sensitivity outlined in the differential-susceptibility framework, where vantage-sensitivity factors increase susceptibility to the effects of good childrearing environments (Pluess, 2017). Such factors include genetic, physiological and psychological traits, though much of the existing work in this area has focused on temperament dimensions such as negative emotionality/reactivity and emphasised that sensitive children have nervous systems on which experience registers more strongly. For instance, children with high levels of negative emotionality have been found to have high self-control in the context of responsive mothering and the lowest levels of self-control in unresponsive mothering contexts (Kim & Konchanska, 2012). The current study advances work in this area by providing evidence of a vantage-sensitivity factor in the form of a temperamental characteristic that has been described as 'behavioural inhibition' or 'reactive control' (e.g., Nigg, 2017). That is, in the case of self-control development, behaviourally inhibited children are not any worse affected by high mother-child conflict, but their greater tendency towards inhibited behaviour may allow them to benefit more from low conflict relationships compared to less behaviourally inhibited children. The parents of more behaviourally inhibited infants tended to report less closeness and more conflict with their children. Thus it may be worthwhile educating parents to understand the potential benefits of low conflict for those children who are the most behaviourally inhibited.

One proposed reason for the preponderance of phenotypes such as high BI in the general population is that the vulnerability they provide for one outcome is counterbalanced by resilience or positive effects for a different outcome (Hassan et al., 2019; Pluess, 2013). Our findings lend some support to this idea, as BI is an established risk factor for anxiety

disorders (Svihra & Katzman, 2004) but we now provide evidence that BI may be beneficial for the development of self-control. Our findings also align with work that suggests it may be fruitful to focus on more specific combinations of temperament and parenting dimensions (Stifter & Dollar, 2016). For instance, when examining the contribution of BI to the development of social anxiety, researchers have analysed numerous parenting dimensions including intrusiveness, over-control, warmth, and sensitivity (Stifter & Dollar, 2016). In fact, combinations of BI and parenting behaviours that support the development of social anxiety likely represent one mechanism by which children's opportunities for learning to self-regulate are restricted (Fox et al., 2005). In sum, more specific analyses of temperament and parental factors are likely to lead to a more detailed understanding of mechanisms affecting self-control development. Future research could do this by empirically testing whether the remaining theoretical mechanisms proposed in Morris and colleagues' Tripartite model are also moderated by children's BI or by other components of temperament (Morris et al., 2017). Perhaps, the less affect-focused parenting mechanisms like modelling and instruction will be moderated by non-affective components of temperament like attentional control.

Our results are consistent with the idea that the heightened attention to novelty that characterises behaviourally inhibited children allows them to make the most of low-conflict relationships with their mothers. Slagt et al.'s (2016) meta-analysis found similar effects for surgency, where the cognitive functioning of low-surgency children (who have some similarity to inhibited children in that low-surgency describes a low-tendency to approach situations) benefited more from positive parenting than high-surgency children. We speculate that greater improvements in self-control among more behaviourally inhibited children could be due to more sensitive executive attention networks (Rothbart, Sheese & Posner, 2007). One evolutionary advantage of high BI is that it provides infants with the ability to detect and avoid novel threats (LeDoux 2000). This may also include paying

attention to which behaviours receive punishment from caregivers (Derryberry & Rothbart, 1997). In low threat environments such as those characterised by very low levels of mother-child conflict, heightened attentional sensitivity may be redeployed for positive means such as learning from maternal instruction. Research into anxiety also suggests early attentional control may interact with BI to predict later self-control development (White et al., 2011). Future research should further explore processes by which executive attention and BI may forecast enhanced outcomes in low conflict mother-child contexts.

Drawing on the possibility that attentional systems and inhibitory control provide a shared basis from which both BI and self-control develop (Derryberry & Rothbart, 1997; Diamond, 2013), we hypothesised that higher BI during infancy would predict greater self-control development between ages 3 and 5 years. Our data did not support this conclusion. This differs from previous research showing aspects of bottom-up reactive control in infancy are associated with later self-control, e.g., fearful children exhibit higher self-control than fearless children (Kochanska and Knaack, 2003). Others have suggested this is because higher levels of infant inhibition regulate approach behaviours that can lead to low self-control, e.g., high levels of impulsivity and activity (Derryberry & Rothbart, 1997). For instance, children with ADHD and anxiety have been found to have lower levels of hyperactivity than children with ADHD only (Pliszka, 1989). One possible reason for an absence of evidence here is that our study relied on a less precise measurement of BI. Our measure is based on five items derived from an older scale not originally designed to assess BI. Because measurement error can attenuate effects and the association was in the expected direction and very close to the conventional cut-off for statistical significance (p = .051) we suggest this hypothesis deserves revisiting in future research.

Strengths, limitations and future directions

Limitations of the current study primarily relate to the nature of using data from a large multidisciplinary birth cohort and the constraints this placed on the measures available. For instance, the most substantial limitation is that we had to rely exclusively on parent-reports. This means it is possible that the associations we found between key variables could be due to shared method variance (Whisman & McClelland, 2005). However, this was unavoidable in the current study because the children in this study were too young to report themselves and direct observation is not conducted in this large and nationally representative study (N = 18,552). While parents are generally considered valid and reliable reporters of infant temperament and young children's self-control, independent observations of parent-child interactions may be more reliable and should be incorporated into future studies. For example, Kochanska et al (2000) used observational methods of parental responsiveness and a behavioural battery of self-control tasks. They found a single measure of maternal responsiveness explained five times as much variance in self-control compared to the four self-report measures used here. Similarly, observer-rated methods for assessing environmental-sensitivity in young children have recently been developed and they found much larger effect sizes compared to those reported in the current study (Lionetti et al., 2019). Meta-analyses also suggest we can expect to find larger effect sizes for parenting-by-temperament interactions when parenting is assessed using observations compared to questionnaires (Slagt et al., 2016). Thus, at present, we are not yet able to give a clear estimate of true effect sizes, as we could potentially be reporting spurious associations due to shared method variance or conversely be reporting conservative effect sizes due to lower reliability of the measures being used. Future research utilising multiple sources of assessment is needed to help clarify effect sizes, but it should be noted that most studies which use observational measures are much smaller than the current study and subsequently more prone to many biases such as inflated effect sizes and false positives. Nevertheless,

based on our results alone, it does currently appear that the moderating effect of BI is very small indeed.

Although a longitudinal design was used here, the results do not provide certainty in terms of causal inferences. Nevertheless, useful temporal information is provided as three indicators of the parent-child relationship at age 3 predicted subsequent (rank-order) changes in children's self-control between age 3 and 5 years. It is also important to consider the possibility of child-driven effects on parent-child relationships (Sameroff, 2009). For instance, our results showed higher BI was associated with poorer quality relationships in terms of both closeness and conflict and this is consistent with previous research on Western samples (note the opposite was found in a Chinese sample; Chen et al., 1998). Thus it is possible that British children who are more behaviourally inhibited find it more difficult to form close, low-conflict relationships with parents. However, we cannot make strong claims about this because the dataset used here was limited to measures of temperament and parenting at single time-points. Future studies with repeated measures of all variables are needed to examine the bidirectional and transactional effects of parenting and children's self-control and to more fully examine whether differential susceptibility processes are important aspects of self-control development across time and other age periods (Sameroff, 2009).

Key strengths of the current study are that it includes data from both mothers and fathers and it uses a large population representative sample which allows us to control for a number of possible confounders, and to generalise our findings to the UK population. In fact, the sample size used here was comparable to the total available sample size used in a recent meta-analysis (Slagt et al., 2016). Further research with large population representative samples will support the ongoing replicability efforts in personality research.

Conclusion

This research supports the assertion that higher quality mother-child and father-child relationships are independently associated with positive changes in self-control between the ages of 3 and 5 years old. Additionally, we provide preliminary evidence of a small moderating effect whereby children high in the temperament trait of behavioural inhibition develop slightly better self-control than low BI children in the presence of low conflict maternal relationships.

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Table 1.

Descriptive statistics and correlations for main and covariate variables (FIML, N = 18552*)*

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1. Self-control age 5	1.00										
2. Self-control age 3	.59***	1.00									
3. Behavioural inhibition	-.03**	-.06***	1.00								
4. Mother-child closeness	.22***	.26***	-.05***	1.00							
5. Mother-child conflict	-.33***	-.42***	.10***	-.27***	1.00						
6. Father-child closeness	.12***	.13***	-.04*	.17***	-.12***	1.00					
7. Father-child conflict	-.18***	-.20***	.03*	-.13***	.31***	-.25***	1.00				
8. Female sex (vs male)	.15***	.13***	.06***	.08***	-.04***	.03**	-.03**	1.00			
9. Birthweight	.08***	.07***	-.02*	.04***	-.04***	.01	-.01	-.10***	1.00		
10. Ethnic minority (vs white)	-.05***	-.04***	.15***	-.03*	.02*	.00	-.01	.01	-.12***	1.00	
11. Parental education	.23***	.22***	-.08***	.18***	-.09***	.13***	-.06***	.01	.12***	-.08***	1
Mean	6.74	6.13	9.86	33.5	17.4	32.4	18.2	0.49	3.37	0.12	2.9
SD	2.36	2.35	3.79	2.31	5.90	2.64	5.54	.50	.58	.33	1.38

Note. *$p<.05$; ***$p<.001$.

Table 2.

Results of path analyses for two-parent families (regression paths for age 5 self-control only)

	b	Lower 95%CI	Upper 95%CI	*p*	Beta
Self-control age 5 REGRESSED ON:					
Behavioural inhibition	.011	.000	.022	.051	.02
Mother-child conflict	-.034	-.043	-.025	.000	-.09
Mother-child closeness	.034	.012	.056	.003	.03
Father-child conflict	-.015	-.025	-.006	.001	-.04
Father-child closeness	.010	-.010	.030	.329	.01
Mother-child conflict * BI	-.003	-.005	-.001	.009	-.03
Mother-child closeness * BI	.001	-.004	.006	.609	.01
Father-child conflict * BI	.002	.000	.005	.079	.02
Father-child closeness * BI	-.002	-.007	.003	.420	-.01
Self-control age 3	.502	.480	.524	.000	.50
Female sex	.379	.299	.459	.000	.08
Ethnic minority (vs white)	-.099	-.229	.031	.134	-.01
Birthweight	.118	.046	.189	.001	.03
Parental education	.147	.112	.181	.000	.08
	R^2= .37				

Note. $^{*}p<.05$; $^{***}p<.001$. BI = Behavioural Inhibition. Continuous variables are mean centred at zero. Coefficients for all model paths can be seen in table S3. R^2 statistics were assessed hierarchically in the following order (i) age 3 self-control, sex, ethnicity, birthweight, education (R^2 = .354), (ii) behavioural inhibition (R^2 = .354), (iii) parent-child relationship variables (R^2 = .365), (iv) interaction terms (R^2 = .366).

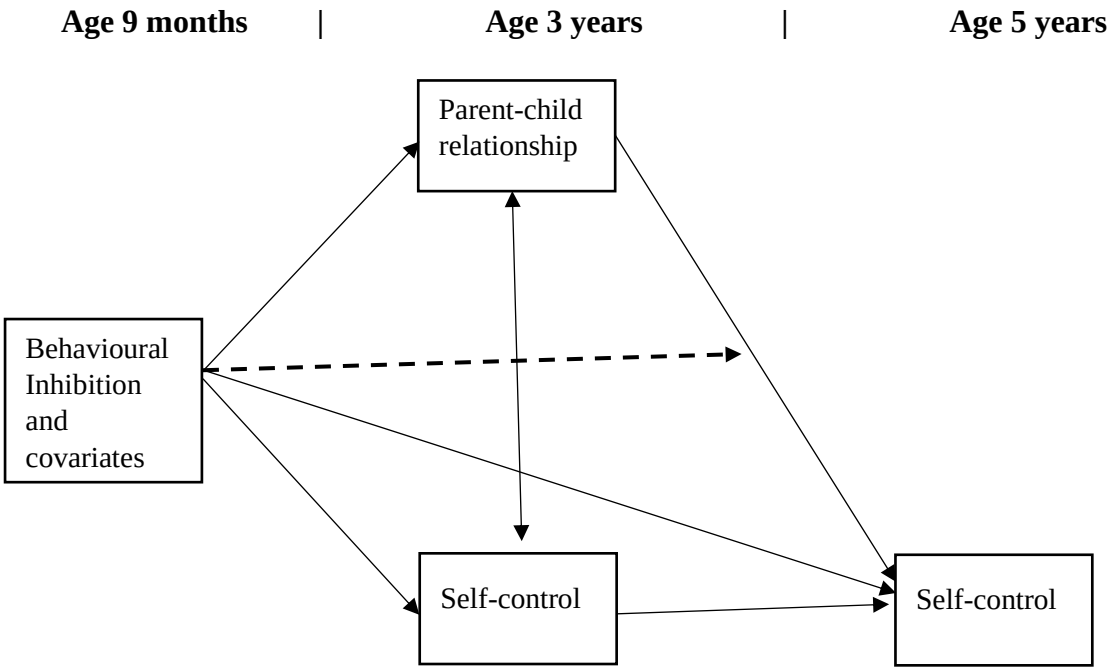

Figure 1. Overview of mains paths to be tested in the path model. Solid lines denote regression paths (single arrow) and correlations (double arrows), dashed lines denote moderation paths.

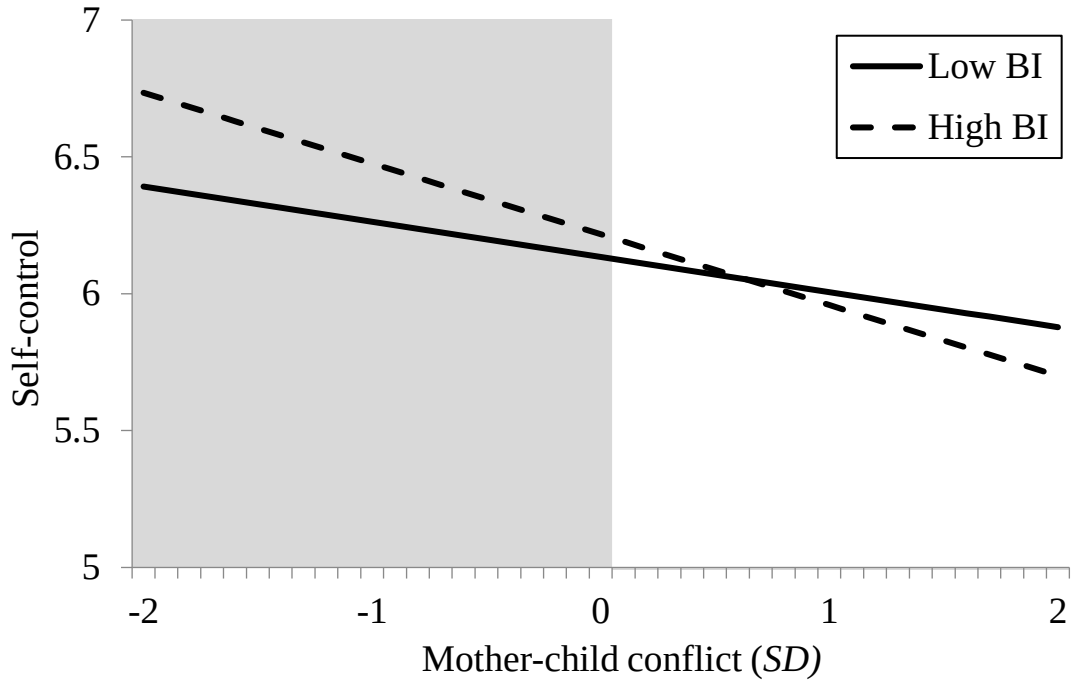

Figure 2. Plot of temperament (BI: behavioural inhibition) by environment (mother-child conflict) interaction for child's self-control at age 5 years. The shaded area represents the region of significance on mother-child conflict.