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The association between toddlerhood self-control and later externalizing problems

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Abstract

Lower self-control is a significant correlate or predictor of a wide range of adult outcomes, and this association may be due to more general tendencies toward childhood externalizing problems. The present study examined the association between toddlerhood self-control expressed within a “don’t” compliance task (at 14 to 36 months) and later externalizing problems (parent-reported externalizing problems from age 4 to 12 years, teacher-reported externalizing problems from age 7 to 12 years, and self-reported conduct disorder symptoms at age 17 years) in a longitudinal, genetically informative study. The slope of self-control, but not its intercept, predicted later teacher-reported, but not parent- or self-reported, externalizing problems. That is, increase in self-control during toddlerhood was associated with lower levels of later teacher-reported externalizing problems. The slope of self-control was no longer a significant predictor of teacher-reported externalizing problems after controlling for observed disregard for others, a robust predictor of externalizing problems. Thus, the hypothesis that self-control is the primary predictor of externalizing problems was not supported. Results from genetic analyses suggested that the covariance between the slope of self-control and teacher-reported externalizing problems is due to both genetic and shared environmental influences.

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Compliance with Ethical Standards

Conflict of Interest: All authors declare no conflict of interest.

Ethical approval: This article does not contain any studies with animals performed by any of the authors. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent: Informed consent was obtained from all individual adult participants included in the study.

Keywords

self-control; conduct disorder; antisocial behavior; behavioral genetics

The study of self-control has received a great deal of interest in the scientific literature and the popular press, as it is a significant correlate or predictor of a wide range of outcomes, including physical health, substance dependence, personal finances, criminal behavior, and executive functioning (e.g., Friedman et al., 2011; Moffitt et al., 2011). However, a recent study found that many of these associations were reduced to non-significance after controlling for childhood conduct problems, suggesting that lower self-control may be a developmental precursor of childhood conduct problems, and that the association between self-control and later outcomes may be due to more general tendencies toward childhood conduct problems (Fergusson et al., 2013). The present study examined the association between very early self-control expressed within a “don’t” compliance task and later externalizing problems (i.e., parent-reported externalizing problems from age 4 to 12 years, teacher-reported externalizing problem from age 7 to 12 years, and self-reported conduct disorder symptoms at age 17 years), addressed whether self-control is the primary explanatory factor for externalizing problems, and estimated the magnitude of genetic and environmental influences on the association between self-control and externalizing problems.

A prominent theory linking early lower self-control to conduct and externalizing problems is Gottfredson and Hirschi’s general theory of crime (1990). Poor self-control is described as the tendency to engage in behavior that produces immediate, short-term pleasure or benefit and avoid acts whose long-term consequences outweigh their immediate benefits. Their theory also applies to other “analogous” behavior or activities that are immediately gratifying, such as aggression, substance use, and gambling. A challenge in this literature is the wide range of definitions and assessments of self-control. There are many terms for self-control and related constructs, including self-regulation, self-discipline, delay of gratification, effortful control, willpower, executive control, time preference, ego strength, and conscientiousness (e.g., Duckworth & Kern, 2011; see also Bridgett et al., 2015, for a review and proposed taxonomy). Duckworth and Kern’s (2011) meta-analysis examined distinct approaches to the measurement of self-control, including executive functioning (i.e., goal-directed, higher-level cognitive processing in which top-down control is exerted over lower-level cognitive processes), delay of gratification (i.e., choosing a larger, delayed reward rather than a smaller, immediate reward), self-report questionnaires, and informant-report questionnaires, and reported moderate convergence across the different assessments of self-control (Duckworth & Kern, 2011).

Another meta-analysis (Pratt & Cullen, 2000) reported that level of self-control is a predictor of crime and analogous behaviors with consistent effect sizes across different operationalizations and assessments of self-control. Although effect sizes were significantly lower in longitudinal studies than in cross-sectional studies, the general conclusion from all studies was that there was an association between lower self-control and crime/analogous behaviors. Literature examining lower self-control as a very early predictor of later

externalizing problems is sparse, but there is supportive evidence from a few studies published since the Pratt and Cullen meta-analysis. Pitzer et al. (2009) found a significant association between earlier lower self-control (age 8 years for boys and age 2 years for girls) and greater externalizing problems at age 15 years, and Barnes et al. (2013) found an association between lower self-regulation at age 2 years and greater externalizing problems at age 5 years.

Toddlerhood is an important period for the development of self-control, including compliance with adult demands (Kochanska et al., 2001) and development from externally imposed control to greater internalization of rules in the absence of monitoring (Eisenberg, 2014). Gottfredson and Hirschi's theory (1990) also emphasizes the importance of early development. They suggest that the tendency toward lack of self-control is inherent, and that self-control is unlikely to be developed unless there is effort to create it via effective parental socialization. Two main sources of variance in self-control are hypothesized. First, there are individual differences in the traits that impact the prospects of effective socialization, such as adventuresomeness and low intelligence. Gottfredson and Hirschi note that such traits predict later problems as soon as they can be reliably measured. Second, there is variance in parental socialization of self-control. Others have suggested similar ideas. For example, Eisenberg suggested that self-control is influenced both by individual differences in temperament, which likely has a genetic basis, and by interactions with parents, with warmth, positive expressivity, and parent-child attachment being potential influences (Eisenberg et al., 2005). There are significant associations between these parenting variables and self-control in studies of infants, toddlers, and young children (see Eisenberg, 2014, for a review).

Gottfredson and Hirschi (1990) suggest that lower self-control is the primary factor contributing to later crime and other adverse outcomes, and that other temperament and cognitive ability influence later problems indirectly via self-control. However, this view is not shared uniformly across developmental researchers. Another theory regarding the development of externalizing problems, the developmental propensity model (Lahey & Waldman, 2003), hypothesizes a more direct role of temperament and cognitive ability on externalizing problems. A recent study testing this model in the sample examined here found that observed disregard for others and cognitive ability assessed during toddlerhood were robust predictors of later externalizing problems assessed by all three informants (parents, teachers, and self; Rhee et al., 2016). Also, DeLisi and Vaughn's theory (2014) emphasizes the role of both effortful control and negative emotionality as predictors of externalizing problems, as does work by Eisenberg and colleagues (e.g., Eisenberg et al., 2009).

In the present study, early self-control was assessed via performance on a "don't" compliance task (age 14, 20, 24, and 36 months), during which children were shown an attractive toy and asked not to touch it. Kochanska et al. (2001) noted that compliance, a prototypic form of early self-regulation, requires several control processes, including awareness of social demands, the ability to initiate, maintain, and cease behavior, and the ability to comply with requests. Performance on this task has been shown to be longitudinally stable (Kochanska et al., 2001; Friedman et al., 2011) and significantly associated with effortful control, or the ability to suppress a dominant response and perform

a subdominant response (Kochanska et al., 2001). Later externalizing problems were assessed via parent- (age 4 to 12 years) and teacher-reported (age 7 to 12 years) externalizing problems and self-reported (age 17 years) conduct disorder symptoms, which were significantly correlated (Rhee et al., 2016).

First, we examined Gottfredson and Hirschi's (1990) hypothesis that self-control is the primary factor contributing to externalizing problems by examining whether lower self-control independently predicts externalizing problems after controlling for two other early predictors that were significantly associated with later externalizing problems across informants and could not be attributed to method covariance (Rhee et al., 2016), general cognitive ability and observed disregard for others. Second, we examined both stable variance common with initial levels of self-control at age 14 months and change in self-control from 14 to 36 months as predictors of later externalizing problems. Gottfredson and Hirschi's suggestion of the two main sources of variance of self-control predict that both stable variance in common with initial levels of self-control at age 14 months and change in self-control from 14 to 36 months should be associated with later externalizing problems. Third, we took advantage of the fact that the present study is a twin study, which compares the correlations between MZ twin pairs (who share 100% of their genes) and DZ twin pairs (who share on average 50% of their genes identical by descent) to estimate the magnitude of genetic and environmental influences on a trait. We examined Gottfredson and Hirschi's suggestion that self-control is influenced by both inherent temperament and parental socialization by estimating the magnitude of genetic, shared environmental (i.e., environmental influences that lead to similarities between siblings), and nonshared environmental (i.e., environmental influences that lead to differences between siblings) influences on self-control. We also examined whether the association between self-control and externalizing problems is due to genetic or environmental influences.

Method

Participants

The Colorado Longitudinal Twin Study (LTS) is a sample of 483 same-sex twin pairs (966 individuals) who were born in the state of Colorado between 1986 and 1990. Twins' parents were initially contacted via the Colorado Department of Health, and more than 50% of contacted families met the inclusion criteria (birth weight not lower than 1000 grams, gestational age of at least 34 weeks, and living within a two-hour drive of Boulder, CO) and enrolled in the study. The ethnicity distribution of the LTS (86.6% Caucasian, 8.5% Hispanic, 0.7% African–American, 1.2% Asian, and 2.9% other) is similar to that reported for Boulder County, Colorado in the United States Census in 1990 (89.5% Caucasian, 3.8% Hispanic, 0.9% African–American, 2.4% Asian, and 3.4% other). The mean number of years of education was 14.29 years for mothers and 14.42 years for fathers. Of all parents, 5% did not complete high school, 29% completed high school without post-secondary education, 49% had some post-secondary education, and 17% had some graduate-level education. For more details regarding the LTS, see Rhea, Gross, Haberstick, and Corley (2006; 2013). The present study included 956 individuals (484 females and 472 males, including 261 monozygotic [MZ] twin pairs, 215 dizygotic [DZ] twin pairs, and two twin pairs for whom

zygosity could not be confirmed¹) who had data for at least one measure of self-control, antisocial propensity (i.e., low cognitive ability or disregard for others), or externalizing problems. The sample size for each measure is presented in Appendix 1 of the Supplementary Online Materials. Written informed consent was obtained after complete description of the study to the participating parents or guardians of the twin pairs. Research protocols and consent forms were approved by University of Colorado Boulder's Institutional Review Board.

Zygosity Determination

Each time participants were seen in person, testers rated the twin pairs' similarity on 10 physical characteristics (Nichols & Bilbro, 1966). Twins were coded as MZ if they were rated highly similar, and coded as DZ if two or more features rated only somewhat similar or not at all similar. Zygosity was considered unambiguous if there was agreement among 85% of the raters. Blood testing was used to resolve ambiguity in nine twin pairs, and the zygosity ratings were confirmed using 11 polymorphic DNA microsatellite markers.

Measures

Self-control—Participants were shown an attractive toy (i.e., a glitter wand), and instructed “Don’t touch!” The latency to touch the toy was recorded, and the participant was told that he or she could touch the toy after 30 seconds. Given that latency to touch was highly skewed, it was transformed into an ordinal variable with three categories (0–10 seconds, 11–29 seconds, and more than 30 seconds [i.e., child did not touch before prohibition was lifted]; see Friedman et al., 2011). The number of categories was chosen to maximize variability while avoiding small cell sizes. Appendix 2 presents the percentage of individuals in each category at age 14, 20, 24, and 36 months.

Other predictors of externalizing problems—Observed disregard for others was coded from home and laboratory sessions during which the mother or the examiner pretended to hurt herself (at 14, 20, 24, and 36 months) or a recording of an infant crying broadcast from a speaker in the lab room containing a baby doll (at 14, 20, and 24 months). Responses indicating disregard for others included “anger”, “hits offending object”, and “hostility”. Inter-rater reliability ranged from .88 to .99. Composite scores were created by summing the scores on the three responses for individuals with data for all items, with a range of zero to three, then transformed into ordinal variables with three categories (score of 0, 1, and 2 or higher).

The Mental Developmental Index of the Bayley Scales of Infant Development (Bayley, 1969) was administered at 14, 20, and 24 months. The Stanford-Binet, Form L–M (Terman & Merrill, 1973) was administered at 36 months.

Externalizing problems—In a recent study, we examined a higher-order externalizing problems factor with loadings on latent parent- and teacher-reported externalizing problems (with loadings on each age) and self-reported conduct disorder symptoms (with loadings on

¹These twin pairs were included in the phenotypic analyses and excluded from the genetic analyses.

each symptom), which were significantly correlated ($r_{\text{parent-teacher}} = .42, p < .01$; $r_{\text{parent-self}} = .29, p < .01$; $r_{\text{teacher-self}} = .43, p < .01$; Rhee et al., 2016; see Appendix 3). The externalizing scale scores of the Child Behavior Checklist (CBCL/4-18; Achenbach, 1991a) and Teacher's Report Form (TRF; Achenbach, 1991b) were used to assess externalizing problems. Parent reports were available at age 4, 5, 7, 9, 10, 11, and 12, and teacher reports were available yearly from age 7 to 12. Given skewness of the data, scores were transformed into ordinal variables with four categories (CBCL – score between 0 to 3, between 4 to 7, between 8 to 12, and 13 or higher; TRF – score of 0, between 1 to 3, between 4 to 10, and 11 or higher); the number of categories was chosen to maximize variability while avoiding small cell sizes.

Self-report of conduct disorder symptoms was assessed via the Diagnostic Interview Schedule for Children-IV (Shaffer et al., 2000) at age 17. Because past year conduct disorder symptoms (as defined by the DSM-IV; American Psychiatric Association, 2000) were not common, the stem questions for the conduct disorder symptoms occurring over the lifetime were assessed to examine the presence/absence of externalizing problems. “Stealing with confrontation” (0.8%) and “forced sex” (0.1%) were dropped given extremely low prevalences.

Analyses

Analyses were conducted in Mplus, version 7 (Muthén & Muthén, 1998–2015). Highly skewed variables were transformed into ordinal variables, as described in the method section (Derks et al., 2004). The weighted least squares, mean and variance adjusted (WLSMV) estimation method was used, and pairwise deletion was used to handle missing data. The TYPE=COMPLEX option was used in computing standard errors and model fit in order to address nonindependence of twin pairs in phenotypic analyses. The significance of the parameters was determined by p -values for the z -statistic (the ratio of the parameter estimate to its standard error), but if there was an inconsistency between the conclusions regarding the parameter significance reached from the p value and the result of a χ^2 difference test dropping the parameter, the χ^2 difference test was used. The α was .05, with no correction for multiple testing, given that there was one main hypothesis of an association between very early self-control and later externalizing problems². Supplementary fit indices were examined given that the χ^2 is sensitive to sample size. A Tucker-Lewis index (TLI; Bentler, 1990) greater than .95 and a root mean square error of approximation (RMSEA; Browne & Cudeck, 1993) less than .06 indicate good model fit (Hu & Bentler, 1998). All models fit the data well, with TLIs > .95 and RMSEAs < .06.

First, we examined latent variables reflecting the common variance underlying self-control or externalizing problems across the ages or items, with freed loadings at all time points. For externalizing problems, two alternative latent variable models were examined. The hierarchical model has a higher-order externalizing problems factor with loadings on the parent-, teacher-, and self-report latent factors and a single correlation between self-control and the higher-order externalizing problems factor. In contrast, the correlated factors model

²We note whether the p value was < .05 vs. < .01 in the results to provide additional information.

allows separate correlations between self-control and parent-, teacher-, and self-reported externalizing problems.

Second, latent growth curve modeling was also conducted to examine changes in self-control or externalizing problems. The latent intercept has unstandardized loadings of 1.0 for all time points; i.e., the intercept influences behavior across all time points. The latent slope factor has a loading of zero for the first time point, a loading of 1.0 for the last time point, and freely estimated loadings for the intermediate time points (Bollen & Curran, 2006). A latent growth curve model with freed slope loadings is a more efficient model of nonlinear changes than those including multiple latent variables for linear, quadratic, and higher polynomials, which can often be highly collinear and difficult to interpret in terms of developmental processes (Ram & Grimm, 2007). Individual differences in initial levels and the variance that is stable and shared in common across time with the initial time point are represented by the intercept, and individual differences in change from the initial time point is represented by the slope. Appendix 3 presents the figures of models for externalizing problems, and Appendix 4 presents the figures of models for self-control.

Finally, a trivariate Cholesky decomposition examining the covariance between the intercept of self-control, the slope of self-control, and externalizing problems was used to examine the magnitude of genetic and environmental influences on self-control, externalizing problems, and the covariance between self-control and externalizing problems (see Figure 1³). In a Cholesky decomposition, the number of latent additive genetic influences (A), shared environmental influences (C), and nonshared environmental influences (E) equals the number of variables examined. The first set of latent variables (A1, C1, and E1) influence all three variables, the second set of latent variables (A2, C2, and E2) influence the only the second and third variables, and the third set of latent variables (A3, C3, and E3) influence only the third variable.

Results

Association Between Self-Control and Externalizing Problems

There were no gender differences in self-control at ages 14 and 20 months, but girls displayed greater self-control than boys at ages 24 and 36 months (see Appendix 2). Also, boys had higher levels of externalizing problems than girls (higher-order externalizing problems factor $\beta=.84$, $p < .01$; parent-reported externalizing problems $\beta=.37$, $p < .01$; teacher-reported externalizing problem $\beta=.67$, $p < .01$; self-reported conduct disorder symptoms $\beta=.53$, $p < .01$). We first examined the correlations between self-control and externalizing problems for males and females separately. There were several instances of bivariate missingness in these analyses (e.g., a zero cell in the bivariate table for “cruelty to animals” and teacher-reported externalizing problems at several ages) when the sample was split into male and female groups, so some conduct disorder symptoms were deleted (four in females and one in males). Therefore, we did not conduct formal tests of sex differences in the parameters. The pattern of correlations between self-control and externalizing problems

³Note that in the model depicted in Figure 1, the covariance between the intercept of self-control and teacher-reported externalizing problems was near zero and dropped from the model.

is very similar in males and females, with the latent self-control variable and the slope of self-control being significantly correlated with teacher-reported externalizing problems, but not parent- or self-reported externalizing problems (see Appendix 5). Given these findings, we conducted all subsequent analyses in the combined sample.

The latent self-control variable, with loadings on self-control assessed at each time point, was correlated with the higher-order externalizing problems factor from the hierarchical model ($r = -.17, p = .04$). It was not correlated with parent- or self-reported externalizing problems ($r = .01$ to $.08, p > .05$), but was negatively correlated with teacher-reported externalizing problems ($r = -.34, p < .01$), indicating that higher levels of early self-control predicts lower levels of later externalizing problems ($\chi^2(399) = 540.824, p < .01, TLI = .975, RMSEA = .019$; see “Latent Variable” in Table 1). The hierarchical model with a higher-order externalizing problems factor with loadings on the parent-, teacher-, and self-report latent factors and a single correlation between self-control and the higher-order externalizing problems factor (see Appendix 3; $\chi^2(401) = 576.498, p < .01, TLI = .969, RMSEA = .021$) fit the data significantly worse than the model allowing separate correlations between self-control and parent-, teacher-, and self-reported externalizing problems (i.e., the correlated factors model; see Appendix 3), ($\chi^2(2) = 16.804, p < .01$). Thus, self-control seems to be specifically associated with teacher-reported externalizing problems rather than being related to the common variance across reporters. A multiple regression analysis including both the latent self-control variable and gender as predictors was conducted; the regression of teacher-reported externalizing problems on the latent self-control variable was significant after controlling for gender ($\beta = -.28, p < .01$).

There was a great deal of increase in self-control from age 14 to 36 months (see Appendix 2). Results of latent growth curve modeling ($\chi^2(397) = 525.041, p < .01, TLI = .977, RMSEA = .018$; see “Intercept” and “Slope” in Table 1) indicated no significant correlations between the intercept factor and externalizing problems ($r = .03$ to $.22, p > .05$), suggesting that the stable variance shared in common with the initial time point is not correlated with later externalizing problems. However, the slope factor of self-control had a significant negative correlation with teacher-reported externalizing problems ($r = -.67, p < .01$), and the regression of teacher-reported externalizing problems on the slope of self-control was significant after controlling for gender ($\beta = -.46, p < .01$); i.e., greater increase in self-control between 14 and 36 months is correlated with lower levels of later childhood externalizing problems. However, the slope of self-control was not correlated with self- or parent-reported, externalizing problems ($r = -.12$ to $-.19, p > .05$). Again, a model in which the self-control growth factors correlated only with a hierarchical externalizing problems factor predicting parent-, teacher-, and self-reported problems ($\chi^2(401) = 556.188, p < .01, TLI = .973, RMSEA = .020$) fit the data worse than one in which the self-control growth factors were allowed to freely correlate with factors for each rater, ($\chi^2(4) = 19.050, p < .01$).

Results examining associations between the growth factors of self-control and the growth factors of parent- and teacher-reported externalizing problems (for which there were multiple assessments across ages) led to similar conclusions. The growth factors of self-control were not correlated with the intercept or slope of parent-reported externalizing problems ($r = -.28$ to $.13, p > .05$). The intercept of self-control was not correlated with the

intercept ($r=.05$, $p=.67$) or slope ($r= -.20$, $p=.30$) of teacher-reported externalizing problems, but the slope of self-control was negatively correlated with the intercept of teacher-reported externalizing problems ($r= -.71$, $p<.01$), suggesting that an increase in self-control is correlated with the variance of teacher-reported externalizing problems that is stable and shared in common across time with the initial time point. Also, the slope of self-control was positively correlated with the slope of teacher-reported externalizing problems ($r=.51$, $p=.01$), suggesting that larger increases in self-control from 14 months to 36 months were correlated with smaller decreases in teacher-reported externalizing problems from 7 years to 12 years, which may be explained by the observation that individuals with lower initial externalizing problems decrease less across time.

To further understand the significant correlations with the slope, but not the intercept, of self-control and later teacher-reported externalizing problems, we examined correlations at each time point. The correlations between self-control assessed at 14 and 20 months and later teacher-reported externalizing problems was close to zero and not significant ($r= -.04$ to $.00$, $p>.05$), whereas 24-month and 36-month self-control had significant negative correlations with teacher-reported externalizing problems ($r= -.22$ to $-.33$, $p<.01$; see Table 2).

Is Self-Control the Primary Predictor of Externalizing problems?

Next, we tested whether lower self-control is an independent predictor of teacher-reported externalizing problems after controlling for two other robust predictors of externalizing problems, observed disregard for others and cognitive ability (Rhee et al., 2016). Observed disregard for others was not correlated with the intercept of self-control ($r= -.06$, $p= .75$), but significantly correlated with the slope of self-control ($r= -.64$, $p= .03$). Cognitive ability was significantly correlated with both the intercept ($r= .40$, $p< .01$) and slope ($r= .48$, $p< .01$) of self-control. In multiple regression structural equation models, the slope of self-control was a significant predictor of teacher-reported externalizing problems after controlling for cognitive ability ($\beta= -.55$, $p< .01$), but not after controlling for observed disregard for others ($\beta= -.13$, $p= .89$).

Genetic and Environmental Influences on Self-Control and Externalizing Problems

Table 3 shows the MZ and DZ within-trait cross-twin correlations for the intercept and slope of self-control and teacher-reported externalizing problems, and the MZ and DZ cross-trait cross-twin correlations for the association between slope of self-control and teacher-reported externalizing problems. The MZ within-trait cross-twin correlations are greater than those for DZs, suggesting that both the intercept and slope of self-control and teacher-reported externalizing problems are influenced by additive genetic influences. The phenotypic correlation between latent self-control and teacher-reported externalizing problems ($r= -.62$, $p< .01$) was similar to the MZ and DZ cross-trait cross-twin correlations, with the MZ cross-trait cross-twin correlation being slightly greater than the DZ cross-trait cross-twin correlation. The results of the trivariate Cholesky decomposition (see Figure 1) suggest that the intercept of self-control ($a^2=.32$, $c^2=.67$, $e^2=.01$), the slope of self-control ($a^2=.15$, $c^2=.43$, $e^2=.42$), and teacher-reported externalizing problems ($a^2=.71$, $c^2=.25$, $e^2=.04$) are influenced by both genetic and shared environmental influences⁴. The model-estimated

correlation between the slope of self-control and teacher-reported externalizing problems in the Cholesky (calculated using path tracing rules on the covariance paths shown in Figure 1; $r = -.58, p < .01$) was statistically significant and equally due to additive genetic ($-.32, p = .44$) and shared environmental ($-.32, p = .36$) influences, but not nonshared environmental influences ($.06, p = .55$); however, neither the genetic nor shared environmental correlation was statistically significant⁵.

Discussion

We examined whether lower toddlerhood self-control expressed within a “don’t” compliance task predicted later externalizing problems assessed by parents, teachers, and self. There was a significant association between early lower self-control and later teacher-reported externalizing problems, but not parent- or self-reported externalizing problems. Later teacher-reported externalizing problems were negatively associated with larger increases in self-control between 14 to 36 months, but not stable variance in common with initial levels of self-control. Self-control was significantly associated with two other robust predictors of externalizing problems in our recent study testing the developmental propensity model of externalizing problems, cognitive ability and observed disregard for others (Rhee et al., 2016). It was not significantly associated with teacher-reported externalizing problems after controlling for observed disregard for others, which was a robust predictor of later externalizing problems assessed by three informants. These results provide little support for Gottfredson and Hirschi’s hypothesis that lower self-control is the primary factor contributing to later adverse outcomes, and are more consistent with other theories hypothesizing a more direct role of temperament and cognitive ability on externalizing problems (e.g., DeLisi & Vaughn, 2014; Lahey & Waldman, 2003). Finally, the association between lower self-control and externalizing problems was due to both genetic and shared environmental influences, with no evidence of common nonshared environmental influences.

Stable variance in common with initial levels of self-control was not associated with later externalizing problems, whereas increases in self-control from 14 to 36 months were significantly associated with lower teacher-reported externalizing problems. Also, the correlations between 14- and 20-month self-control and later teacher-reported externalizing problems were near zero, whereas 24- and 36-month self-control was significantly negatively associated with later teacher-reported externalizing problems. These results are consistent with those of Pitzer et al. (2009), who found that lower self-control assessed at age 2 years predicted externalizing problems assessed at age 15 years in girls, whereas there were no significant associations with self-control assessed at age three months.

It should be noted that 73.3% of children touched the toy within ten seconds at 14 months, whereas by 36 months, only 22.2% of children did so. This pattern confirms suggestions that toddlerhood is an important period for the development of self-control (Kochanska et al., 2001; Eisenberg, 2014), but also raises the possibility that the null association between the

⁴The magnitude of nonshared environmental influences is very low for the intercept of self-control and teacher-reported externalizing problems. This is likely due to the fact that the phenotypes examined are latent variables, which have lower measurement error.

⁵These p values are those from the z -statistic for the correlation due to the genetic and environmental influences calculated using the NEW option of the MODEL CONSTRAINT command in Mplus.

intercept of the self-control trajectory arose because self-control assessed via a compliance task may not be informative at an age when the majority of the children fail to comply. However, evidence contrary to this possibility was reported in Friedman et al. (2011), who found that early self-control assessed at 14 and 20 months predicted executive functioning and general cognitive ability at age 17 in this sample. These results suggest that although self-control is assessed reliably and validly at ages 14 and 20 months, it is the successful development of skills leading to increased self-control from early to later toddlerhood, rather than initial levels in early toddlerhood, that is important in the prediction of later externalizing problems. They also suggest an intriguing dissociation, where very early self-control relates more to later executive function than externalizing problems.

The present study has a number of strengths. It contributes to the sparse literature examining self-control during toddlerhood, an important period of development, as a predictor of later externalizing problems (Barnes et al., 2013; Pitzer et al., 2009). There were multiple assessments of self-control across toddlerhood, and multiple methods were used to assess other early predictors and later externalizing problems. Finally, examination of a genetically informative sample allowed us to conduct analyses examining the relative role of genetic and environmental influences on the association between self-control and externalizing problems.

The results of the present study should be interpreted while considering the following limitations. Self-control was associated only with teacher-reported externalizing problems, not parent- or self-reported externalizing problems. It is possible that the association between early self-control and teacher-reported externalizing problems are context-specific. Our assessment of early self-control (i.e., a compliance task administered by an examiner) and teacher-reported externalizing problems may have commonalities that are less relevant to problems that arise at home and more likely to be reported by parents or children themselves. These include compliance with instructions in a formal setting and fear of authority figures, which also may be associated with later adult outcomes. However, another possibility is that teachers provide a more valid assessment of externalizing problems than parents or adolescents. There is some evidence suggesting that teacher reports may be better screeners of future externalizing behavioral problems than parent reports (Dwyer, Nicholson, & Battistutta, 2006), which may be especially true when the common variance from different teacher reports across several years is examined, as in the present study.

Second, the assessment of self-control was limited to a single “don’t” compliance task. Compliance requires self-control (e.g., Kochanska et al. [2001] noted that compliance is a prototypic form of early self-regulation), but also may reflect fearfulness, tendency to follow rules, or listening to authority. A latent variable including additional assessments, such as a delay of gratification task or parent report, would have strengthened the measurement of self-control, and may be a more robust predictor of externalizing problems across reporters. Finally, there was lack of power to find significant genetic and shared environmental influences on the association between self-control and teacher-reported externalizing problems. Additional well-powered developmental behavior genetic studies examining the interaction between children’s characteristics and socializing influences on externalizing problems are needed.

As noted in the introduction, Fergusson et al. (2013) found significant associations between self-control assessed during childhood and adult outcomes at age 30, such as criminal offending, education, employment, and mental health, but many of the associations were not significant after controlling for childhood externalizing problems. Data on adult outcomes at age 30 in the LTS are being collected currently, and our future directions include examining whether toddlerhood self-control predicts adult outcomes, and whether this association is mediated by externalizing problems.

In conclusion, the present study suggests that there is an association between lower self-control assessed by a “don’t” compliance task during toddlerhood and externalizing problems, although the association is limited to change in self-control across the second and third years and teacher-reported externalizing problems, and results were not consistent with the assertion that self-control is the primary early predictor of externalizing problems. Self-control and the association between self-control and teacher-reported externalizing problems seem to be influenced by both genetic and shared environmental influences, although lack of power was an issue in the genetic analyses.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.

Trivariate Cholesky decomposition examining self-control and teacher-reported externalizing problems. A₁ = genetic influences on the intercept of self-control, C₁ = shared environmental influences on the intercept of self-control, E₁ = nonshared environmental influences on the intercept of self-control, A₂ = genetic influences specific to teacher-reported externalizing problems, C₂ = shared environmental influences specific to teacher-reported externalizing problems, E₂ = nonshared environmental influences specific to teacher-reported externalizing problems, A₃ = genetic influences specific to teacher-reported externalizing problems, C₃ = shared environmental influences specific to teacher-reported externalizing problems, E₃ = nonshared environmental influences specific to teacher-reported externalizing problems. Given that the covariance between the intercept of self-control and teacher-reported externalizing problems was near zero, and dropping it did not lead to a significant decrement in fit, $\chi^2(3)=0.867$, $p=.83$, it was not included in the final model. Age-specific genetic, shared environmental, and nonshared environmental influences were included in the model, but not shown for the sake of simplicity. The significance of the parameters was determined by p -values for the z -statistic. * $p<.05$, ** $p<.01$

Table 1

Correlations between latent toddlerhood self-control and latent childhood/adolescent externalizing problems

Self-Control (14 to 36 months)	Externalizing problems		
	Parent-reported (4 to 12 years)	Teacher-reported (7 to 12 years)	Self-Reported (17 years)
Latent Variable	.01	-.34 **	.08
Intercept	.18	.03	.22
Slope	-.19	-.67 **	-.12

Note. Latent Variable = Results from model examining the correlations between latent variable with loadings on 14- to 36-month self-control (see Appendix 4) and latent variables from the correlated factors model for externalizing problems (see Appendix 3). Intercept and Slope = Results from correlational models examining the Intercept and Slope growth factors of self-control (see Appendix 4) and latent variables from the correlated factors model for externalizing problems (see Appendix 3).

**
 $p < .01$

Table 2

Correlations between self-control (ordinal variable with three categories) assessed at each age during toddlerhood and later externalizing problems (latent variable with loadings on each age or item)

Self-Control	Externalizing problems		
	Parent-reported (4 to 12 years)	Teacher-reported (4 to 12 years)	Self-Reported (17 years)
14 months	.10	.00	.13
20 months	.02	-.04	.06
24 months	.05	-.22 **	-.02
36 months	-.07	-.33 **	.05

Note. Results from model examining the correlations between self-control assessed at each age with latent variables from the correlated factors model for externalizing problems (see Appendix 3).

**
 $p < .01$

Table 3

Within-trait cross-twin and cross-trait cross-twin correlations

	Within-Trait Cross-Twin <i>r</i>			Cross-Trait Cross-Twin <i>r</i>
	Intercept of Self-Control	Slope of Self-Control	Teacher-reported Externalizing problems	Slope of Self-Control and Teacher-reported Externalizing problems
Monozygotic	1.00	.51	.96 **	-.60 **
Dizygotic	.86 ⁺	.13	.59 **	-.52 **

Note.

⁺
 $p < .10$,**
 $p < .01$.

The monozygotic twin correlation was > 1.0 in the model where it was freely estimated, but fixing the correlation to 1.0 did not result in significant decrement in model fit ($\chi^2(1)=1.73$, $p=.19$). The phenotypic correlation between the intercept of self-control and slope of self-control, the phenotypic correlation between the intercept of self-control and teacher-reported externalizing problems, and the corresponding monozygotic and dizygotic cross-trait cross-twin correlations were near zero ($r = -0.06$ to $.03$).