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Mothers' Early Mind-Mindedness Predicts Educational Attainment in Socially and  
Economically Disadvantaged British Children

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**Abstract**

Relations between mothers' mind-mindedness (appropriate and non-attuned mind-related comments) at 8 months ( $N=206$ ) and children's educational attainment at ages 7 ( $n=158$ ) and 11 ( $n=156$ ) were investigated in a British sample. Appropriate mind-related comments were positively correlated with reading and mathematics performance at both ages, but only in the low socioeconomic status (SES) group. Path analyses showed that in the low SES group, appropriate mind-related comments directly predicted age-11 reading performance, with age-4 verbal ability mediating the relation between appropriate mind-related comments and age-7 reading. In contrast, maternal sensitivity and infant–mother attachment security did not predict children's educational attainment. These findings are discussed in terms of genetic and environmental contributions to reading and mathematics performance.

Mothers' Early Mind-Mindedness Predicts Educational attainment in Socially and Economically Disadvantaged British Children

Growing up in socially and economically disadvantaged circumstances is known to relate to wide-ranging negative outcomes for children. The educational achievement gap between children from more and less socially and economically disadvantaged backgrounds is well established and is believed to constrain these children's social mobility (Blanden & Gregg, 2004; Sirin, 2005; White, 1982). These findings have led to increasing attention to the mechanisms via which disadvantage relates to lower school achievement.

Despite these findings, children from disadvantaged backgrounds appear to benefit most from intervention programs aimed at improving school readiness and educational performance. Research in this area has defined disadvantage in terms of social factors (low levels of maternal education) and economic factors (qualification for free or subsidized school lunch). For example, evaluations of North Carolina's Smart Start and More at Four programs, which involved over 1 million children from birth to age 5, showed larger effects on children's Grade-3 reading and mathematics performance for children whose mothers had limited education compared with the children of more educated mothers (Ladd, Mushkin, & Dodge, 2014). These differential effects were maintained at the end of elementary school, with a stronger effect for age-11 reading and mathematics performance in children who qualified for free or subsidized lunch than in their non-qualifying peers (Dodge, Bai, Ladd, & Mushkin, 2016). Dodge et al.'s (2016) evaluation also demonstrated that the intervention programs had more impact throughout elementary school on children's reading performance than on their mathematics performance.

These initiatives in North Carolina are likely to be successful because they operate on a grand scale. For all children and families state-wide, the aim is to increase take-up of

developmental screening and access to high-quality childcare, improve children's health and early literacy, and facilitate partnerships between parents and providers of child-focused services. However, improving things like the quality of childcare will only impact attainment in children from low socio-economic (SES) backgrounds if they are given access to it. In the absence of universal programs, low SES children are less likely to be enrolled in preschool (Tucker-Drob, 2012) and unfortunately will thus not have the opportunity to benefit from enriched experiences in childcare settings. Children from low SES backgrounds also have fewer educational resources and less cognitive stimulation at home (e.g., Hart & Risley, 1995; Tucker-Drob, 2012), exacerbating their lack of access to learning opportunities outside the home.

Given these findings, it is important to investigate home-based factors that predict socially and economically disadvantaged children's educational attainment. The present study addressed this issue by investigating whether children's educational attainment was predicted by three variables indicating the quality of the early mother-child relationship: maternal mind-mindedness (Meins, 1997), maternal sensitivity (Ainsworth, Bell, & Stayton, 1971, 1974), and infant-mother attachment security (Ainsworth, Blehar, Waters, & Wall, 1978). Previous research has identified links between children's educational attainment and higher levels of early maternal sensitivity (e.g., Raby, Roisman, Fraley, & Simpson, 2014) and secure infant-mother attachment (e.g., Aviezer, Sagi, Resnick, & Gini, 2002; West, Matthews, & Kerns, 2013). The present study was the first to investigate whether early mind-mindedness predicted children's later academic performance.

Mind-mindedness indexes caregivers' attunement to their preverbal infants' internal states and is assessed from coding caregivers' comments about their infants' thoughts and feelings during infant-parent interaction (Meins, Fernyhough, Fradley, & Tuckey, 2001;

Meins et al., 2012). Such mind-related comments are dichotomously coded as appropriate (accurate interpretations of the infant's likely internal state, e.g., saying the infant wants the ball if she reaches toward it, or is excited if he squeals joyfully) or non-attuned (misinterpretations of the infant's internal state, e.g., saying the infant is bored with the car while she is still actively engaged in playing with it).

A growing body of literature shows that early mind-mindedness predicts various positive aspects of children's later development. Both indices of mind-mindedness make independent contributions to parent-child attachment security, with higher levels of appropriate mind-related comments and lower levels of non-attuned mind-related comments predicting secure parent-child attachment (Meins, Bureau, & Fernyhough, 2017; Meins et al., 2012). Early mind-mindedness is also positively related to children's sociocognitive development throughout early childhood. For example, mothers' appropriate mind-related comments in the first year of life predict superior theory of mind abilities between ages 2 and 4 (Laranjo, Bernier, Meins, & Carlson, 2010, 2014; Meins et al., 2002, 2003; Meins, Fernyhough, Arnott, Leekam, & de Rosnay, 2013) and better age-4 emotion understanding (Centifanti, Meins, & Fernyhough, 2016). Research has so far failed to identify mediating factors in the relation between early appropriate mind-related comments and children's later mentalizing abilities. For example, this relation is not mediated by infant-mother attachment security (Meins et al., 2002), mothers' mind-mindedness at age 4 (Meins et al., 2003), or children's age-2 language and perspectival symbolic play abilities or age-4 verbal ability (Meins, Fernyhough et al., 2013). The literature thus far indicates that this relation between mind-mindedness in the first year of life and children's later sociocognitive development is direct.

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The findings of two studies are of particular relevance to the question of whether mind-mindedness predicts socially and economically disadvantaged children's educational attainment. First, Bernier, McMahon, and Perrier (2016) reported that mothers' appropriate mind-related comments at age 12 months predicted children's cognitive school readiness (knowledge of numbers, shapes, letters, colors, etc.) at age 6 via their age-2 language abilities and effortful control at ages 3 and 4. The fact that mind-mindedness predicts cognitive school readiness gives reason to suggest that mind-mindedness may also play a role in predicting children's later educational attainment. The mediating effect of language and behavioral control observed in this study additionally suggests that these variables may play a similar role in the developmental pathway linking early mind-mindedness with children's later educational attainment.

The second study identified different associations between mind-mindedness and children's behavioral difficulties as a function of SES. Mothers' appropriate mind-related comments in the first year of life predicted fewer behavioral difficulties at ages 3 and 5 specifically in children from low SES families; there was no such association in their high SES peers (Meins, Centifanti, Fernyhough, & Fishburn, 2013). However, this should not be taken to mean that there is an association between maternal SES and early mind-mindedness; in fact, the evidence on this link is somewhat equivocal. For example, Meins, Fernyhough, Arnott, Turner, and Leekam (2011), Bigelow, Power, Bulmer, and Gerrior (2015), and McMahon, Camberis, Berry, and Gibson (2016) reported no association between SES and mothers' appropriate mind-related comments, whereas Bernier et al. (2016) and Laranjo and Bernier (2013) reported small to medium positive correlations between SES and appropriate comments (*r*s of .20 and .26 respectively). In contrast, there is a well established negative association between SES and children's behavioral difficulties (Hurtig, Taanila, Ebeling,

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Miettunen, & Moilanen, 2005; Hurtig et al., 2007; Pokropek, Borgonovi, & Jakubowski, 2015; van Oort et al., 2011). Thus, rather than SES determining mind-mindedness, it may be that higher levels of appropriate mind-related comments in mothers from low SES backgrounds have a protective effect on their children in relation to behavior. The observed SES-specific relation between mind-mindedness and behavioral difficulties (Meins, Centifanti et al., 2013) also points to the possibility that children's early behavioral control may play a mediating role in the association between mind-mindedness and educational attainment.

The present study investigated whether mothers' mind-mindedness in the first year of life related to children's educational attainment in the elementary school years in a sample of families from the United Kingdom, where children sit national examinations (Standardized Assessment Tests) at ages 7 and 11 to assess their core English and mathematics abilities. Given the findings discussed above, we predicted that early mind-mindedness would be positively associated with educational attainment specifically in children from low SES backgrounds. We defined low SES in terms of parental educational level and occupational status, rather than household income. In the United Kingdom, women are entitled to 52 weeks of statutory maternity leave, and are paid at 90% of their average weekly earnings for the first 6 weeks of leave, and 90% or the equivalent of \$186 (whichever is lower) for the next 33 weeks of leave. Relying on household income in the first year of life would therefore not provide an accurate measure of SES. The children classed as low SES in our study came from families where both parents were unemployed or in low-paid employment and had left school at the minimum leaving age.

We also explored possible developmental pathways from mind-mindedness to children's reading and mathematics performance. Mind-mindedness is known to relate to maternal sensitivity and to predict infant-mother attachment security (Meins et al., 2001,

2012, 2017), both of which have been associated with better academic performance (Aviezer et al., 2002; Raby et al., 2014; West et al., 2013). The present study thus investigated whether sensitivity or attachment security could explain any observed relation between mind-mindedness and children's educational attainment. Given the reported relation between mind-mindedness and fewer behavioral difficulties specifically in low SES families (Meins, Centifanti et al., 2013), and the fact that behavioral difficulties are negatively associated with both SES (Hurtig et al., 2005, 2007; Pokropek et al., 2015, van Oort et al., 2011) and academic performance (Breslau, Breslau, Miller, & Raykov, 2011; Riglin, Frederickson, Shelton, & Rice, 2013), it is also possible that mind-mindedness relates to socially and economically disadvantaged children's educational attainment via its negative association with early behavioral difficulties.

A further possibility is that mind-mindedness predicts educational attainment in children from low SES families via early verbal ability. Verbal ability is an established predictor of academic performance (Strenze, 2007), and lower verbal ability in children from low SES backgrounds has been identified as a causal factor in their lower educational attainment (see Hoff, 2013). Early mind-mindedness is associated with superior expressive and receptive verbal abilities in the preschool years (Bernier et al., 2016; Meins, Fernyhough et al., 2013), lending support to the notion that verbal ability may mediate the relation between appropriate mind-related comments and educational attainment in children from low SES backgrounds. The present study thus investigated the potential mediating role of children's verbal ability.

We also considered the possibility that the association between mind-mindedness and academic achievement is direct. As discussed above, research has so far failed to find factors that mediate the association between mothers' appropriate mind-related comments in the first



year of life and children's mentalizing abilities in the later preschool years, indicating that the relation between these variables is direct. It may be the case that a similar relation holds for appropriate mind-related comments and educational attainment in children from low SES backgrounds. Early attunement to the infant's internal states might index a quality of the mother-child relationship under conditions of social and economic stress that relates directly to children's academic achievement.

In summary, we investigated whether (a) early mind-mindedness was associated with better performance in national examinations at ages 7 and 11, (b) SES moderated any observed relations, (c) maternal sensitivity or infant-mother attachment security could explain any observed relations between mind-mindedness and educational attainment, and (d) children's behavioral difficulties and verbal ability mediated any observed relations between mind-mindedness and academic achievement.

## Method

### Participants

Participants were 206 mothers and children (108 girls) from north-east England who were recruited onto a longitudinal study when children were age 8 months. The majority of children were White (98%), 42% were first-born, and families' SES varied widely, with Hollingshead scale scores (Hollingshead, 1975) ranging from 11 to 66. The Hollingshead scale designates families into high versus low SES groups on the basis of parental educational level and occupational status. Around half ( $n=90$ ) of the families were classified as low SES (parents with no post-16 education and unemployed or in menial or manual employment). Families were followed up at ages 15 months ( $n=206$ ), 44 months ( $n=171$ ), 51 months ( $n=161$ ), and 61 months ( $n=164$ ), and educational attainment data were obtained when children were ages 7 ( $n=158$ ; age range 6 years 9 months to 7 years 8 months) and 11 ( $n=156$ ; age

range 10 years 9 months to 11 years 8 months). At age 7, educational attainment data were available for 59 low SES children and 99 high SES children; at age 11, educational attainment data were available for 59 low SES children and 97 high SES children. The observational data were collected between April 2002 and April 2007, and the educational attainment data were obtained in February 2016.

Dyads where educational attainment data were obtained at age 11 did not differ from those lost to the study with respect to appropriate mind-related comments, non-attuned mind-related comments, behavioral difficulties at ages 3 and 5, and age-4 verbal IQ, but dyads with educational attainment data had higher maternal sensitivity scores,  $t(203) = 2.17, p = .031$ , and higher SES,  $t(204) = 3.13, p = .002$ . Dyads with and without age-11 educational attainment data did not differ with respect to attachment security,  $\chi^2(1) = 0.57, p = .452$ .

Ethical approval was obtained from University and local health authority committees, and participants provided informed consent. Separate consent was obtained from the Department for Education to access the children's educational attainment data.

## Materials and Methods

Data at ages 8, 15, 44, 51, and 61 months were collected from testing sessions conducted at the university's developmental laboratories. Children's teachers provided separate assessments of children's behavioral difficulties at age 61 months. Children's educational attainment marks at ages 7 and 11 were obtained from the National Pupil Database.

**Mind-Mindedness** was assessed when infants were aged 8 months from a 20-minute infant-mother free play session. Mothers were instructed to play with their infants as they would if they had spare time together at home. All speech during the session was transcribed into individual comments, which were defined as words, phrases, or sentences that could be

distinguished on the basis of a semantic or temporal (2s) discontinuity. Comments that focused on the infant's internal state (e.g., "you like the teddy", "you're getting excited") were identified (mind-related comments). The entire filmed observation was viewed in conjunction with the transcript, and each mind-related comment was coded as appropriate or non-attuned (Meins et al., 2012). Appropriate mind-related comments are those which (a) accurately reflect the infant's current internal state, (b) link the infant's internal state with similar events in the past or future, (c) suggest new activities that the infant would like or want if there was a lull in the interaction, or (d) voice what the infant would say if he or she could talk. In contrast, non-attuned mind-related comments attribute an internal state that appears at odds with the infant's current behavior.

Mind-mindedness was assessed by a trained researcher who was blind to all other data and the hypotheses of the study, and a randomly selected 25% was coded by a second blind researcher. There was perfect agreement for coding variables as mind-related. Inter-rater agreement for dichotomously coding mind-related comments as appropriate or non-attuned was  $\kappa = .70$ , and disagreements were resolved by discussion. Mothers received scores for appropriate and non-attuned mind-related comments as a proportion of the total number of comments made during the interaction in order to control for maternal verbosity. High scores for appropriate mind-related comments or low scores for non-attuned mind-related comments indicate high levels of mind-mindedness.

**Maternal Sensitivity.** The 8-month 20-minute free play observations were also coded for maternal sensitivity using Ainsworth et al.'s (1974) 9-point scale. The trained researcher was blind to all other measures and to the study's hypotheses. A second trained, blind researcher coded a randomly selected 25% of the sessions. Neither researcher was involved in coding mind-mindedness. Inter-rater reliability (intra-class correlation) was .83.

**Attachment Security.** At age 15 months, infant–mother attachment security was assessed using the strange situation procedure. Infants were classified into secure, insecure-avoidant, insecure-resistant, and insecure-disorganized categories (Ainsworth et al., 1978; Main & Solomon, 1986, 1990). A trained and reliable researcher who was blind to all other measures and the study's hypotheses coded the strange situations, with a second blind, reliable researcher coding a randomly selected 25%. Inter-rater reliability for the dichotomous secure versus insecure categories was  $\kappa = 0.86$ .

**Children's Behavioral Difficulties** were assessed using the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997), which includes 25 items that are each rated on a 3-point scale ("not true", "somewhat true", "certainly true"), yielding scores of behavioral difficulties in four areas: (a) emotional symptoms, (b) conduct problems, (c) hyperactivity, and (d) peer problems. Scores on the four subscales can be summed to give a Total Difficulties score (range 0–40). The SDQ was completed by mothers at age 44 months ( $n=171$ ), and mothers and teachers at 61 months ( $n=164$ ). For the 61-month scores, responses from mother and teacher were combined into a resolved score by using the higher score for an individual item if the mother and teacher disagreed (Kamphaus & Frick, 2002). Cronbach's  $\alpha$  was .79 at 44 months and .81 at 61 months.

**Receptive Verbal Ability** was assessed at 51 months ( $n = 157$ ) using the British Picture Vocabulary Scale II (Dunn, Dunn, Whetton, & Burley, 1997). Standardized BPVS scores were used in the analyses.

**Educational attainment** data at both ages consisted of the marks attained in the reading and mathematics tests. At age 7, the reading test involved multiple choice and short answer questions to assess comprehension of short paragraphs of text, and the mathematics test

assessed understanding of basic mathematical concepts; marks for both tests were out of 30. At age 11, children completed three mathematics tests (calculator allowed, calculator not allowed, mental arithmetic) with total marks out of 100, and a reading test assessing comprehension of five fiction and non-fiction texts with total marks out of 50.

## Results

### Descriptive Statistics and Preliminary Analyses

Table 1 shows the mean scores for the whole sample and the low and high SES groups for all variables. Mind-mindedness and maternal sensitivity data were unavailable for one participant due to technical recording difficulties, and two strange situation procedures were terminated because of undue infant distress. Mothers' scores for non-attuned mind-related comments were positively skewed, but the distribution of all other variables did not differ unacceptably from normal. As shown in Table 1, compared with their high SES counterparts, children in the low SES group were reported to have higher levels of behavioral difficulties at ages 3 and 5, and achieved lower scores for all educational attainment components at ages 7 and 11. Mothers in the high SES group were more sensitive than their low SES counterparts (see Table 1).

Children's educational attainment at ages 7 and 11 was unrelated to gender ( $ts < 0.84$ ,  $ds < .14$ ) and to whether children were first-born or had older siblings ( $ts < 1.68$ ,  $ds < .27$ ).

### Attachment Security and Educational attainment

Table 2 shows the educational attainment data as a function of infant–mother attachment security. The secure and insecure groups did not differ on any of the educational attainment variables ( $ts < 1.33$ ,  $ps > .186$ ), with small effects for all variables. Attachment security is thus not considered as a predictor of educational attainment in the analyses reported below.

### **Bivariate Correlations**

Table 3 shows the correlation matrix for all continuous variables. In line with previous research, children's academic performance was negatively correlated with behavioral difficulties and positively correlated with both verbal ability and maternal sensitivity (see Table 3). As shown in Table 3, non-attuned mind-related comments were unrelated to all variables; the analyses below thus focus exclusively on appropriate mind-related comments as the index of mind-mindedness. Given the high positive correlation between the behavioral difficulties variables at ages 3 and 5 (see Table 3), a composite measure was created by summing the Total Difficulties scores at the two ages. Composite behavioral difficulties scores were used in the analyses below.

### **Predictors of Children's Educational attainment**

To test the hypothesized pathways from appropriate mind-related comments at 8 months to children's reading and mathematics performance at ages 7 and 11, we conducted regressions using multi-group analysis in Mplus 7.3 (Muthén & Muthén) with Full Information Maximum Likelihood. For this analysis, we used complete data for the 156 participants who were in the follow-up at age 11. These analyses tested (a) direct and indirect paths from appropriate mind-related comments to children's educational attainment, and (b) whether SES moderated relations between the variables. Manifest variables rather than latent measures were used, because we used single measures as outlined in the Method. In these analyses, the models were fully saturated,  $\chi^2 = 0.00$ , CFI = 1.00, TLI = 1.00, RMSEA = 0.00.

We ran separate models for reading and mathematics. In the first model tested, we ignored the SES grouping to determine paths from appropriate mind-related comments to children's verbal ability and behavioral difficulties. The variables at the final two time points were the reading scores or mathematic scores. To test whether any observed relations with

appropriate mind-related comments were independent of sensitivity, maternal sensitivity was controlled in these models. To examine the moderational effect of SES, the models first constrained all estimates to be equal across the high and low SES groups in the regression paths. We compared the constrained models to the unconstrained models where estimates were allowed to vary across the high and low SES groups to determine whether constraining the estimates to be equal resulted in a significantly poorer model. Where the constrained model was significantly worse, we ran models allowing the regression estimates to vary in predicting scores in the low and high SES groups. To test whether children's verbal ability or behavioral difficulties mediated the effect between appropriate mind-related comments and the educational attainment variables, we requested the indirect effects within the regression model for the potential indirect pathways that were hypothesized in the Introduction. The path analyses were conducted with bootstrapped standard errors at 1000 iterations.

**Mathematics Performance.** The path analysis model predicting mathematics scores, but without any grouping of SES, is shown in Figure 1. Unstandardized estimates with 95% confidence intervals are shown. Confidence intervals failing to include zero indicate significant paths, which are shown in bold. The model with constraints of all estimates across the SES groups was not significantly more poorly fitting than the unconstrained model, suggesting that the estimates can be assumed to be essentially similar across the low and high SES groups,  $\chi^2(15) = 16.90, p = .325$ . Thus, we did not interpret path analyses separately for the low and high SES groups. Figure 1 shows that appropriate mind-related comments did not predict mathematics scores; better verbal ability and fewer behavioral difficulties predicted higher mathematics scores at age 7, which in turn predicted higher mathematics scores at age 11.  $R^2$  for predicting mathematics scores at ages 7 and 11 was .32 and .55 respectively. No indirect effects were significant from appropriate mind-related comments to mathematics

scores at either age. Thus, we found no mediation effects from appropriate mind-related comments via verbal ability or behavioral difficulties in predicting later mathematics scores.

**Reading Performance.** For the path analysis predicting reading scores at ages 7 and 11, the constrained path model was a significantly poorer fit than the unconstrained model,  $\chi^2(15) = 37.58, p = .001$ , so we present the results for the models where we allowed the regression estimates to vary between the two SES groups. Figures 2 and 3 respectively show the results of the regression paths for the low and high SES groups; significant paths are shown in bold.

For the low SES group, the significant direct paths were as follows: (a) from verbal ability to age-7 reading, (b) from appropriate mind-related comments to age-11 reading, and (c) from age-7 reading to age-11 reading. The variance explained in age 7 reading was  $R^2 = .56$ , and the explained variance for reading scores at age 11 was  $R^2 = .55$ .

To test whether verbal ability or behavioral difficulties mediated the relation between appropriate mind-related comments and reading scores at age 7 and age 11, we requested the indirect effects. We tested a moderated mediation, since these paths were tested between the SES groups. The path analysis tested the direct and indirect effect of appropriate mind-related comments on reading scores at ages 7 and 11 via verbal ability and behavioral difficulties. The sum of the two indirect effects (i.e., via verbal ability and behavioral difficulties) predicting reading at age 7 was significant, estimate = 0.277, SE = 0.115, 95%CI = 0.052, 0.502. Specifically, the indirect effect via age-4 verbal ability was significant, estimate = 0.228, SE = 0.097, 95%CI = 0.037, 0.419, but the indirect effect via behavioral difficulties was non-significant, estimate = 0.049, SE = 0.047, 95%CI = -0.042, 0.141. The indirect effect predicting age-11 reading via age-7 reading was at trend level, estimate = 0.426, SE = 0.220, 95%CI = -0.006, 0.858. In summary, in the low SES group, mothers' early appropriate mind-



related comments predicted children's age-7 reading via their age-4 verbal ability, and directly predicted children's age-11 reading, independent of the path via age-7 reading.

Turning to predictors of children's reading performance in the high SES group, Figure 3 shows the results of the path analysis. There were no direct paths from appropriate mind-related comments to children's reading performance at either 7 or 11 years. As shown in Figure 3, higher verbal ability at age 4 predicted better reading scores at ages 7 and 11, and earlier reading scores predicted later reading scores. The variance explained in age-7 reading was  $R^2 = .19$ , and the explained variance in reading scores at age 11 was  $R^2 = .53$ .

As described above for the low SES group, we requested indirect effects to test hypothesized mediated pathways. The indirect effect of appropriate mind-related comments on age-7 reading scores via verbal ability was non-significant, estimate = -0.008, SE = 0.039, 95%CI = -0.084, 0.067. The indirect effect via behavioral difficulties was also non-significant, estimate = 0.011, SE = 0.018, 95%CI = -0.024, 0.046. Finally, the sum of these indirect effects in predicting age-11 reading scores via age-7 reading scores was non-significant, estimate = 0.004, SE = 0.066, 95%CI = -0.126, 0.134.

Although we found that appropriate mind-related comments indirectly predicted reading scores via verbal ability in the low SES group but not in the high SES group, it is necessary to test the statistical significance of the difference between the two indirect effects to establish whether there is a significant moderation by SES. We thus tested whether the magnitude of the indirect effect of appropriate mind-related comments on age-7 reading scores for the low SES group was significantly different from the magnitude for the high SES group. We multiplied the effect of appropriate mind-related comments on verbal ability by the effect of verbal ability on age-7 reading scores separately for the two SES groups, and then tested whether the difference between the two values was significantly different from zero

(using the Model Test statement). The magnitudes were significantly different, Wald Test of Parameter Constraints ( $df=1$ ) = 4.85,  $p = .028$ . Thus, the magnitudes of the indirect effects were different between the low and high SES groups, further suggesting that verbal ability is an important mediator for the low SES group, but not for the high SES group.

Given the observed effect of SES in moderating relations between appropriate mind-related comments and children's educational attainment, for completeness, bivariate correlations between appropriate mind-related comments and the variables included in the path analyses are presented separately for the low and high SES groups in Table 4.

### Discussion

Our results show that one measure of maternal mind-mindedness—appropriate mind-related comments—predicted children's performance in national examinations at ages 7 and 11, but only in children from low-SES families. Although bivariate analyses showed positive associations between appropriate mind-related comments and children's performance in both reading and mathematics, multivariate analyses indicated that appropriate mind-related comments specifically predicted children's reading attainment.

In children from low SES backgrounds, the path analyses showed that mothers' appropriate mind-related comments in the first year of life predicted better reading performance at age 7 via superior age-4 verbal abilities, and directly predicted better reading performance at age 11. This direct path to age-11 reading was independent of a trend for appropriate mind-related comments to predict age-11 reading via age-7 reading performance. These direct and indirect effects controlled for maternal sensitivity in the first year of year and were independent of children's early behavioral difficulties. Moreover, unlike mothers' appropriate mind-related comments, the other variables assessing the quality of infant–mother interaction—maternal sensitivity and infant–mother attachment security—did not predict

children's educational attainment. These findings suggest that mothers' early attunement to their infants' internal states has long-lasting positive relations with reading attainment in children from more deprived backgrounds.

Why might effects be observed for reading, but not for mathematics? In the Introduction, we discussed the findings from the state-wide intervention programs in North Carolina, which showed that the intervention had a greater impact on children's reading performance across the elementary school years than on their mathematics performance (Dodge et al., 2016). Enriched early experiences—in the form of mind-minded caregiving or state-funded intervention—thus appear to be less effective in improving children's mathematics performance. One reason for seeing effects for reading but not mathematics may be the changing contributions of genetic and environmental influences to these different skill domains as children become older. Mind-mindedness is proposed to be a quality of specific close relationships rather than being driven by the individual characteristics of the parent or child (Meins, Fernyhough, & Harris-Waller, 2014) and will therefore contribute to the effect of the nonshared environment in a behavioral genetics model.

Given the increasing interest in the genetic contribution to children's educational attainment (Davis et al., 2014; Krapohl et al., 2014), it would be interesting to investigate how early mind-mindedness predicts children's later academic performance using a study with a genetically sensitive design. Future research of this nature should also consider caregivers' abilities. Although the present study included a measure of children's early verbal abilities, it did not measure mothers' verbal or non-verbal IQ. Assessing parental and child IQ would enable us to investigate whether aspects of the early social environment such as mind-mindedness predict socially and economically disadvantaged children's educational attainment over and above the contribution of both the parent's and child's underlying

abilities. The present study also focused exclusively on mothers, and therefore did not assess fathers' contribution to predicting children's educational attainment. Research on mind-mindedness in fathers suggests that paternal mind-mindedness relates to children's development in the preschool years in the same way that maternal mind-mindedness does (Lundy, 2003, 2013). It would thus be interesting to investigate how both maternal and paternal mind-mindedness predict children's development over the longer term.

Bronfenbrenner and Ceci (1994) proposed that processes such as parenting are instrumental in enabling children to actualize their genetic potential. Their bioecological model posits that the environmental context is less powerful than processes such as parenting in influencing children's development. For example, Bronfenbrenner and Ceci discussed how the effects of parenting can be greater in more deprived environments, where they have the potential to reduce the achievement gap between children from high and low SES backgrounds. The present study's finding that appropriate mind-related comments are associated with better academic performance in socially and economically disadvantaged children therefore fits perfectly with the bioecological model.

Considering the potential for gene–environment correlations may prove particularly fruitful in attempting to identify potential routes via which appropriate mind-related comments in the first year of life relate to children's educational attainment. For example, Harlaar, Dale, and Plomin (2007) reported such a gene–environment correlation for children's reading performance up to age 12. Children's tendency to seek out reading experiences was influenced by genetic contributions to earlier reading achievement, with the tendency to seek out reading reciprocally influencing children's reading achievement via shared environmental paths. More mind-minded parents may be more responsive to their children's early interest in reading and stories. This may lead them to provide their children with more educational

resources and spend more time in book-sharing and other activities known to predict later reading achievement (Moll & Bus, 2011; Sénéchal & LeFevre, 2002). This model could additionally explain why the effect of mind-mindedness on children's educational attainment was specific to low SES families. Children from higher SES backgrounds are known to have greater access to these educational resources and activities than their low SES counterparts (e.g, Hart & Risley, 1995; Tucker-Drob, 2012), but low SES parents who are mind-minded may choose to invest in such resources and activities in response to recognizing their children's interest and engagement. Future research should investigate this possibility.

Turning to why mind-mindedness is related to low SES children's educational attainment in reading but not mathematics, previous research suggests that children's academic achievement in particular subjects is facilitated only by subject-specific parent-child activities and not by general parental involvement (Sheldon & Epstein, 2005). Early exposure to literacy activities such as book-sharing and letter learning is more common in the home environment than exposure to numeracy activities such as counting games and number learning (Skwarchu, Sowinski, & LeFevre, 2014). Consequently, mind-minded parents will not have as many opportunities to observe their children's early interest in numeracy, and thus will not be able to respond by investing in resources and activities that facilitate children's mathematical development. Observing relations with reading but not mathematics is therefore not unexpected.

The fact that children's early behavioral difficulties were found not to be strong independent predictors of children's educational attainment is worthy of further discussion. Behavioral difficulties are known to be negatively related to children's educational attainment (Breslau et al., 2011; Riglin et al., 2013), and mothers' appropriate mind-related comments were found to have a protective effect against behavioral difficulties specifically in children

from low SES backgrounds (Meins, Centifanti et al., 2013). It therefore appeared possible that behavioral difficulties would mediate the relation between mind-mindedness and educational attainment in socially and economically disadvantaged children. However, the regression analyses provided no support for such a mediational role. Indeed, the path analyses showed that behavioral difficulties were not directly to children's age-11 attainment in either reading or mathematics.

It may be that behavioral difficulties are less strongly predictive of educational attainment when SES, the quality of caregiver-child interaction, and children's early verbal abilities are taken into account. Alternatively, it may be the case that concurrent, rather than earlier, behavioral difficulties are most important in predicting children's educational attainment. A limitation of the present study is that behavior was not assessed at ages 7 and 11, and so the data presented here cannot speak to this issue. That said, there is evidence for stability in behavioral difficulties over the course of the elementary school years. For example, Bilancia and Rescorla (2010) reported impressive stability in behavioral difficulties over a 6-year period up to age 13 in a large, representative sample of children. These findings suggest that the lack of association between behavioral difficulties and educational attainment observed in the present study may not be due to the fact that behavior was assessed in early childhood.

In summary, reading is one of the most important skills developed in the elementary school years, and its involvement in accessing educational material more generally makes it a prime target for interventions aimed at overcoming the educational impacts of poverty. Our findings thus have the potential to inform interventions aiming to improve the life chances of socially and economically disadvantaged children. Early intervention to facilitate mind-

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mindfulness in parents from low SES backgrounds may prove useful in increasing school attainment in their children over the longer term.

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Table 1

*Mean (SD) Scores for All Continuous Variables as a function of SES*

	Whole sample	Low SES	High SES	Effect size for SES ( <i>d</i> )
Appropriate mind-related comments	5.34 (3.64)	4.83 (3.76)	5.72 (3.51)	.24
Non-attuned mind-related comments	1.59 (1.88)	1.70 (1.89)	1.50 (1.88)	.11
Maternal sensitivity	5.64 (1.48)	5.32 (1.54)	5.89 (1.39)**	.39
Behavioral difficulties (age 3)	10.15 (5.20)	11.90 (6.15)	9.02 (4.12)***	.56
Behavioral difficulties (age 5)	10.70 (5.88)	12.75 (6.48)	9.41 (5.10)***	.58
Verbal ability (age 4)	103.20 (12.99)	100.80 (12.27)	104.64 (13.25)	.30
Age 7 reading mark	16.82 (4.01)	15.51 (4.99)	17.61 (3.06)***	.52
Age 7 mathematics mark	16.75 (3.73)	15.34 (4.00)	17.59 (3.30)***	.62
Age 11 reading mark	34.81 (9.56)	32.25 (10.88)	36.37 (8.34)**	.43
Age 11 mathematics mark	77.34 (18.44)	72.95 (21.24)	80.01 (16.05)*	.38

*Note:* group difference significant at \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$ .



Table 2

*Mean (SD) Educational attainment Marks as a Function of Attachment Security*

	Secure	Insecure	Effect size ( <i>d</i> )
Age-7 reading	17.13 (3.67)	16.21 (4.66)	.22
Age-7 mathematics	16.74 (3.81)	16.83 (3.57)	.02
Age-11 reading	35.07 (9.54)	34.31 (9.78)	.08
Age-11 mathematics	77.67 (18.46)	77.27 (18.19)	.02

*Note:* insecure group:  $n = 48$  at ages 7 and 11; secure group:  $n = 109$  at age 7,  $n = 107$  at age 11.

Table 3

*Bivariate Correlations for the Whole Sample*

	1	2	3	4	5	6	7	8	9
1. AMRC	–								
2. NAMRC	.07	–							
3. Sensitivity	.39***	.04	–						
4. Age-3 BD	-.21**	-.14	-.26***	–					
5. Age 5 BD	-.18*	-.09	-.19*	.66***	–				
6. Age 4 verbal ability	.18*	.11	.23**	-.23**	-.17*	–			
7. Age-7 reading	.19*	-.02	.19*	-.36***	-.26**	.50***	–		
8. Age-7 mathematics	.09	-.00	.19*	-.31**	-.31***	.49***	.78***	–	
9. Age-11 reading	.23**	.03	.17*	-.27**	-.20*	.49***	.69***	.58***	–
10. Age-11 mathematics	.13	.14	.16	-.32***	-.27**	.35**	.60***	.73***	.63***

*Note:* AMRC = appropriate mind-related comments, NAMRC = non-attuned mind-related comments, BD = behavioral difficulties.

† $p < .10$ , \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$ .

Table 4

*Bivariate Correlations with Mothers' Appropriate Mind-Related Comments in the Low and High SES Groups*

	Low SES	High SES
	AMRC	AMRC
Age-3 behavioral difficulties	-.30*	-.09
Age-5 behavioral difficulties	-.10	-.23*
Age-4 verbal ability	.33**	.07
Age-7 reading	.40**	-.09
Age-7 mathematics	.25*	-.10
Age-11 reading	.45***	.01
Age-11 mathematics	.23*	.02

*Note:* AMRC = appropriate mind-related comments.

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

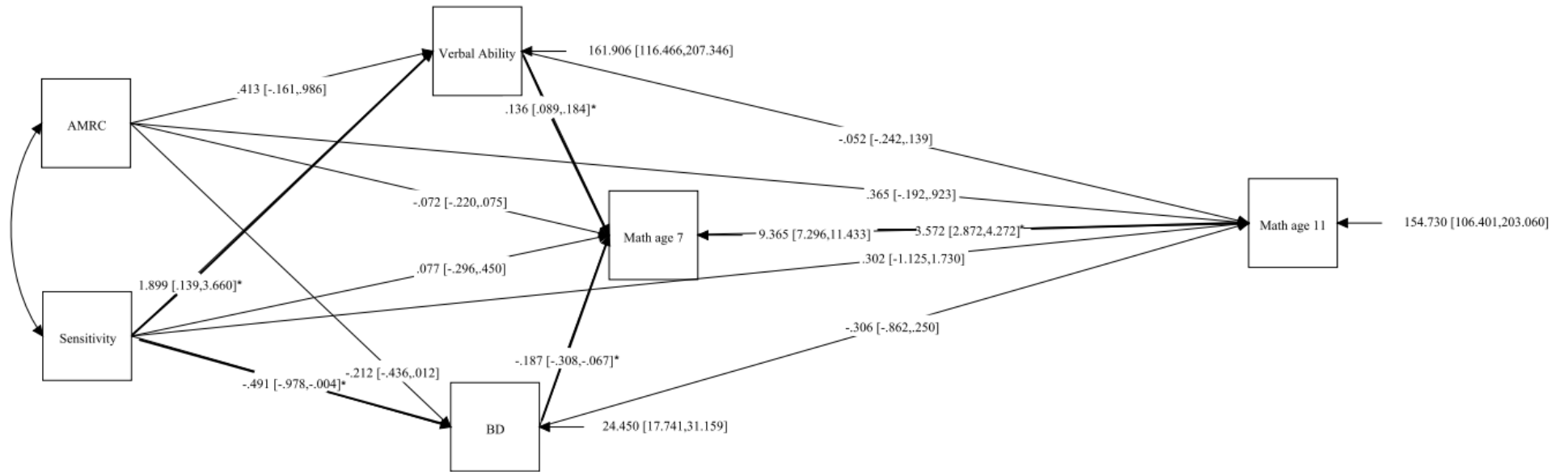
**Figure Captions**

*Figure 1.* Path analysis showing pathways from mothers' appropriate mind-related comments to children's age-11 mathematics in the whole group. *Note:* AMRC = appropriate mind-related comments; BD = behavioral difficulties.

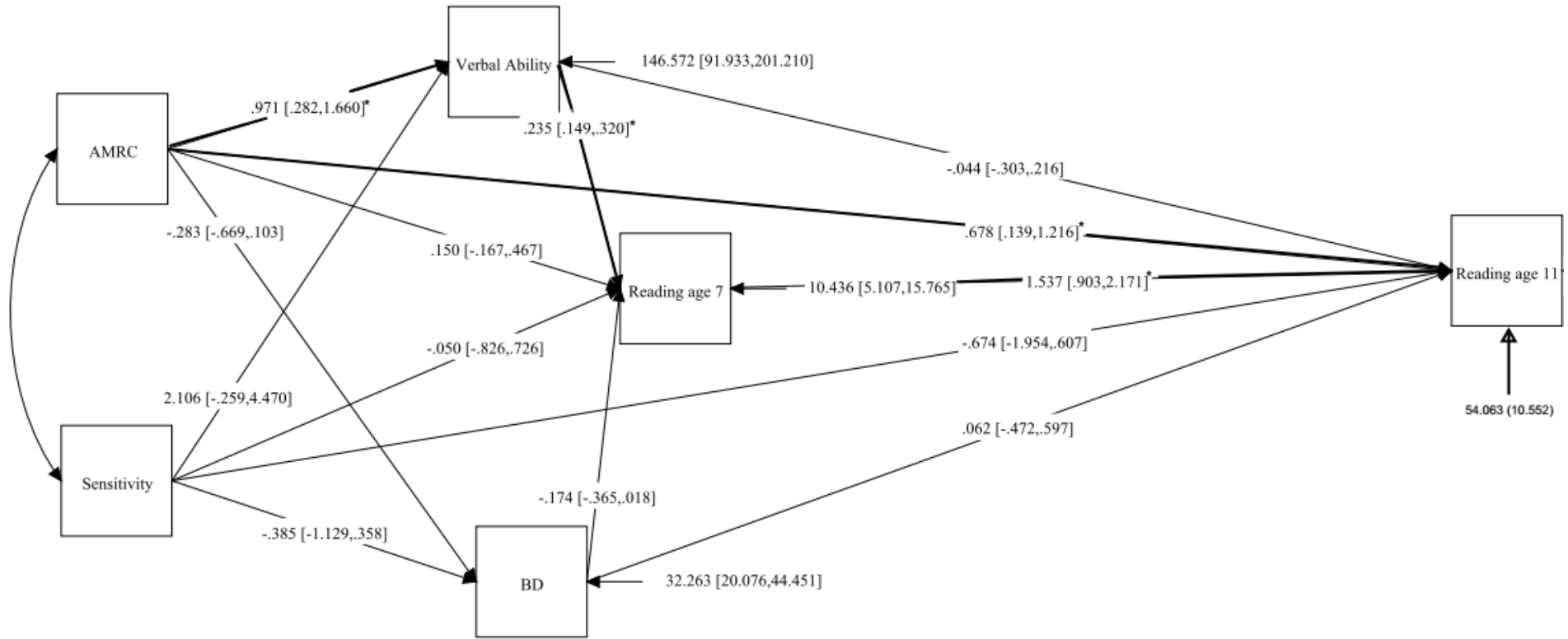
*Figure 2.* Path analysis showing pathways from mothers' appropriate mind-related comments to children's age-11 reading in the low SES group. *Note:* AMRC = appropriate mind-related comments; BD = behavioral difficulties.

*Figure 3.* Path analysis showing pathways from mothers' appropriate mind-related comments to children's age-11 reading in the high SES group. *Note:* AMRC = appropriate mind-related comments; BD = behavioral difficulties.

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