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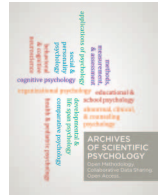
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SPECIAL SECTION: EDUCATIONAL PSYCHOLOGY

Antecedents and Consequences of Social–Emotional Development:
A Longitudinal Study of Academic Achievement

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A B S T R A C T

Different aspects of social–emotional development in early childhood—including self-regulation, hyperactivity, emotional problems, and peer problems—have each been shown to individually influence academic achievement into primary and secondary school. Environmental and demographic factors have also been shown to influence a child’s academic development. The current study extends previous work to consider a broader array of antecedents and measures and their relative relations with later academic outcomes. Parent-reported data on a nationally representative sample of children at ages 3 and 5 years, and academic assessment at age 7, from the Millennium Cohort Study were analyzed. Results indicated contributions from the child’s social–emotional, environmental, and demographic background on their academic progress. These results suggest diverse factors in early childhood are important predictors of later academic success, and could assist in programs to support parents and educators.

S C I E N T I F I C A B S T R A C T

Different aspects of social–emotional development in early childhood—including self-regulation, hyperactivity, emotional problems, and peer problems—have each been shown to individually influence academic achievement into primary and secondary school. Environmental and demographic factors have also been shown to influence a child’s academic development. The current study extends previous work to consider—concurrently, using structural equation modeling—a broader array of antecedents and measures of social–emotional development to understand their relative relations with later academic outcomes. Parent-reported data on a nationally representative sample of children ($N = 10,080$) at ages 3 and 5 years, and academic assessment at age 7, from the Millennium Cohort Study were subjected to longitudinal modeling. Results indicated the individual and collective contributions of social–emotional, environmental, and demographic antecedents of academic progress. These results suggest that malleable factors in early childhood are important predictors of later academic success, and thus may be viable targets for intervention.

Keywords: self-regulation, home learning environment, hyperactivity, social–emotional development, academic achievement

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Data for this study were drawn from the Millennium Cohort Study (MCS; Centre for Longitudinal Studies, University of London, United Kingdom). Previous researchers have used the MCS dataset for other analyses, which have been published in other research papers and presented at conferences. The current combination of variables and hypotheses in this article has not been previously reported. The authors have made available for use by others the data that underlie the analyses presented in this paper (see Hammer, Melhuish, & Howard, 2017b), thus allowing replication and potential extensions of this work by qualified researchers. Next users are obligated to involve the data originators in their publication plans, if the originators so desire.

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Research has established that children's academic achievement is influenced by a number of individual, parental, and educational factors. Many of these investigations have focused on the antecedents of cognitive development, such as socioeconomic status (family income, parental educational level; Davis-Kean, 2005; Foster, Lambert, Abbott-Shim, McCarty, & Franze, 2005), gender (McClelland et al., 2014), parenting (Grolnick & Ryan, 1989; Hammer, Melhuish, & Howard, 2017a), and home learning environment (HLE; Melhuish, Phan, et al., 2008). Each one of these factors has been shown to independently predict subsequent academic achievement, yet often their concurrent predictive strength is not evaluated. There is also growing recognition that "noncognitive" (e.g., social, emotional) development may also play an important role in fostering children's academic outcomes (Caprara, Barbaranelli, Pastorelli, Bandura, & Zimbardo, 2000; Dobbs, Doctoroff, Fisher, & Arnold, 2006; Heckman & Rubenstein, 2001), yet this has received comparatively less attention and is rarely considered in conjunction with cognitive development factors.

Current available research suggests that certain social-emotional behaviors are especially predictive of later academic achievement, including prosocial behaviors, conduct problems, hyperactivity, peer problems, and emotional problems (Gross, 1998; Ponitz, McClelland, Matthews, & Morrison, 2009; Trentacosta & Shaw, 2009). For instance, Dobbs et al. (2006) found that preschool social problems predicted later math achievement. Loe and Feldman (2007) found hyperactive behaviors in children (even those subclinical for attention deficit/hyperactivity disorder) predicted later academic outcomes. Research also suggests more positive peer relationships are associated with better academic outcomes in both literacy and math (Malecki & Elliot, 2002). For instance, Liem and Martin (2011) found that children with positive peer relationships in primary school had better school engagement and academic outcomes (an association also found with adolescents; Caprara et al., 2000).

A recent study that sought to combine these lines of investigation further supports the robust association between social-emotional development and academic outcomes (Hammer et al., 2017a). This study found that when social-emotional factors (i.e., prosocial behaviors, hyperactivity, conduct problems, peer problems, and emotional problems) were considered concurrently, only two of these factors predicted later academic outcomes. Specifically, strong associations were found for hyperactivity and peer problems, measured in preschool, with academic outcomes (literacy and numeracy) in primary school and early high school. These associations remained even when controlling for influential covariates such as parental educational level, socioeconomic status (SES), and gender. This suggests that hyperactivity and peer problems may independently influence a child's academic outcomes, beyond that of previously established factors. It further suggests that relationships with academic outcomes that are established in isolation of other important predictors (e.g., conduct problems) may in fact be subserved by other social-emotional (e.g., peer problems), demographic (e.g., SES, parental education level), personal (e.g., gender), or parenting factors (e.g., hostile parenting).

Although the Hammer et al. (2017a) findings add to the evidence base indicating the importance of social-emotional development for longitudinal academic progress (particularly the consistent association of hyperactivity on academic outcomes), the findings are nevertheless constrained by the data available. Specifically, in using data from the Longitudinal Study of Australian Children—a large and nationally representative dataset—the authors were unable to account for other factors that have been shown as strongly predictive of academic outcomes (e.g., self-regulation and HLE; Best, Miller, & Naglieri, 2011; Melhuish, Belsky, & Leyland, 2008; Melhuish, Belsky, Ley-

land, Barnes, et al., 2008). Furthermore, in that study the associations between social-emotional factors at age 4 to 5 years and academic outcomes in later primary school (Grades 3, 5, and 7) were investigated by separate analyses for antecedents and outcomes, warranting further comprehensive and concurrent modeling to link social-emotional development with other important predictors of academic progress.

These issues raised by Hammer et al. (2017a) are notable given the robustness with which self-regulation has been shown to influence child academic and life outcomes into adulthood (Howse, Lange, Farran, & Boyles, 2003; Moffitt et al., 2011; Raver et al., 2011). In a longitudinal Australian study, for instance, Sawyer et al. (2015) found emotional self-regulation and task attentiveness at 2 to 3 years old predicted literacy at 6–7 years of age (task attentiveness also predicted later numeracy outcomes). Furthermore, children's ability to self-regulate their behaviors in early life has been shown to be related to continued academic success into high school and beyond (Bernier, Carlson, & Whipple, 2010; Evans & Rosenbaum, 2008; Ponitz et al., 2009).

The role of antecedents of social-emotional and self-regulatory development also remains unclear. One of the most robust and consistently identified antecedents to self-regulation is SES (Cadima, Gamelas, McClelland, & Peixoto, 2015; Kopp, 2001; Montroy, Bowles, Skibbe, & Foster, 2014). In some other studies, parenting (Bernier et al., 2010; Kaufmann et al., 2000; Kopp, 1982; Tamis-LeMonda, Briggs, McClowry, & Snow, 2009) and gender have been suggested as important (such that girls tend to self-regulate better than boys; DuPaul, Kern, Caskie, & Volpe, 2015; Kaufmann et al., 2000; Kochanska, Philibert, & Barry, 2009). Despite much research, however, findings remain inconsistent (Cadima et al., 2015; Calkins, 2004; Gunzenhauser & von Suchodoletz, 2015; Montroy et al., 2014). Similarly, there is much discrepancy in the literature regarding the antecedents for academic outcomes such as gender (McClelland et al., 2014), SES (Davis-Kean, 2005; Foster et al., 2005), and self-regulation (Ponitz et al., 2009). A prime example of this discrepancy is the role of the HLE during the preschool years, which has also been identified as an important predictor of children's academic outcomes (Foster et al., 2005; Melhuish, Belsky, Leyland, Barnes, et al., 2008; Sonnenschein & Munsterman, 2002). HLE is commonly defined by a composite of various enrichment activities undertaken with a child, including reading, other home-learning interactions (e.g., learning songs/poems, drawing), and additional enrichment educational experiences (e.g., visiting museums, libraries; Foster et al., 2005; Melhuish, Belsky, Leyland, Barnes, et al., 2008). Research suggests that HLE is one of the most influential predictors of later academic outcomes (Melhuish, Belsky, Leyland, Barnes, et al., 2008; Sammons et al., 2008). HLE is also shown to influence development of self-regulation (Zimmerman, 1989) and social-emotional behaviors among children (Foster et al., 2005), suggesting a possible mediational association between these factors. However, Hartas (2015) found HLE had no significant association with learning outcomes in children at 7 years of age (instead suggesting the importance of family income and parent education), while Sammons et al. (2015) found HLE influenced later academic development even after controlling for parental income, education, and other demographic factors. There is thus a need for a comprehensive, concurrent model linking independently established predictors of academic outcomes with the influence of social-emotional development.

Current Study

Given the inconsistencies in findings and limitations of previous research, the current study extends previous work to consider—

concurrently, using structural equation modeling—a broader array of antecedents and aspects of social–emotional development to understand their relative associations with academic outcomes. Specifically, the current study utilizes a large, longitudinal dataset to evaluate a priori models of social–emotional development predicting academic outcomes. The specific aims of this study were as follows:

1. Replicate the findings of Hammer et al. (2017a). A concurrent model reflecting the findings of Hammer et al. (2017a) was evaluated (including their antecedents of social–emotional development) to establish whether those findings were supported with a concurrent modeling approach.
2. Extend this model by including HLE and self-regulation. A second model was developed that incorporates additional predictors (i.e., self-regulation, HLE) that are proposed to influence both social–emotional development and academic outcomes.
3. Explore self-regulation as a latent construct. Lastly, we evaluated a model that combined self-regulation and social–emotional factors as a latent variable to evaluate whether these variables influenced academic outcomes via a common developmental factor, or through diverse pathways.

Consistent with prior research, it was expected that the initial model of Hammer et al. (2017a) would be improved by the inclusion of self-regulation and HLE, supporting a model of diverse influences on later academic outcomes.

Method

Participants

Data from the Millennium Cohort Study (MCS) were analyzed for this study. The MCS is a longitudinal study of 17,034 children, initially born between mid-2000 and mid-2001 (48.9% girls; Centre for Longitudinal Studies, 2000). Families were recruited from stratified and then randomly selected electoral wards across the United Kingdom. Individuals were randomly selected from these wards using government child benefit records, which excluded families whose residency was temporary (e.g., foreign workers) or uncertain (e.g., asylum seekers). However, this sampling did include children living in temporary accommodation (e.g., women’s refuges, hostels), as well as children not born in the United Kingdom but who were established as residents at 9 months of age (Plewis, Calderwood, Hawkes, Hughes, & Joshi, 2007). There was nevertheless a slight and unin-

tended overrepresentation of Black and Asian families (Plewis et al., 2007).

Educational attainment data were available for the children from England within the MCS ($n = 10,080$; 49.9% girls), and the current study thus used data for these children, captured at 3, 5, and 7 years of age, for longitudinal modeling. Retention of participants in this England subsample during the period under study was 77.1%. Of the retained sample, at age 7, 76% had complete outcome data.

Measures

Academic outcomes. Children’s numeracy and literacy data were drawn from teacher-report assessments of reading, writing, spoken language, and mathematics undertaken as part of England’s national curriculum framework at 7 years of age (Key Stage I; Department for Education, 2013). England’s national curriculum provides guidelines on the subjects that need to be taught to children within state-funded schools. Assessments of children’s attainment according to curriculum guidelines are regularly undertaken across both primary and secondary school, including at the end of Key Stage I. These national assessments are indexed against progress standards within England’s National Curriculum, identifying expected student achievements at each key stage (Department for Education, 2013). Stobart (2009) suggested that through these ongoing assessments across the whole curriculum, as well as between-schools moderation, threats to validity (e.g., construct underrepresentation) are reduced. For this study, literacy was indexed by reading, writing, and speaking outcomes. Further details on literacy and numeracy outcomes at Key Stage I can be found in *The National Curriculum in England: Key Stage 1 and 2 Framework* document (Department for Education, 2013).

Socioemotional development. Socioemotional development at age 5 was assessed using maternal ratings of child behavior on the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997). The SDQ is a 25-item scale yielding one “strength” (i.e., prosocial behavior) and four “difficulties” subscales (i.e., conduct problems, hyperactivity, peer problems, emotional problems), with these indices derived by averaging each subscale’s five constituent items. All items involved indicating the extent to which a child engaged in a target social–emotional behavior on a 3-point Likert scale rated as 0 (*not true*), 1 (*somewhat true*), or 2 (*certainly true*). SDQ has been widely used and has acceptable internal consistency with this age group ($\alpha = .73$; Goodman, 2001). The current study used hyperactivity (e.g., “child is constantly fidgeting”) and peer problems (e.g., “child is picked on or bullied by other children”) subscales on the basis of previous research showing these subscales predicting later math and literacy outcomes (Hammer et al., 2017a).

Table 1
Correlations Between Predictors of Child Academic Outcomes

Predictors	Gender	Inc	MEduc	FEduc	SR	Hyp	PP	PRI	HLE
Gender	—	.00	.00	.01	.14**	-.14**	-.06**	-.10**	.12**
Inc		—	.28**	.29**	.06**	-.18**	-.17**	-.13**	.08**
MEduc			—	.41**	.09**	-.20**	-.15**	-.12**	.20**
FEduc				—	.05**	-.16**	-.11**	-.08**	.14**
SR					—	-.35**	-.22**	-.22**	.17**
Hyp						—	.31**	.35**	-.16**
PP							—	.20**	-.10**
PRI								—	-.17**
HLE									—

Note. Inc = income; MEduc = maternal education; FEduc = paternal education; SR = self-regulation; Hyp = hyperactivity; PP = peer problems; PRI = Parenting Risk Index; HLE = home learning environment.

** $p < .001$.

Table 2
Descriptive Statistics for Variables Used in the Study

Variable	<i>n</i>	<i>M</i>	<i>SD</i>	Min	Max
Mother's education level	16,882	1.94	1.48	.00	4.00
Father's education level	12,978	2.00	1.52	.00	4.00
Income	15,445	2.18	0.82	1.00	3.00
Parent Risk Index	9,551	4.24	2.19	.00	12.00
Home learning environment	11,064	25.87	7.89	.00	42.00
Peer problems	14,772	1.23	0.29	1.00	3.00
Hyperactivity	14,772	1.57	0.57	1.00	3.00
Behavioral self-regulation	14,773	2.52	0.35	1.00	3.00
Literacy	6,762	15.26	3.98	3.00	24.00
Numeracy	6,762	16.10	3.76	3.00	27.00

Note. Min = minimum; Max = maximum.

Behavioral self-regulation. Child behavioral self-regulation was assessed at age 5 using a maternal-rated extension to the SDQ created for the National Evaluation of Sure Start (Melhuish, Phan, et al., 2008), which contains a five-item scale of behavioral self-regulation rated similarly to the SDQ. Scores for this subscale are derived from the mean of its five constituent items (e.g., "child likes to work things out for self," "child persists in the face of difficult tasks"; Schoon, Joshi, & Smith, 2012). Internal consistency of this self-regulation scale has been shown to be good ($\alpha = .92$; Sammons et al., 2003).

Parenting. The Parent Risk Index (PRI) is a composite score that is derived from the following six parenting variables (Melhuish, Belsky, & Leyland, 2008): observer ratings of mother's responsivity to child; observer ratings of mother's acceptance of child; and mother's ratings of parent-child conflict, parent-child closeness, discipline, and home chaos. These variables were combined to provide a composite PRI score ranging from 0 to 12. Low values on the PRI indicate lower amounts of parenting risk than do higher scores (Melhuish, Belsky, & Leyland, 2008). This PRI index has been shown to be a significant predictor of positive and negative social and self-regulatory behaviors at age 3 (Melhuish, Belsky, & Leyland, 2008).

Home learning environment (HLE). HLE at 3 years of age was captured by an index comprising six mother-reported variables: frequency of child being read to, going to the library, painting and drawing, being taught letters, being taught numbers, and learning songs/poems/rhymes. The frequency of each variable was coded into a 8-point scale (0 = *not occurring* to 7 = *occurring very frequently*; Table 1) and then combined to generate a HLE score that ranged from 0 to 42 (Melhuish, Belsky, & Leyland, 2008). HLE has been shown to be a significant predictor of social and self-regulatory behaviors at age 3 (Melhuish, Belsky, & Leyland, 2008) and academic achievement at ages 5 and 7 (Melhuish, Phan, et al., 2008).

Demographic and contextual antecedents. Demographic and contextual factors captured at 3 years of age, which have been shown to predict academic outcomes, were also modeled. These maternal-reported demographics were family income (total annual gross income including salary and benefits received; Institute of Education, 2014), parental education level for mother and father, and the child's gender.

Plan for Analysis

Given that previous research has largely established antecedents of social-emotional development and academic outcomes separately (Hammer et al., 2017a; Sammons et al., 2008), the current study used structural equation modeling (SEM) to model and evaluate these relationships concurrently. In total, three possible a priori models were comparatively evaluated. The first model replicated, using SEM approaches, prior analyses of demographic and socioemotional variables that independently predicted academic outcomes at age 7 (Hammer et al., 2017a). Given research highlighting the importance of the HLE and children's self-regulation (variables not available in that previous study), the second model incorporated self-regulation at age 5 and HLE at age 3. The final model investigated whether the social-emotional variables could be combined into a latent variable, providing a more parsimonious and stronger model of predictors of

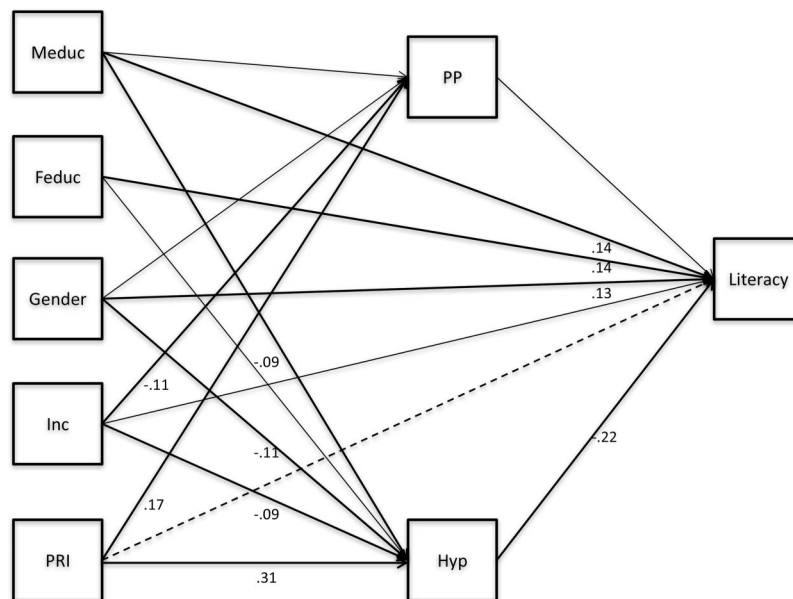


Figure 1. Literacy Model 1, evaluating the findings of Hammer et al. (2017a) in a concurrent structural equation modeling analysis. Meduc = maternal education; Feduc = paternal education; Inc = family income; PRI = Parenting Risk Index; PP = peer problems; Hyp = hyperactivity. Standardised beta weights > .08 are indicated by bolded lines. Dashed lines indicate nonsignificant pathways.

academic outcomes. Ethics approval for the research was granted by the relevant university human research ethics committee.

Results

To investigate associations among social-emotional variables, their antecedents, and later academic outcomes (literacy and numeracy), three models for each academic outcome were evaluated using SEM (Mplus, version 7; Muthén & Muthén, 2011). Absolute model fit was evaluated using chi-squared statistics, and relative fit was assessed by Bentler's comparative fit index (CFI; with values $>.95$ indicating good model fit; Hu & Bentler, 1999), standardized root-mean-square residual (SRMR, with values $<.08$ indicating good model fit; Hu & Bentler, 1999), and root-mean-square error of approximation (RMSEA, with values $<.05$ indicating good model fit; Hu & Bentler, 1999). Correlations between the predictors in the model ranged between .00 and .41 (see Table 1), suggesting that multicollinearity was not an issue. Descriptive statistics for key predictor and outcomes variables are provided in Table 2.

Literacy

Model 1. Model 1 confirmed the model previously advanced by Hammer et al. (2017a), now through a concurrent SEM approach, which modeled contributions of demographic (SES, gender, parental education level) and parenting factors (PRI) at age 3 and socioemotional development at age 5 on literacy scores at age 7. This model provided good fit across all fit indices $\chi^2(1, n = 7,910) = 12.34, p < .001, CFI = 1.00, SRMR = .01, RMSEA = .04$. Fifteen of the 16 pathways in Model 1 were significant, with 7 having good explanatory value (indicated by beta weights $>.08$; Figure 1). Hyperactivity was the strongest direct predictor of literacy scores 2 years later, with peer problems also predicting literacy levels (see Table 3). Demographic factors of maternal educational level, paternal educational level, child gender, and family income also directly predicted literacy scores. Although parenting did not directly predict literacy scores, it was associated with both hyperactivity and peer problems, and hence exerted an indirect effect. Other demographics also predicted social-emotional development, albeit more modestly.

Model 2. Model 2 extended Model 1 to include a broader range of possible predictors of academic outcomes. Specifically, Model 2 incorporated HLE and self-regulation. Even with the addition of these variables—additional complexity that is often penalized in model fit statistics—model fit improved marginally across the fit indices, $\chi^2(1, n = 7,910) = 11.26, p < .001, CFI = 1.00, SRMR = .00, RMSEA = .04$. Twenty-four of the 26 pathways in Model 2 were significant, and 16 provided good explanatory value (indicated by beta weights $>.08$; Figure 2). Hyperactivity and peer problems again had significant, direct paths to literacy outcomes. Behavioral self-regulation also directly predicted literacy outcomes, reducing the size of the effect for hyperactivity on literacy found in Model 1. The same antecedents of social-emotional development remained significant in Model 2, while gender, parenting style, and HLE also predicted behavioral self-regulation (see Table 3).

Model 3. Model 3 evaluated the possibility of a common social-emotional factor contributing to prediction of academic outcomes. This was evaluated by creating a latent variable comprising the shared variance among hyperactivity, peer problems, and behavioral self-regulation (to yield a "purer" self-regulation factor that included its behavioral, social, and emotional components). Despite greater parsimony in this model, the addition of the latent variable saw the model fit decline to levels that were lower than those for Models 1 and 2, $\chi^2(14, n = 7,910) = 166.80, p <$

Table 3
Standardized Beta Weights for Literacy Models

Variable	Literacy model		
	Model 1	Model 2	Model 3
Predictors of peer problems			
Mother's education level	-.07**	-.06**	—
Income	-.11**	-.11**	—
Gender	-.04**	-.03*	—
Parent Risk Index	.17**	.17**	—
Home learning environment	—	-.03*	—
Predictors of hyperactivity			
Mother's education level	-.09**	-.08**	—
Father's education level	-.05**	-.05**	—
Income	-.09**	-.09**	—
Gender	-.11**	-.11**	—
Parent Risk Index	.31**	.30**	—
Home learning environment	—	-.06**	—
Predictors of self-regulation			
Mother's education level	—	.03*	—
Father's education level	—	-.02	—
Income	—	.03*	—
Gender	—	.11**	—
Parent Risk Index	—	-.18**	—
Home learning environment	—	.11**	—
Predictors of self-regulation latent variable			
Mother's education level	—	—	-.10**
Father's education level	—	—	-.06**
Income	—	—	-.12**
Gender	—	—	-.16**
Parent Risk Index	—	—	.42**
Home learning environment	—	—	-.11**
Peer problems	—	—	.40**
Hyperactivity	—	—	.71**
Behavioral self-regulation	—	—	-.49**
Direct predictors of literacy			
Mother's education level	.14**	.12**	.10**
Father's education level	.14**	.14**	.13**
Income	.07**	.07**	.04*
Gender	.13**	.11**	.08**
Parent Risk Index	-.01	.01	.10**
Home learning environment	—	.12**	.10**
Peer problems	-.06**	-.05**	—
Hyperactivity	-.22**	-.18**	—
Behavioral self-regulation	—	.12**	—
SR (latent variable)	—	—	-.41**

Note. SR = self-regulation. Beta weights $>.08$ are in boldface type.
* $p < .05$. ** $p < .001$.

.001, $CFI = .97, SRMR = .02, RMSEA = .04$ (see Figure 3). All antecedents predicted the latent variable and the literacy variable. In contrast to previous models, parenting style (PRI) was found to have a significant direct pathway to literacy outcomes. All other pathways were also replicated from the previous literacy models. Considering model fit evidence, Model 2 was adopted as the final model, given its superior fit statistics despite comparatively greater model complexity (and associated fit statistic penalties).

Numeracy

Model 1. The first numeracy model also confirmed the findings of Hammer et al. (2017a), utilizing an SEM approach. Model fit across all the fit indices indicated good fit, $\chi^2(1, n = 7,910) = 12.31, p < .001, CFI = 1.00, SRMR = .01, RMSEA = .04$, with 15 of the 16 pathways statistically significant (and 10 had beta weights $>.08$; Figure 4). As with Literacy Model 1, direct relationships with numeracy were observed for hyperactivity, peer problems, demographic variables (i.e., parental education level and income), and gender. Hyperactivity was again the strongest pre-

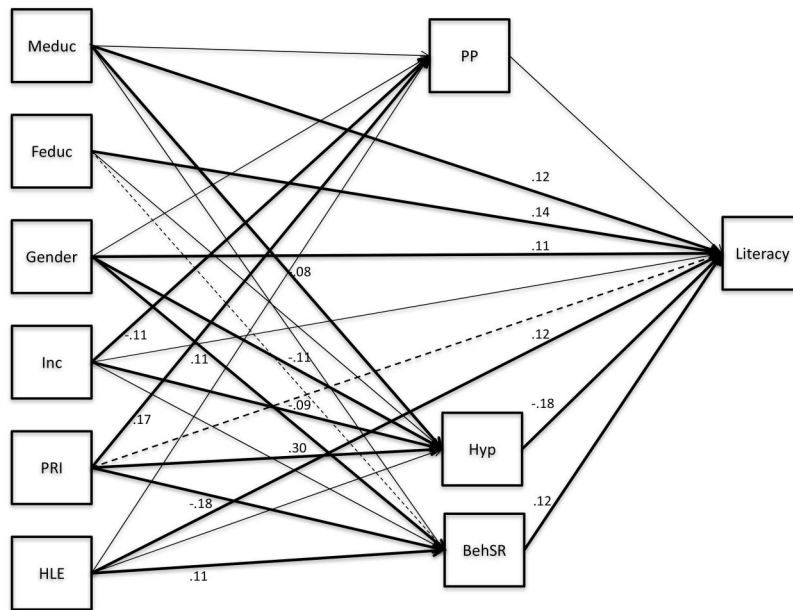


Figure 2. Literacy Model 2, extending the findings of Hammer et al. (2017a) by inclusion of home learning environment and self-regulation factors. Pathways are denoted by standardized regression weights. Meduc = maternal education; Feduc = paternal education; Inc = family income; PRI = Parenting Risk Index; PP = peer problems; Hyp = hyperactivity; HLE = home learning environment; BehSR= behavioral self-regulation. Standardised beta weights > .08 are indicated by bolded lines. Dashed lines indicate nonsignificant pathways.

dictor of numeracy development. Unlike literacy, the association between gender and numeracy was reversed, with boys scoring higher than girls. The paths from demographic variables (parental educational level and income) were comparable to the pathways found in the literacy models. That is, parenting (PRI) did not show a significant association with numeracy outcomes, but was found

to predict hyperactivity and peer problems, and thus showed an indirect effect (see Table 4).

Model 2. Model 2 additionally incorporated HLE and self-regulation variables. Addition of these variables marginally improved model fit before rounding: $\chi^2(1, n = 7,910) = 11.23, p < .001, CFI = 1.00, SRMR = .00, RMSEA = .04$. Model 2 had 24 of 26

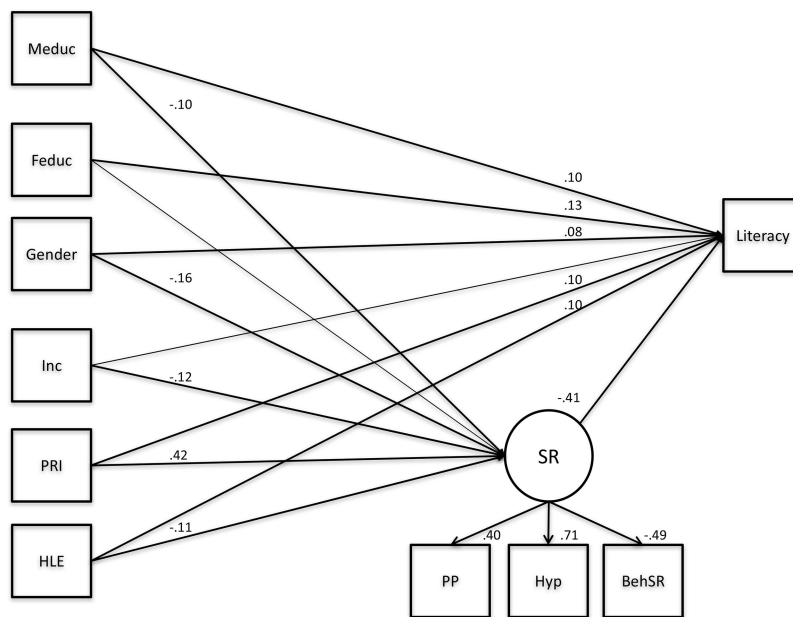


Figure 3. Literacy Model 3, evaluating a latent social-emotional/self-regulatory variable predicting literacy outcomes. Meduc = maternal education; Feduc = paternal education; Inc = family income; PRI = Parenting Risk Index; PP = peer problems; Hyp = hyperactivity; HLE = home learning environment; BehSR= behavioral self-regulation; SR = self-regulation latent variable. Standardised beta weights > .08 are indicated by bolded lines.

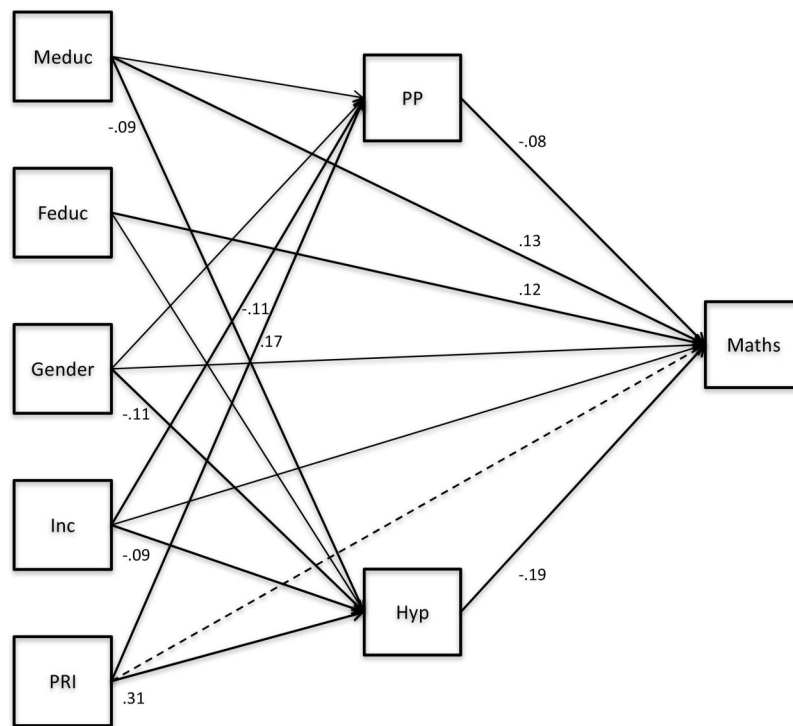


Figure 4. Numeracy Model 1, evaluating the findings of Hammer et al. (2017a) in a concurrent structural equation modeling analysis. Pathways are denoted by standardized regression weights. Meduc = maternal education; Feduc = paternal education; Inc = family income; PRI = Parenting Risk Index; PP = peer problems; Hyp = hyperactivity; Maths = numeracy. Standardised beta weights $> .08$ are indicated by bolded lines. Dashed lines indicate nonsignificant pathways.

pathways significant (see Figure 5) and 14 beta weights $> .08$. The addition of HLE and self-regulation did not affect the significance of paths from Model 1, but rather added to the explanatory value of the model. That is, self-regulation and HLE were some of the strongest predictors of numeracy outcomes (see Table 4).

Model 3. Model 3 modeled a latent variable comprising hyperactivity, peer problems, and self-regulation. The inclusion of the latent variable yielded marginally poorer fit to the data, $\chi^2(14, n = 7,910) = 178.58, p < .001, CFI = .96, SRMR = .02, RMSEA = .04$, with 15 of the 16 pathways within the model gaining significance and beta weights $> .08$ (Table 4 and Figure 6). As in previous models, some demographic variables (parental educational level, gender, and family income), HLE, and parenting style directly predicted numeracy outcomes. The self-regulation latent variable also predicted numeracy outcomes (see Table 4). When considering model fit statistics, Model 2 was again adopted as the final model. Model 2 showed superior fit statistics despite increased complexity.

Discussion

The current study explored the longitudinal associations among a broad array of social, emotional, demographic, and contextual predictors of literacy and numeracy. Many of these had not been concurrently considered, providing opportunity to clarify and qualify previous findings showing independent prediction of academic outcomes by these factors. Our results indicated that the model previously indicated by Hammer et al. (2017a) was improved by inclusion of HLE and self-regulation. In addition, not all previously suggested predictors of academic outcomes were supported in the current modeling; factors suggested in prior research, such as parenting style, were

found to be nonsignificant in their direct effects on literacy and numeracy outcomes (instead showing only indirect effects through social-emotional and self-regulatory development). Results also suggested that hyperactivity, peer problems, and behavioral self-regulation, though related, each accounted for unique variance in later academic outcomes, instead of representing a unified dimension of social-emotional development that contributes to academic outcomes.

To evaluate a previously proposed model of socioemotional development, Model 1 confirmed the work of Hammer et al. (2017a), including variables of socioemotional behaviors (hyperactivity and peer problems), SES (parenting education level and family income), parenting, and child's gender. Consistent patterns of factor loadings with prior research were observed for SES (mother's educational level and family income), gender, hyperactivity, and peer problems on academic outcomes at age 7 years (Davis-Kean, 2005; Foster et al., 2005; Hammer et al., 2017a; Liem & Martin, 2011; McClelland et al., 2014). Parenting showed a discrepant pattern, however, with no direct influence on academic outcomes. This divergence also contrasts previous studies that suggest maternal parenting style is associated with academic achievement and cognitive development (Hammer et al., 2017a; Landry, Smith, & Swank, 2003). Rather than a direct effect, the current study suggests the effect may be more indirect, with lower parent risk supporting the development of abilities that have a more direct effect on learning and academic outcomes (e.g., self-regulation, Schmitt, McClelland, Tominey, & Acock, 2015; hyperactivity, Du Paul et al., 2015; peer problems, Malecki & Elliot, 2002). It thus may be that, when considered together, the direct association of parenting with academic outcomes is mitigated. This suggestion is consistent with previous studies that have found strong links between parenting

Table 4
Standardized Beta Weights for Numeracy Models

Variable	Numeracy model		
	Model 1	Model 2	Model 3
Predictors of peer problems			
Mother's education level	-.07**	-.06**	—
Income	-.11**	-.11**	—
Gender	-.04**	-.03**	—
Parent Risk Index	.17**	.17**	—
Home learning environment	—	-.03*	—
Predictors of hyperactivity			
Mother's education level	-.09**	-.08**	—
Father's education level	-.05**	-.05**	—
Income	-.09**	-.09**	—
Gender	-.11**	-.11**	—
Parent Risk Index	.31**	.30**	—
Home learning environment	—	.06**	—
Predictors of self-regulation			
Mother's education level	—	.03*	—
Father's education level	—	-.02	—
Income	—	.03*	—
Gender	—	.11**	—
Parent Risk Index	—	-.18**	—
Home learning environment	—	.11**	—
Predictors of self-regulation latent variable			
Mother's education level	—	—	-.10**
Father's education level	—	—	-.06**
Income	—	—	-.12**
Gender	—	—	-.16**
Parent Risk Index	—	—	.42**
Home learning environment	—	—	-.12**
Peer problems	—	—	.40**
Hyperactivity	—	—	.70**
Behavioral self-regulation	—	—	-.49**
Direct predictors of numeracy			
Mother's education level	.13**	.11**	.09**
Father's education level	.12**	.12**	.11**
Income	.05**	.05*	.02
Gender	-.05**	-.07**	-.10**
Parent Risk Index	-.01	.02	.10**
Home learning environment	—	.11**	.09**
Peer problems	-.08**	-.06**	—
Hyperactivity	-.19**	-.14**	—
Behavioral self-regulation	—	.15**	—
SR (latent variable)	—	—	.40**

Note. SR = self-regulation. Beta weights >.08 are in boldface type.
* $p < .05$. ** $p < .01$.

practices and child adjustment within primary school (Anthony et al., 2005; Kaufmann et al., 2000; Masten & Coatsworth, 1998).

To further evaluate separate studies suggesting the prominent role of HLE and self-regulation in academic success (Cadima et al., 2015; Melhuish, Phan, et al., 2008), Model 2 incorporated these two additional variables. Consistent with previous studies (Melhuish, Phan, et al., 2008; Ponitz et al., 2009), Model 2 supported direct associations between HLE and self-regulation with academic outcomes. Beta weights for variables in Model 1 changed little with these added variables, yet the strong explanatory value of these factors and slightly improved model fit statistics (despite increased complexity of the model) suggested they were important inclusions. While expected associations largely held in Model 2, it is noted that, in contrast to previous research, previously suggested associations between SES (parental educational level, family income; Evans & Rosenbaum, 2008; Wanless et al., 2011) and behavioral self-regulation were not found. This may indicate that the noneducational effects of SES may be mediated through HLE and parenting.

In support of this possibility, HLE—a composite measure of home activities that support learning—was shown to influence child aca-

ademic outcomes at 7 years of age. When added to the model, HLE became one of the strongest predictors of academic outcomes, adding unique explanatory variance at similar levels as maternal education. This finding suggests that HLE effects appear to extend to at least 7 years of age, thus supporting findings of Melhuish, Sylva, et al. (2008) and extending the age range considered by other studies (Foster et al., 2005; Sylva, Melhuish, Sammons, Siraj-Blatchford, & Taggart, 2008). This finding also contradicts earlier research (Hartas, 2015) that suggests HLE is not an independent predictor of academic outcomes once SES is considered, and supports findings such as those of Sammons et al. (2015). Instead, the current model suggests the reverse mediation, such that SES influences academic outcomes through key parenting factors. Also notable, parenting style did not show a direct path to academic outcomes, suggesting the importance of parents' educationally enriching behaviors over general "style" (Bernier et al., 2010; Karreman, van Tuijl, Aken, & Deokovic, 2006; McCabe, Cunningham, & Brooks-Gunn, 2004). In fact, effects of HLE remained even after measures of SES, parental educational level, parenting, social-emotional behavior, and gender were considered.

Beyond its direct association with academic outcomes, the influence of HLE was also indicated by its prediction of child social-emotional development (peer problems, hyperactivity, and behavioral self-regulation). A more positive HLE was related to lower child hyperactivity and peer problems at age 5. Children who experienced a more positive HLE also showed better self-regulation at age 5. While these influences on child social-emotional development are consistent with prior studies of children in preschool and early primary school (Foster et al., 2005), these variables have rarely been considered together. As such, the concurrent consideration of these variables serves to consolidate the importance of HLE as a key predictor of social, emotional, and academic development, even after considering other important covariates.

Behavioral self-regulation similarly added substantial, independent explanatory value to the prediction of academic outcomes. While this relationship has previously been suggested (Cadima et al., 2015; Karreman et al., 2006; Ponitz et al., 2009), the current study confirms these relationships, extends them more longitudinally (to age 7), and does so in the context of a broader range of predictors. In fact, the addition of behavioral self-regulation to Model 2, while not changing the relationships among hyperactivity, peer problems, and academic outcomes seen in previous models, contributed further explanatory value. As such, the current study provides converging support for the suggestion of self-regulation's role in promoting academic success.

Given the possibility of a common core of hyperactivity, peer problems, and self-regulation that influences academic achievement (e.g., ability to focus and remain on task; Kopp, 1982; Patrick, 1997; Ponitz et al., 2009), a latent self-regulation variable was evaluated in Model 3. The possibility of an underlying latent factor was suggested by strong correlations between these factors in previous research as well (e.g., Howard & Melhuish, 2016). This model provided similarly good fit to the data, and each variable loaded well on the latent variable. However, the overall model fit was slightly inferior to that of Model 2, which is particularly problematic given its increased parsimony—and thus fit statistic advantage. That is, the results of this modeling suggested that a common core of self-regulation (across cognitive, behavioral, and social-emotional behaviors/domains) did not provide improved fit for explaining academic outcomes compared to modeling of these factors independently. That parenting style became a nonsignificant predictor in this model further suggested that the creation of a latent variable was not capturing the same variability as each independent socioemotional factor.

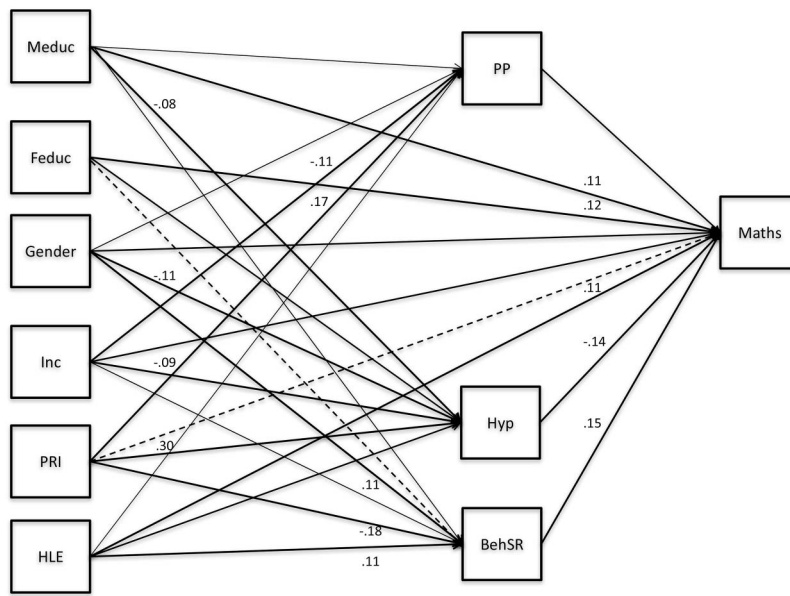


Figure 5. Numeracy Model 2, extending the findings of Hammer et al. (2017a) by inclusion of home learning environment and self-regulation factors. Pathways are denoted by standardized regression weights. Meduc = maternal education; Feduc = paternal education; Inc = family income; PRI = Parenting Risk Index; PP = peer problems; Hyp = hyperactivity; HLE = home learning environment; BehSR = behavioral self-regulation; Maths = numeracy. Standardised beta weights > .08 are indicated by bolded lines. Dashed lines indicate nonsignificant pathways.

Although the current findings provide robust longitudinal evidence on the factors that most strongly predict better academic outcomes for children in primary school, there are some limitations that nevertheless constrain interpretation. First, the nature of using existing longitudinal data sets means investigations are constrained by data that are

available (rather than ideal data). As an example, direct assessment of self-regulation is often considered superior to parent or educator reports (Smith-Donald, Raver, Hayes, & Richardson, 2007). Luckily, we were able to create a self-regulation variable that has been found to be highly predictive of a broad range of later outcomes (Melhuish,

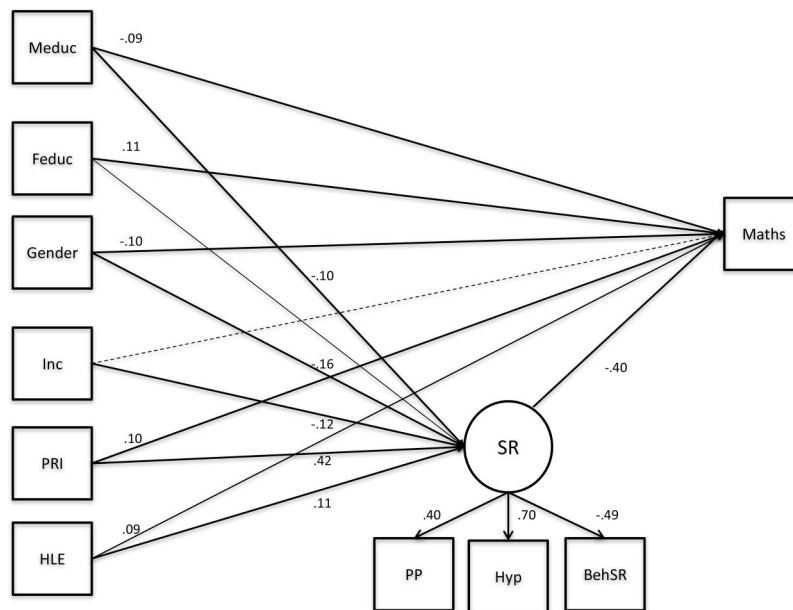


Figure 6. Numeracy Model 3, evaluating a latent social-emotional/self-regulatory variable predicting literacy outcomes. Pathways are denoted by standardized regression weights. Meduc = maternal education; Feduc = paternal education; Inc = family income; PRI = Parenting Risk Index; PP = peer problems; Hyp = hyperactivity; HLE = home learning environment; BehSR = behavioral self-regulation; SR = self-regulation latent variable; Maths = numeracy. Standardised beta weights > .08 are indicated by bolded lines. Dashed lines indicate nonsignificant pathways.

Phan, et al., 2008). Similarly, we were able to create a well-established Parenting Risk Index from these data (Melhuish, Belsky, & Leyland, 2008). Despite this, future investigations would benefit from an exploration of potential differences (e.g., in developmental trajectories, predictive strength) between different methods of indexing these influential aspects of child development.

These results are also constrained by the nature of the sample. While the sample was largely representative of England's population, there was a slight bias in the sample. While future research is required to evaluate whether the current patterns of associations hold across population subgroups, given the large sample and only slight deviations from population composition, it is not expected that this bias would unduly influence the current findings.

Lastly, it is unclear to what extent child social-emotional development plays a role in many nonacademic areas. For example, while it is clear that self-regulation plays an essential role in academic development (DuPaul et al., 2015; Schmitt et al., 2015; Zimmerman, 1989) and nonacademic adult outcomes (Moffitt et al., 2011), further clarity is required on the nature of this influence (e.g., with risky behaviors, does self-regulation influence the uptake, age of onset, quantity or quality of the risky behavior—or perhaps all of these?). Further longitudinal studies considering the association between childhood self-regulation and adolescent behaviors (including risky behaviors) could clarify the predictive nature of these associations.

The current results suggest the importance of children's often-overlooked social-emotional development in the promotion of academic outcomes. This study thus adds to the limited literature exploring the concurrent, relative influence of these factors on children's academic outcomes. Specifically, the current data provides evidence of the independent contributions of early HLE and self-regulation for children's academic outcomes, over and above social-emotional, demographic, and contextual factors. The influence of behavioral (i.e., behavioral self-regulation, hyperactivity) and social-emotional (i.e., peer problems) aspects of development as predictors of later academic outcomes suggests the importance of taking a broad perspective and approach to early academic development, rather than one focused exclusively on cognitive (e.g., focus of attention, resistance to distraction) or behavioral (e.g., behavior management) development. The current results also reinforce the importance of high-quality home-learning environments, which can be fostered through parenting programs and strong links with early childhood education and care services (e.g., preschools, long-day care, nurseries, supported play groups). More broadly, these results suggest that a child's academic trajectory may be improved—in academic and nonacademic terms—through consideration of more than just cognitive and content-area learning outcomes.

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