

Joint effects of parental stimulation and nutrition status on child development:

Evidence from rural Cambodia

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Research highlights:

- This study analyzes the relative contributions of parenting and nutrition status to wealth gradients in early cognitive and socio-emotional development in a low-income country.
- While wealth gradients in executive function skills manifest before age 3, gradients in language and early numeracy skills grow substantially between ages 3 to 5.
- Parenting is multidimensional with cognitive parenting, socio-emotional parenting and negative parenting each contributing differently to child development.
- The association between cognitive stimulation and cognitive development is stronger for non-stunted children, highlighting that interventions should address parenting and nutrition simultaneously.

Abstract

Substantial work has demonstrated that early nutrition and home environments, including the degree to which children receive cognitive stimulation and emotional support from parents, play a profound role in influencing early childhood development. Yet less work has documented the joint influences of parenting and nutrition status on child development among children in the preschool years living in low-income countries. Using panel data on parenting, nutrition status and early developmental outcomes of about 7000 Cambodian preschool-aged children, our findings demonstrate that inequities in early development associated with family wealth are evident at the start of preschool and increase over time. A significant share of these inequalities can be explained by differences in parental stimulation and early nutrition status. Better educated parents engage in better parental activities that stimulate children's development. However, the positive association between parental activities and child outcomes is particularly strong for non-stunted children and parental activities can only explain about 8-13% of the cognitive gap between the lowest and the highest wealth quintile. Results highlight the need for integrated interventions that address both parenting and early nutrition, also suggesting that parenting interventions for the most disadvantaged families should be carefully designed and evaluated to ensure maximum effectiveness.

Keywords: parental stimulation, parenting, nutrition, early development, wealth gap, Cambodia

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Early childhood development sets the course for lifelong learning, health and well-being (Black et al., 2017). Despite the potential social capital that can be built through early investments in early childhood development (e.g. Heckman, 2006), recent estimates suggest that 250 million children living in low- and middle-income countries are at risk of not fulfilling their developmental potential (Black et al., 2017).

Family poverty is associated with several conditions that negatively impact child development. Children who experience early stunting, poor health or lack of educational opportunities are less likely to achieve their developmental potential than other children (Britto et al., 2017), with a common underlying influence of family poverty. Family poverty has been shown to have a wide range of negative effects on child development in many countries, with gradients in child development due to family income evident as early as 4 months of age and growing throughout the course of childhood (Paxson and Schady, 2007; Naudeau et al., 2011, Fernald, Kariger, Hidrobo & Gertler, 2012; Schady et al., 2015; World Bank 2018).

Yet, the mechanisms accounting for the correlation between family wealth and cognitive development remain imperfectly described and likely include a range of factors, including health and nutrition as well as the quality of home environments (e.g., McLoyd, 1998; Black et al., 2017). While perinatal (in-vitro and during the first months after birth) health and nutrition conditions are known to impact later cognition (Veena, Gale, Krishnaveni, Kehoe, Srinivasan, & Fall, 2016), little is known about the how parenting may help compensate for disparities in development due to poverty.

Impacts of parenting and family wealth on child development

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Defining the mechanisms that link family assets to child development is critical for developing effective interventions. One such mechanism is parenting. Parenting quality has been shown to have strong and long-term impacts on child development (Bradley & Corwyn, 2002; see Bornstein, 2005, for a complete review). Parenting has been posited to be a central mediator of the relationship between family poverty and negative child outcomes (Blair & Raver, 2010). Parenting quality may be lower among families living in poverty due to the stress of living without adequate economic resources and the concomitant characteristics of poverty, such as low levels of parental education, which in turn contributes to the negative impacts of poverty on children. Thus, a key hypothesis is that parenting quality mediates the association between family poverty and child development: Family poverty decreases parenting quality, which in turn leads to negative child outcomes.

While parenting quality clearly has important impacts on child development overall, both child development and economic theories suggest two sources of variation in parenting on child development: first, that different types of parenting may affect different domains of child development and, second, that parenting may have variable effects on child development depending on child characteristics and environmental impacts.

Role of different types of parenting on child development. In interactions with young children, parents engage in multiple forms of teaching and support. Parenting is the primary mechanism by which children's health and nutrition, as well as overall growth and development are facilitated (Phillips & Shonkoff, 2000). Emotionally responsive parenting refers to parents' abilities to respond sensitively to children both verbally and physically, while cognitively stimulating parenting refers to parents' stimulation of learning through use of language,

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introduction of new games and ideas, as well as exposure to high-quality learning environments (Bornstein & Putnick, 2012).

Existing research suggests some degree of differentiation between domains of parenting: parents who are emotionally responsive are not necessarily cognitively stimulating; in addition, there is some degree of differentiation demonstrating that emotionally-responsive parenting is especially important for social/emotional development, while cognitively-stimulating parenting promotes young children's learning and development. Negative parenting, or reliance on harsh, punitive physical and verbal parenting, relates to disruptions in social/emotional development and also delayed cognitive development (Chang, Schwartz, Dodge & McBride-Chang, 2003; Hughes et al., 2006). Maternal education and, specifically, executive function (Cuevas et al., 2014) show relations with the development of children's executive function. An overall tendency for parents to engage in more emotionally-supportive parenting than cognitively stimulating parenting has been documented across countries (Bornstein & Putnick, 2012).

Defining differential impacts of parenting on child development. Recent work has documented that environmental conditions may influence children's development differently. Describing the interaction between the child and their environment has emerged as a seminal element of understanding child development, especially in relation to the interaction between biological and environmental factors (Ellis, Boyce, Belsky, Bakersmans-Kranenburg, & van Ijzendoorn, 2011). Recent research suggests that children's responsiveness to environmental conditions, and thus reactivity to both positive and negative stimuli, is not uniform across children (e.g., Belsky, Bakersmans-Kranenburg, & van Ijzendoorn, 2007). While most of this work has been conducted in high-income countries, the concept of studying child x environment interactions may also apply to children who have experienced extreme environmental

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deprivation, such as stunting. Economic analyses have also suggested that children with very low cognitive and emotional resources may respond less to parenting, based on the theory that low vectors of skill development persist over time, even when environmental resources are enhanced (Heckman, Stixrud & Urzua, 2006). Little work to date has examined this interaction in the context of environmental conditions that characterize child development in low- and middle-income countries.

Nutrition and child development

A large body of work demonstrates strong associations between early nutrition status and child development (Prado & Dewey, 2014). Children with poor early nutrition fail to reach expected linear growth milestones, leading to stunting and long-term cognitive and motor deficits (e.g., Galasso, Wagstaff, Naudeau & Shekar, 2017; Sudfield et al., 2015). Some work similarly demonstrates that cognitive stimulation can ameliorate some of the effects of poor early nutrition on child development, especially when coupled with parenting interventions (Paxson & Schady, 2007; Grantham-McGregor, Powell, Walker & Hines, 1993). Most evidence to date has been produced through intervention studies, with less work conducted using large-scale samples, where effects may be more representative of typical interactions between parenting and nutrition status.

The present study examines the emergence of wealth gradients in child development and the joint roles of nutrition status and parenting in explaining the gaps between high- and low-wealth children. We had three hypotheses: first, we expected to find gradients in child development based on family wealth in a low-income country. Second, based on existing parenting literature, we expected to find that there are different types of parenting, such as cognitively-stimulating and emotionally-responsive, with unique implications for child

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development, and that parenting quality is associated with both family wealth and child development. Third, we hypothesized that parenting and nutrition status would jointly influence child development, and that parenting could have different impacts on child development depending on nutrition status. In sum, we hypothesized that family assets would exert a strong and consistent impact on child development, but that parenting quality and nutrition status could account for a portion of the variance attributable to family wealth, demonstrated by a reduction in the impact of family assets on child development when parenting and nutrition status are included in the model. Our analysis is informed by two rounds of data, collected from a large sample of children and their caregivers in rural Cambodia.

Methods

We investigated our hypotheses using data from a large panel of children in rural Cambodia. We rely on a unique panel dataset of about 7000 children (age 2-4 in 2016) and their families, collected in rural Cambodia in 2016 and 2017. The child survey comprises a comprehensive battery of cognitive tests (executive function, language and early numeracy) as well as anthropometric measures (height and weight). The caregiver survey includes basic socio-economic characteristic, questions about the socio-emotional development of the child (Strengths and Difficulties Questionnaire), as well as 25 questions about parental practices, measuring three key dimensions of parenting (cognitive parenting, emotional parenting, negative parenting). Thus, the caregiver survey allows for distinguishing the role of socio-economic characteristics and the role of specific parental practices in explaining children's cognitive development.

Participants

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During the baseline data collection exercise in 2016, a survey firm¹ used an adapted version of the EPI walk to select 6934 eligible households in 305 villages.² Each sampled household included children aged between 24 and 59 months.³ Approximately 11 months later, the same survey firm revisited 93% of the sampled households.⁴ The follow-up sample, which forms the main sample for the analysis in this study, includes 6452 households with 6914 tested children at the age ($M = 3.91$), of 2 ($n = 184$), 3 ($n = 2271$), 4 ($n = 2459$), 5 ($n = 1965$) and 6 ($n = 35$). Hence, the average number of followed up households per village is 21.2 and the average number of eligible children per household is 1.07. Using the follow-up sample instead of baseline allows to control for baseline test scores in regressions and to observe outcomes during an age period which is critical for the development of language and early numeracy skills.

Upon arrival at households' home, the enumerator first identified the main caregiver and the eligible children,⁵ and administered the household and caregiver surveys as well as completed the anthropometric measures and development tests. The child's testing session lasted an average of 31 minutes ($p50 = 30$).

Measures

We developed and adapted the battery of child tests in close cooperation with the researchers of the Measuring Early Learning Quality and Outcomes project (MELQO; UNESCO, 2017) and the local survey firm. The survey firm recruited interviewers based on their familiarity with data collection and their experience with young children. To ensure that children and parents correctly understood the questionnaire and that the instruments were reliable, the research team pretested every instrument at least three times before collecting data on the sampled villages. The survey firm translated the questionnaires into Khmer and an independent third party back-translated them into English. The research team participated in the interviewer

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training conducted by the local firm's fieldwork manager. Field staff was organized into six groups, each comprising of four interviewers, one supervisor and one field editor. All supervisors had several years of data collection experience in Cambodia and were responsible for household sampling and quality control procedures. Editors supported supervisors doing spot-checks, interviewer observations, and conducted independent re-interviews of at least 20% of interviews in each village.⁶

Household survey. The household survey includes information about family structure and socio-economic background. We constructed a dwelling quality index and household assets index.⁷ Both indexes were then standardized and summed up to create a wealth index. We use quintiles and quartiles of this index to analyze the cognitive gap in rural Cambodia. To construct a binary measurement of household wealth, we define low living standard as belonging to the lowest 2 quintiles of the wealth index. We use household size ($M = 4.48, SD = 1.68$) and share of households with low living standard as measures of socio-economic background on the household level.

Caregiver survey. The educational background of the caregiver is measured by years of schooling ($M = 3.48, SD = 3.15$). For better interpretability, we use a binary indicator for completion of primary school (6 years) ($M = .266$) in our regressions. Caregiver non-verbal reasoning is measured using a set of 12 Raven's Progressive Matrices (Carpenter et al. 1990; Raven 2000). This test was also administered at baseline. Non-verbal reasoning scores showed good correlation over time when administered to the same caregiver again 11 months later ($r_{sp} = .46$).

To account for the multidimensionality of parent-child interaction (Bornstein, 2012), we developed a questionnaire that covers multiple aspects of parenting and that fits well the

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Cambodian context. Caregivers answered 25 items related to regular activities, parent-child bonding, punitive behavior and different child-rearing methods. Possible responses ranged from 1 (never or almost never) to 5 (every day or almost every day). The factor structure of these parenting questions is reported in the Results section.

Child survey and assessment. We control for child age, measured as the number of days between birth and follow-up, divided by 365.25. Stunted growth is defined as having a height-for-age below two standard deviations of the growth standards by the World Health Organization (2006) ($M = .380, r_{sp} = .706$).

The child assessment includes different tests for the domains language development, early numeracy and executive function. Most of the child tests are based on the Measuring Early Learning Quality and Outcomes (MELQO) toolkit (see UNESCO, 2017 for a description of the measures development process).

We implemented multiple pretests to obtain reliable measures. Some tests from MELQO were removed during the adaptation process. For example, we removed a backward-digit span test and a mental transformation tasks because very few children were able to understand them. Likewise, as children in our sample were unable to write Khmer letters, we removed tests that included writing. Sound (phoneme) discrimination tests were also too difficult for our sample of children.

Some of the MELQO tests included in our battery were adapted to the local context or modified to fit the competences of the sampled children. For example, as some children rarely visit markets or stores, a question asking for things that can be bought and eaten at a market was changed to things that can be eaten. Likewise, letters and numbers used in some of the tests were selected to fit the local preschool curriculum. A number identification test was replaced with a

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quantity comparison test where children had to compare quantities of printed objects instead of printed numbers. A simple addition test was merged with the same quantity comparison test by asking children questions about the total number of objects obtained after adding or subtracting a given number of objects. Since the overall purpose was to generate a well-functioning test for Cambodia (as opposed to maintaining consistency for other purposes, such as international comparisons), adaptations were prioritized to ensure adequate fit to local context.

To obtain a rich set of tests that capture different constructs of the main domains, the MELQO tests were complemented with other assessments in order to derive a test scale that covers these different constructs. Specifically, we added the Dimensional Change Card Sort test (Zelazo, 2006), a receptive vocabulary test similar to the PPVT (Dunn & Dunn, 2007), a test for familiarity with print objects and a sustained attention test. The measure of socio-emotional problems is based on the caregiver-reported SDQ instead of a child assessment. Note that the SDQ results are not reversed: a higher score means more behavioral difficulties.

Before constructing the composite scores of child test domains, individual tests were first scored and standardized, thus ensuring that all tests contributed equal variance to their composite score. Then, tests of one category were summed into a composite score and standardized again for better interpretability. After these steps, we obtained the following composite scores:

Executive function ($\alpha = .74, r_{sp} = .60$).⁸ The final executive function score includes four tests, of which the first two listed here are from the MELQO toolkit. The construct inhibitory control is assessed with the head-knee task (McClelland et al., 2014). Working memory (short-term auditory memory) is assessed with a forward digit span test. The Dimensional Change Card Sort test is used as a measure of cognitive flexibility. We use a self-developed cancellation task to measure sustained attention. In this test, children see a printed

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matrix with different symbols and are asked to cross-out all symbols that match the given one (e.g. cross out all flowers). When completed, a larger matrix is given and a new symbol has to be crossed-out. The test continues until a child has completed 4 matrices, crossed out more wrong than correct images in a matrix, until the child loses attention or states that it is done.

Language development ($\alpha = .71, r_{sp} = .65$). Language and literacy skills are assessed with a letter name knowledge test in which children have to identify common letters of Khmer script. Expressive language skills are assessed with a self-developed test, similar to the PPVT (Dunn & Dunn, 2007) where children are asked to match a word to one out of four pictures. Receptive language is assessed with a listening comprehension test. Knowledge of reading concepts is assessed by showing a children's storybook and asking questions such as where and in which direction one should start reading the story. A drawing test, where children copy shapes, like circles or squares, is used to assess fine-motor skills.

Early numeracy ($\alpha = .73, r_{sp} = .56$). The tests for early numeracy includes a test for measurement concepts, e.g. if the child understands concepts such as tallest/shortest. In a test for verbal counting, children had to count up to 30. Numbers and operations are also administered with a quantitative comparison test, a number identification test analogous to the letter name knowledge test and a shape recognition test where children have to identify basic geometric shapes.

Socio-emotional problems ($\alpha = .69, r_{sp} = .26$). To test for behavioral problems, we use the total difficulties score of the Strengths and Difficulties Questionnaire (SDQ). The score is composed of 5 questions for each of the four categories: emotional symptoms, conduct problems, hyperactivity/inattention, and peer relationship problems. This test for socio-emotional problems

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is the only child development measure that is based on the caregiver survey instead of the direct child assessment.

Results

The analyses plan was designed to test the four main research questions: 1) are there gradients in child development based on family wealth for children three to five years of age; 2) does parenting show unique components and if so, how do they differentially affect child development, and how is parenting associated with family wealth and child development; 3) how do parenting and nutrition status jointly contribute to child development, and do they account for a portion of the variance in child development due to wealth gradients? We are also interested in looking across these three questions to estimate the proportion of child development accounted for by variations in family wealth, parenting quality, and nutrition status.

Are there gradients in child development based on family wealth for children aged three to five years? We start our analysis by looking at the wealth gradient for our four child development measures in Table 1 (“No control” columns). The data shows large differences between children from households with low and high levels of wealth. The top wealth quintile performs between 0.45 and 0.71 SD higher than the lower quintile and between 0.43 and 0.62 SD separate the top and bottom quartile in cognitive competences (language, early numeracy and executive function). Since one of our language tests is fairly similar to the TVIP used by Schady et al. (2015), we use the language score to compare the size of these gaps with others documented in Latin America. In rural Cambodia, the cognitive gap lies at the lower end of the wealth gradients of the five Latin America countries studied by Schady et al. (2015) (0.57 SD to 1.21 SD).

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The gap for socio-emotional problems (-0.248 between top and bottom quintiles) is smaller than for cognitive competences. A larger socio-emotional problem gap might arise later, potentially as a consequence of earlier cognitive difficulties. Importantly, the socio-emotional problems (SDQ) are reported by parents while other tests are directly administered to children, which means that measurement error may contribute to dampening the size of the gap.

The last three rows (age 3, age 4 and age 5) of Table 1 and column ‘No controls’ clearly indicate that the wealth gaps significantly widen with time. Between 3 and 5 years old, the gap increases, especially for early numeracy and language. From a small and barely significant .09 SD at age 3 in early numeracy (0.3 in language), the gap reaches a large magnitude of 0.92 SD in early numeracy (1.18 in language) by age 5. This result is consistent with the fact that the 3 to 5 years of age period is critical for both competences. The gap increases to a lesser extent in executive function from 0.39 to 0.53 SD, which may indicate that the gap in executive function widened before age 3 and, hence, is better accounted for by earlier factors (perinatal care, nutrition, early health). The gap for socio-emotional problems more than doubles from -0.17 to -0.35 SD.

To better visualize the differences in child development by socio-economic status over age, we used separate nonparametric regressions for the lowest and highest quintiles of the SES index (Figure 1). Gaps in executive function, language and early numeracy skill are large and already evident at the age of 3, the earliest enrollment age for public preschools in Cambodia. The gradient in executive function skills stabilizes at the age of 4, with a size of approximately 0.5 standard deviations. This is in stark contrast to gradients in language and early numeracy skills. The initial gap at the age of three is comparable to executive function. However, the gap continues to grow until primary school-age to a magnitude of 0.9 SD (early numeracy) and 1.2

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(language) standard deviations. This gap is of substantial magnitude and equivalent to a delay of 14-18 months (a child progressing of .75 SD per year).

Does parenting show unique components, and associations with family wealth and child development? We conducted explanatory factor analysis in order to determine if the parenting scores could be grouped by distinct dimensions of parenting. Sampling adequacy was supported by a Kaiser-Meyer-Olkin statistic of 0.868 (Kaiser, 1974), confirming a compact pattern of correlations between the 25 parenting items. Bartlett's test for sphericity rejected the null hypothesis of zero covariance, $p < .001$. Parallel analysis suggested that there are 11 factors, equaling the number of factors with eigenvalue greater than zero. We followed a similar procedure as Jones et al. (2017) to reduce the number of factors retained. We rejected the large number of factors as only 3 of them had more than 1 item with a factor loading greater than 0.3 and all but 3 factors had poor reliability ($\alpha < .6$). We gradually reduced the number of factors until all factors had reliability of at least $\alpha \geq .6$ and at least two items with loadings greater than 0.3. With this procedure we obtained three parenting factors, which are summarized in Table 2.

The three identified parenting factors capture three dimensions of parenting. First, "cognitive parenting" measures how parents actively interact with the child in ways that are likely to develop cognitive competencies: games, reading books and playing with toys or objects. The second dimension, "socio-emotional parenting" captures the emotional support and responsiveness of the child and the parent. Third, "negative parenting", in which higher values indicate more negative parenting, refers to the degree to which parents use harsh or punitive statements to discipline the child.

To assess the extent to which the three parenting scores capture meaningful differences in parenting behavior, we correlate them with other family characteristics. Table 3 indicates that

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parenting quality is strongly correlated with socio-economic characteristics of the household and of the caregiver: wealthier and more educated families tend to adopt parenting behavior that is more cognitively stimulating and positive towards children. Cognitive parenting is positively correlated with caregiver education ($0.26, p < .001$) and caregiver non-verbal reasoning ($0.18, p < .001$), but negatively correlated with a low household living standard ($-0.08, p < .001$) and the caregiver's age ($-0.15, p < .001$). A similar pattern was observed for socio-emotional parenting, although the correlations are smaller. Interestingly, while cognitive parenting and socio-emotional parenting are positively correlated ($0.38, p < .001$), negative parenting is negatively correlated with cognitive parenting ($-0.05, p < .001$) but positively correlated with socio-emotional parenting ($0.14, p < .001$), i.e. parenting behaviors which often rely on punitive behavior are not inconsistent with other behaviors linked to positive socio-emotional interactions.

Cognitive parenting is significantly positively correlated with scores on the child tests, negative parenting is significantly negatively correlated with these scores, and the direction of the effect of socio-emotional parenting is ambiguous in this correlation analysis. While socio-emotional parenting is negatively correlated with socio-emotional problems ($-0.04, p < .001$), it is also negatively correlated with the executive function score ($-0.03, p = .040$). Since parenting is significantly associated with several other household characteristics, isolating the independent role of parenting is important. We show below that after controlling for household and caregiver characteristics and even baseline test scores, the effect of parenting remains significant and that socio-emotional parenting does not negatively affect executive function skills.

What are the joint roles of parenting and nutrition in explaining variation in child development? The size of the raw wealth gap is substantially reduced after conditioning on

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parenting (the three separate parenting composite scores) or anthropometrics (height for age z-scores). Both set of control variables reduce the gap in executive function by the same amount, about 8% (Table 1). The gap in language skills is reduced by about 10% when controlling for parenting and 5% when controlling for height for age. Similarly, the gap in early numeracy skills is reduced by 13% when controlling for parenting, and by 7% when controlling for nutrition. The biggest difference is in the case of socio-emotional problems where parenting can account for 42% of the gap and height for age cannot explain any of it (0%).

To investigate further the variation accounted for by parenting and other factors, as well as to test the hypothesis that the wealth gap is partially mediated by parenting and nutrition, in Table 4, we use four specifications in a hierarchical regression model. In a first step (column (1)), we regress the dependent variable on child age and child gender to determine how much of the total variation is explained by exogenous characteristics. The R-squareds in these regressions vary from 2.1% for socio-emotional problems, to 38% for early numeracy and approximately 43% for executive function and language skills. Recall that the three child-administered test scores increased by approximately 0.72 to 0.78 SD by year of age. This means that the cognitive gap that separates a child from the bottom quintile and the top quintile (between 0.44 and 0.62 SD, see Table 1) corresponds to between 60 and 80 percent of one year of average development. Girls perform significantly better than boys across all domains (9-12% of a SD). The gender difference is particularly pronounced for executive function.

Common caregiver and household control variables added in column 2 explain additional variation for the domains of executive function ($R^2\Delta = .020$), language ($R^2\Delta = .037$), early numeracy ($R^2\Delta = .021$), and socio-emotional problems ($R^2\Delta = .016$). Joint significance of the added set of variables was confirmed with an F -test ($p < .001$ for all 4 outcomes). Low living

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standard, household size, caregiver education and caregiver non-verbal reasoning affect children cognition in the expected directions, with all coefficients highly significant and of relatively large magnitude.

To test if the three parenting variables explain additional variation in child outcomes, they are added to the regression model in column 3 of Table 4. Parenting explains additional variance for all four child outcomes. The change in the R-squared is by far the highest for socio-emotional problems ($\Delta R^2 = .122$) and of relatively smaller size for executive function ($\Delta R^2 = .003$), language ($\Delta R^2 = .010$), and early numeracy ($\Delta R^2 = .010$). Joint significance of the three parenting variables was confirmed with an *F*-test ($p < .001$ for all 4 outcomes). For the cognitive domains, the parameters of all household and caregiver controls are reduced once parenting is added to the model. The largest change is for caregiver education and household living standard for the socio-emotional problems outcome.

Of our three parenting measures, cognitive parenting had the strongest effect on the three cognitive scores. A one SD increase in our measure of cognitive parenting is associated with a 0.093-0.100 SD increase in language and early numeracy scores, an increase that is comparable to half to two-thirds of the negative effect of stunting, low living standard, or low caregiver education. Based on the magnitudes of these associations, to compensate for the cumulative detrimental effect of low caregiver education, low living standard and stunting, the cognitive parenting behavior score would need to move from the bottom 19 percentile to the top 95 percentile (3 SD), i.e. from a fairly poor parent to one of the best parents in our sample. Given this large magnitude, it is perhaps unreasonable to expect that parenting alone might be able to make up for the effects of negative shocks or a negative environment.

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Socio-emotional parenting affects executive function skills positively but does not affect the other cognitive competences. Higher scores on socio-emotional parenting is also significantly associated with less socio-emotional problems. While smaller in size than for cognitive parenting, the effect of negative parenting is significantly negative for all cognitive competences. The size of the relationship is especially large for the socio-emotional problem score (0.346 SD).⁹

To test if nutrition also explains additional variance we performed a similar exercise by adding it to the model in column 4 instead of the parenting variables. Stunting cannot explain variance in socio-emotional problems ($\Delta R^2 = .000$), similar to Table 1. It explains a larger share of variance in executive function than our measures of parenting do ($\Delta R^2 = .008$), a similar share for language ($\Delta R^2 = .008$) and a slightly smaller share for early numeracy ($\Delta R^2 = .006$). The coefficients of household and caregiver variables change only marginally when stunting is added to the model. Thus, while the relationships with outcomes are significant—equivalent to about 3 months of cognitive development, for example—stunting seems to be a weaker mediator of caregiver education than parenting behaviors are.¹⁰

We explore additional associations and mediating factors in Table 5. First, we include baseline test scores collected 11 months prior to the main outcomes of this study (which would also have the effect of controlling for unobserved factors already captured in those scores). While the magnitudes fall, the relationships with parenting typically remain significant, suggesting that the effect of parenting is cumulative (and not “one-shot”).¹¹

We also hypothesized that parenting may have differential effects on child development, depending on children’s nutrition status. To test the hypothesis that the association of cognitive

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parenting and child outcomes is weaker for stunted children, we looked in column 3 of Table 5 at the effect of parenting, separately for stunted and non-stunted children and with baseline controls. We focused on cognitive parenting because of the notable role of nutrition status in cognitive development; we thus hypothesized that cognitive parenting and subsequent child development would be especially sensitive to nutrition status. While no significant interactions between parenting and child nutrition status were observed for executive function and socio-emotional problems, effects of cognitive parenting differed by stunting for language and early numeracy outcomes. The magnitude of the cognitive parenting effect is about 34% weaker for effects on language and 53% weaker for effects on early numeracy, showing that the positive effect of cognitive parenting is weaker for stunted children. We repeated the same exercise without baseline controls in column 2 of Table 6 and observed similar interaction effect sizes. However, the interaction term for the language outcome is only significant in Table 5 where baseline test scores were added to the model.

While the cognitive parenting x stunting interaction is statistically significant for our language and early numeracy outcomes, this finding can also be explained by an unobserved heterogeneous effect by parenting quality, since parenting quality is correlated with stunting. As proxy for parenting quality we therefore chose caregiver education, which is also negatively correlated with stunting. We then added a cognitive parenting x caregiver education to the models in the last columns of Table 5 and Table 6 to see if the coefficient of the cognitive parenting x stunting interaction changes. The inclusion of caregiver education, and its interaction with nutrition status, did not change the significance of the previous interaction. We thus conclude that cognitive parenting has a stronger impact on some domains of child development for non-stunted vs. stunted children.

Discussion

The objective of this study was to quantify the role of parenting and nutrition in explaining the cognitive gap that we observed between children from low and high wealth backgrounds. This gap exists in Cambodia and is large: the difference between the highest and lowest quintile amounts to about 7-9 months of child development. For pre-academic competencies (language and early numeracy) the gap widens significantly between age 3 to 5: confirming that this period is crucial for development of early numeracy and language skills and is a time when gaps emerge and may become entrenched.

We document four main findings. First, building on previous research on socio-economic gradients in developing countries, we confirm that a substantial cognitive gap exists between children from different backgrounds in rural Cambodia (confirming earlier findings in Naudeau et al., 2011). In our sample, 0.62 SD separate the children in the bottom quartile of a wealth distribution from the children in the top quartile (language test). The gap appears larger for cognitive competences (executive function, language, early numeracy) than for non-cognitive/socio-emotional outcomes (Strengths and Difficulties Questionnaire). While significant and large, these gaps in rural Cambodia are at the low end of those documented in rural Latin America by Schady et al. (2015) (between 0.57 to 1.12 SD on a similar language test).

Second, the gap in child development due to family wealth widens with age (e.g. Paxson & Schady, 2007; Fernald et al., 2012). Between three and five years of age, the gap especially widens in language (from 0.31 SD at age 3 to 1.18 SD at age 5) and early numeracy, but only marginally for executive function. It also doubles for socio-emotional problems. The fact that the executive function gap is already present at age 3 and only marginally increases between age 3 and 5 suggests that before age 3, children are already experiencing substantial growth in executive function that is affected by family socio-economic status.

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Third, we confirm that cognitive-stimulating and emotionally-responsive parenting is one of the important explanatory factors of cognitive differences due to family wealth. Our measure of parenting behaviors are strongly correlated with children's performance, accounting for about 8-13% of the gap in cognitive competences observed among 3 and 5 year olds. While the explanatory power of parenting is robust, the magnitude of the parental effect is relatively small in comparison with other explanatory factors: We show that a large 1 SD improvement in the main parental competences--an improvement beyond the scope of most parenting programs--would only compensate about a half of the effect of stunting.

Fourth, we provide evidence that the positive effects of parenting may be stronger for children who are not stunted. This is an important finding for two reasons. First, it demonstrates the importance of designing and testing integrated program models of child development that anticipate the complex interactions that will arise between child characteristics and environmental stimuli. It is unlikely that "one size fits all" (Shonkoff, Radner & Foote, 2017). Second, this interaction – albeit a small one, and not consistent across all domains of parenting or child development – adds to the growing body of research documenting the variable effects of environments on child development, by adding undernutrition as a condition that may moderate the effects of later environmental stimuli on child development.

Encouraging stimulating and responsive parenting and improving children's educational environments are key to reducing cognitive inequality and improving children's performance during that critical time when the cognitive gap widens. Yet, to fully compensate for initial inequality, better parenting is not a panacea: relative to other factors (nutrition, poverty level), the magnitude of the parenting effect remains small.

The wealth gradient in child development is well-documented in many countries. We show that parenting behaviors explain a share of this—but other factors matter as well. More

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work is needed to examine the broader range of environmental conditions that contribute to this gap, and perhaps more critically, how they interact with one another. Such analyses would help guide the design of effective interventions which would exploit complementarities between parenting, nutrition and other factors for the promotion of child development in challenging contexts.

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Footnote

¹ Angkor Research©, under the close supervision of the Principal Investigators.

² EPI refers to the Expanded Programme on Immunization of the World Health Organization (see e.g. Henderson & Sundaresan (1982)).

³ The study was approved by the institutional review board of the Paris School of Economics and the National Ethics Committee for Health Research by the Cambodian Ministry of Health. The data was collected as part of a randomized controlled trial investigating the effects of preschools on school readiness of children in rural Cambodia. Our main outcomes for this study, collected in 2017, stem from a first follow-up on the trial intervention. Between baseline and the first follow-up, community preschools were constructed in some of the sample villages. An awareness campaign was conducted to stimulate enrollment into the new preschools. Further, a home-based program, in which trained core-mothers address a range of topics around parenting, was implemented. These interventions were randomized between villages and still at an early stage during the time of the first follow-up. We therefore ignore the interventions in this analysis. All our regression estimates are robust to the inclusion of treatment group variables to account for the randomized treatment.

⁴ The attrition rate of 7% can almost entirely be explained by seasonal and permanent relocation of households. The study does not follow up on households that move beyond the boundaries of sample villages.

⁵ The caregiver is defined as the direct relative that takes care of the child most of the time. In most cases the caregiver is the biological mother.

⁶ Initial re-interviews were limited to a set of 20 questions to reduce the burden to respondents. In case of inconsistencies between the initial interview and the re-interview, households were called or visited again to obtain clarity.

⁷ The direction of each categorical variable for dwelling quality (quality of the floor, quality of the roof, electricity, toilet...) was first assessed using a Multiple Correspondence analysis. Then, each variable was coded using the sign of the coordinate of the first MCA dimension. We then took the average of the standardized version of each coded variable. The Cronbach alpha is 50%. For the household asset, we simply standardized each asset and took the standardized version of the sum. The Cronbach alpha is 65%.

⁸ Cronbach's α for composite test scores are based on the covariance between the standardized test scores of the individual tests. The rank correlation coefficient for composite test scores give the correlation between baseline and follow-up composite scores with 11 months in between on average.

⁹ As with all these results, the estimates should not necessarily be interpreted as causal impacts. In this case in particular, for example, it is possible that socio-emotional problems could be cause rather than result of negative parenting practices (i.e. reverse causation).

¹⁰ The fact that wealth gradients remains large even after controlling for anthropometrics and parenting should be interpreted with care. As our measure of parenting are only self-reported and based on recall, it is possible that it does not capture the full dynamic of parenting throughout the children's life time. Our measure of parenting could for instance be imperfectly correlated with past parenting (during pregnancy or breastfeeding). Our measure of parenting may also imperfectly measure the quality of parenting. Longitudinal and external measures of parenting would be necessary to enhance our measures.

¹¹ Note that in Table 5 we control for both parenting and stunting. The effects of each are relatively unchanged.

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Table 1

Results of linear regressions predicting different domains of child development from quantile/quintile dummies and parenting variables or child anthropometrics.

	Executive function			Language			Early numeracy			Socio-emotional problems		
	No control	Parenting	Height for age	No control	Parenting	Height for age	No control	Parenting	Height for age	No control	Parenting	Height for age
Quartilegap - Full sample	0.442***	0.407***	0.407***	0.620***	0.560***	0.586***	0.426***	0.371***	0.397***	-0.211***	-0.124***	-0.211***
Quintilegap - Full sample	0.483***	0.443***	0.442***	0.709***	0.640***	0.670***	0.452***	0.388***	0.419***	-0.248***	-0.139***	-0.249***
... age 3	0.392***	0.367***	0.356***	0.314***	0.287***	0.286***	0.090*	0.062	0.075	-0.169**	-0.098	-0.168**
... age 4	0.534***	0.478***	0.496***	0.734***	0.646***	0.699***	0.446***	0.375***	0.422***	-0.248***	-0.144**	-0.256***
... age 5	0.534***	0.506***	0.484***	1.176***	1.089***	1.114***	0.918***	0.822***	0.850***	-0.349***	-0.183**	-0.334***

Notes. Table only shows parameter estimates for the highest quantile (first row) or highest quintile (row 2-5). Column ‘No control’ shows results using only quantile/quintile dummies as explanatory variables. Columns ‘Parenting’ add the three parenting composite scores to explanatory variables. Columns ‘Height for age’ add height for age z-scores to control variables. Dependent variables are standardized residuals of a linear regression of original test scores on the first three polynomials of age. Two-tailed p-values for t-tests using robust standard errors clustered on the village level. *p < .1 **p < .05 ***p < .01

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Table 2

Pattern matrix for exploratory factor analysis (iterated principal factor) with promax oblique rotation of the parenting measures

Items (abbreviated)	Mean	SD	Cognitive parenting	Socio-emotional parenting	Negative parenting
Read book or magazine and look at pictures	1.78	1.25	0.57	-0.02	-0.03
Play games with words	1.70	1.23	0.50	0.00	0.01
Tell stories	1.57	1.09	0.50	-0.01	-0.01
Sing songs	2.16	1.51	0.46	0.12	-0.01
Play games with numbers	2.64	1.57	0.51	0.10	-0.03
Play active games, e.g. with running or ball	1.42	1.00	0.42	0.01	-0.02
Draw or paint	1.49	1.01	0.56	-0.07	-0.01
Spend time with child so he/she can feel love and care	4.18	1.20	-0.04	0.47	-0.02
Show love by hugging, kissing, caring	4.44	1.07	0.02	0.48	-0.08
Teach to become self-sufficient in daily routines	4.50	0.98	-0.01	0.46	-0.01
Talk to child when he/she did something wrong	4.02	1.16	-0.01	0.45	0.17
Comfort child when he/she feels sad	3.89	1.22	-0.03	0.49	0.07
Encourage, compliment when child does something	3.77	1.20	0.11	0.51	-0.08
Tell child that he/she makes you happy	2.66	1.50	0.21	0.30	-0.02
Talk about reasons when forbidding something	4.18	1.11	-0.01	0.40	0.14
Feel that it is hard taking care of child	3.06	1.65	0.03	0.00	0.44
Physical punishment (kicking, slapping, beating)	2.04	1.20	0.04	-0.04	0.56
When angry, throw anger at child by shouting	2.84	1.38	-0.05	0.04	0.63
Feel annoyed with what child has done	2.68	1.37	0.01	-0.03	0.72
Feel annoyed or angry when child cries	2.59	1.40	-0.01	0.05	0.59
Shout or speak loudly to child	3.00	1.41	-0.07	0.04	0.65
Call child dumb, lazy or similar	1.59	1.11	0.05	-0.12	0.37
Talk, e.g. name objects, describe daily routines	3.29	1.53	0.23	0.24	0.03
Ignore when child cries	1.47	0.97	0.08	-0.12	0.24
Go for a walk with child	3.36	1.51	0.01	0.29	0.06
Cronbach's alpha of composite score			0.72	0.69	0.77

Notes. Factor loadings >.3 in bold are the items of the three parenting composite scores.

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Table 3

Pairwise correlations between follow-up child test scores, child, household and caregiver control variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 Executive function	1.00													
2 Language development	0.75***	1.00												
3 Early numeracy	0.66***	0.77***	1.00											
4 Socio-emotional problems	-0.15***	-0.16***	-0.16***	1.00										
5 Age (years)	0.65***	0.66***	0.61***	-0.14***	1.00									
6 Female	0.06***	0.04***	0.04***	-0.05***	-0.01	1.00								
7 Stunted	-0.13***	-0.13***	-0.11***	0.02	-0.03***	-0.03**	1.00							
8 Household size	-0.01	-0.05***	-0.02	-0.02	0.01	-0.01	0.02*	1.00						
9 Low living standard	-0.10***	-0.13***	-0.10***	0.06***	-0.00	0.00	0.06***	-0.08***	1.00					
10 Caregiver age	0.01	0.03***	0.03**	0.04***	0.01	-0.01	0.02	0.05***	-0.15***	1.00				
11 Caregiver primary school	0.07***	0.09***	0.07***	-0.11***	-0.03**	0.00	-0.06***	-0.05***	-0.13***	-0.32***	1.00			
12 Caregiver non-verbal reasoning	0.08***	0.10***	0.07***	-0.06***	-0.02	-0.00	-0.06***	-0.04***	-0.07***	-0.37***	0.38***	1.00		
13 Cognitive parenting	0.05***	0.11***	0.10***	-0.12***	-0.03***	0.01	-0.03**	-0.07***	-0.08***	-0.15***	0.26***	0.18***	1.00	
14 Socio-emotional parenting	-0.03**	-0.02	-0.01	-0.04***	-0.11***	-0.01	-0.03**	-0.06***	-0.05***	-0.03**	0.11***	0.08***	0.38***	1.00
15 Negative parenting	-0.07***	-0.07***	-0.08***	0.35***	-0.04***	-0.10***	0.00	0.02	0.05***	-0.04***	-0.05***	-0.01	-0.05***	0.14***

Notes. Table shows pairwise correlations. Two-tailed p-values: *p < .1 **p < .05 ***p < .01

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Table 4

Results of hierarchical regression analysis predicting different domains of child development from parental stimulation, nutrition and other household, caregiver and child variables.

	Executive function				Language				Early numeracy				Socio-emotional problems			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Age (years)	0.770***	0.772***	0.775***	0.768***	0.777***	0.780***	0.783***	0.776***	0.722***	0.725***	0.727***	0.722***	-0.158***	-0.161***	-0.153***	-0.161***
Female	0.124***	0.124***	0.119***	0.119***	0.092***	0.092***	0.086***	0.087***	0.088***	0.089***	0.081***	0.085***	-0.106***	-0.107***	-0.041*	-0.107***
Household size		-0.010*	-0.008	-0.009		-0.034***	-0.030***	-0.033***		-0.015**	-0.011**	-0.014**		-0.014*	-0.022***	-0.014*
Low living standard		-0.158***	-0.150***	-0.149***		-0.218***	-0.203***	-0.209***		-0.161***	-0.146***	-0.154***		0.091***	0.051*	0.091***
Caregiver age		0.003***	0.003***	0.003***		0.005***	0.005***	0.005***		0.004***	0.004***	0.004***		0.001	0.002**	0.001
Caregiver primary school		0.140***	0.117***	0.132***		0.184***	0.136***	0.176***		0.160***	0.112***	0.153***		-0.223***	-0.141***	-0.223***
Caregiver non-verbal reasoning		0.078***	0.074***	0.073***		0.092***	0.084***	0.087***		0.065***	0.058***	0.062***		-0.018	-0.007	-0.017
Cognitive parenting			0.034***				0.100***				0.093***				-0.051***	
Socio-emotional parenting			0.023**				0.004				0.008				-0.077***	
Negative parenting			-0.025**				-0.022**				-0.033***				0.346***	
Stunted				-0.191***				-0.189***					-0.159***			0.003
Constant	-3.447***	-3.508***	-3.525***	-3.421***	-3.464***	-3.499***	-3.530***	-3.413***	-3.222***	-3.317***	-3.344***	-3.245***	0.750***	0.817***	0.733***	0.816***
Observations	6699	6699	6699	6699	6699	6699	6699	6699	6699	6699	6699	6699	6704	6704	6704	6704
R ²	0.432	0.452	0.455	0.460	0.437	0.474	0.484	0.483	0.378	0.399	0.409	0.405	0.021	0.037	0.159	0.037
F	2846.5***	891.5***	629.3***	816.9***	1755.3***	557.8***	400.3***	502.6***	1018.2***	322.0***	233.4***	288.5***	72.3***	33.2***	127.7***	29.1***
R ² Δ		0.020	0.003	0.008		0.037	0.010	0.008		0.021	0.010	0.006		0.016	0.122	0.000
FΔ		41.10***	9.57***	86.05***		68.47***	34.81***	101.02***		35.79***	28.35***	73.21***		16.97***	306.33***	0.011

Notes. Changes in the R² (R²Δ) and F-tests for joint significance of additional variables (FΔ) refer to a comparison of (2) vs. (1) in column (2), (3) vs. (2) in column (3) and (4) vs. (2) in column (4). Two-tailed p-values for t-tests and F-tests using robust standard errors clustered on the village level. *p < .1 **p < .05 ***p < .01

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Table 5

Results of hierarchical regression analysis predicting different domains of child development using baseline controls, a cognitive parenting x stunted and a cognitive parenting x caregiver education interaction term.

	Executive function				Language				Early numeracy				Socio-emotional problems			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Age (years)	0.771***	0.501***	0.501***	0.502***	0.779***	0.423***	0.423***	0.423***	0.724***	0.377***	0.378***	0.378***	-0.153***	-0.101***	-0.101***	-0.101***
Female	0.114***	0.094***	0.094***	0.094***	0.081***	0.057***	0.058***	0.058***	0.077***	0.052***	0.052***	0.052***	-0.041*	-0.032	-0.032	-0.032
Household size	-0.007	-0.002	-0.002	-0.002	-0.029***	-0.021***	-0.021***	-0.021***	-0.010*	-0.002	-0.003	-0.003	-0.022***	-0.018***	-0.018***	-0.018***
Low living standard	-0.141***	-0.084***	-0.084***	-0.084***	-0.194***	-0.119***	-0.119***	-0.119***	-0.139***	-0.069***	-0.069***	-0.069***	0.051*	0.048*	0.048*	0.048*
Caregiver age	0.003***	0.001	0.001	0.001	0.005***	0.003***	0.003***	0.003***	0.004***	0.002***	0.002***	0.002***	0.002**	0.002*	0.002*	0.002*
Caregiver primary school	0.109***	0.078***	0.078***	0.073***	0.129***	0.079***	0.079***	0.079***	0.106***	0.058**	0.058**	0.056**	-0.141***	-0.120***	-0.120***	-0.116***
Caregiver non-verbal reasoning	0.070***	0.052***	0.052***	0.052***	0.080***	0.057***	0.057***	0.057***	0.055***	0.031***	0.031***	0.031***	-0.007	-0.001	-0.000	-0.001
Cognitive parenting	0.033***	0.011	0.012	0.005	0.099***	0.066***	0.076***	0.076***	0.093***	0.058***	0.072***	0.070***	-0.051***	-0.041***	-0.047***	-0.042**
Socio-emotional parenting	0.021*	0.017	0.017	0.017*	0.002	-0.005	-0.005	-0.005	0.007	0.000	0.001	0.001	-0.077***	-0.067***	-0.067***	-0.067***
Negative parenting	-0.026**	-0.019*	-0.019*	-0.019*	-0.022**	-0.011	-0.011	-0.011	-0.033***	-0.022**	-0.022**	-0.022**	0.346***	0.311***	0.311***	0.311***
Stunted	-0.189***	-0.132***	-0.132***	-0.132***	-0.187***	-0.110***	-0.111***	-0.111***	-0.158***	-0.082***	-0.082***	-0.082***	0.005	-0.004	-0.003	-0.004
Child executive function (baseline)		0.165***	0.165***	0.165***		0.061***	0.061***	0.061***		0.029*	0.029*	0.030*		0.018	0.018	0.018
Child language (baseline)		0.115***	0.115***	0.115***		0.329***	0.329***	0.329***		0.247***	0.247***	0.247***		-0.043**	-0.043**	-0.042**
Child early numeracy (baseline)		0.114***	0.114***	0.114***		0.115***	0.115***	0.115***		0.235***	0.235***	0.235***		-0.012	-0.012	-0.012
Socio-emotional problems (baseline)		0.004	0.004	0.004		0.003	0.003	0.003		0.002	0.002	0.002		0.197***	0.197***	0.197***
Cognitive parenting x Stunted			-0.003	-0.001			-0.026*	-0.026*			-0.038**	-0.037**			0.014	0.013
Cognitive parenting x Caregiver primary school				0.021				-0.001				0.005				-0.014
Constant	-3.437***	-2.226***	-2.226***	-2.227***	-3.443***	-1.851***	-1.851***	-1.851***	-3.271***	-1.722***	-1.721***	-1.722***	0.730***	0.486***	0.486***	0.487***
Observations	6699	6699	6699	6699	6699	6699	6699	6699	6699	6699	6699	6699	6704	6704	6704	6704
R ²	0.463	0.531	0.531	0.531	0.493	0.611	0.611	0.611	0.415	0.538	0.538	0.538	0.159	0.197	0.197	0.198
F	599.5***	515.2***	483.2***	455.1***	372.1***	432.1***	407.1***	391.0***	216.5***	265.7***	251.0***	236.4***	116.6***	110.2***	103.4***	97.3***
R ² Δ		0.068	0.000	0.000		0.119	0.000	0.000		0.123	0.000	0.000		0.038	0.000	0.000
FΔ		163.8***	0.027	1.032		296.2***	3.322*	0.001		272.7***	4.941**	0.056		89.10***	0.315	0.317

Notes. Changes in the R² (R²Δ) and F-tests for joint significance of additional variables (FΔ) refer to a comparison of (2) vs. (1) in column (2), (3) vs. (2) in column (3) and (4) vs. (3) in column (4). Two-tailed p-values for t-tests and F-tests using robust standard errors clustered on the village level. *p < .1 **p < .05 ***p < .01

JOINT EFFECTS OF PARENTING AND NUTRITION

Table 6

Results of hierarchical regression analysis predicting different domains of child development using a cognitive parenting x stunted and cognitive parenting x caregiver education interaction term.

	Executive function			Language			Early numeracy			Socio-emotional problems		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Age (years)	0.771***	0.771***	0.771***	0.779***	0.779***	0.779***	0.724***	0.724***	0.724***	-0.153***	-0.153***	-0.153***
Female	0.114***	0.114***	0.114***	0.081***	0.081***	0.081***	0.077***	0.077***	0.077***	-0.041*	-0.041*	-0.041*
Household size	-0.007	-0.007	-0.008	-0.029***	-0.029***	-0.030***	-0.010*	-0.011*	-0.011*	-0.022***	-0.022***	-0.022***
Low living standard	-0.141***	-0.141***	-0.141***	-0.194***	-0.194***	-0.194***	-0.139***	-0.139***	-0.139***	0.051*	0.051*	0.051*
Caregiver age	0.003***	0.003***	0.003***	0.005***	0.005***	0.005***	0.004***	0.004***	0.004***	0.002**	0.002**	0.002**
Caregiver primary school	0.109***	0.109***	0.102***	0.129***	0.128***	0.124***	0.106***	0.105***	0.100***	-0.141***	-0.140***	-0.134***
Caregiver non-verbal reasoning	0.070***	0.070***	0.070***	0.080***	0.080***	0.080***	0.055***	0.054***	0.055***	-0.007	-0.007	-0.007
Cognitive parenting	0.033***	0.034**	0.023	0.099***	0.109***	0.103***	0.093***	0.106***	0.099***	-0.051***	-0.056***	-0.047**
Socio-emotional parenting	0.021*	0.021*	0.022**	0.002	0.002	0.003	0.007	0.007	0.007	-0.077***	-0.077***	-0.077***
Negative parenting	-0.026**	-0.026**	-0.026**	-0.022**	-0.023**	-0.022**	-0.033***	-0.034***	-0.033***	0.346***	0.346***	0.346***
Stunted	-0.189***	-0.189***	-0.189***	-0.187***	-0.187***	-0.187***	-0.158***	-0.158***	-0.158***	0.005	0.005	0.005
Cognitive parenting x Stunted		-0.001	0.001		-0.026	-0.025		-0.036*	-0.034*		0.015	0.013
Cognitive parenting x Caregiver primary school			0.029			0.016			0.021			-0.027
Constant	-3.437***	-3.437***	-3.437***	-3.443***	-3.443***	-3.444***	-3.271***	-3.271***	-3.271***	0.730***	0.730***	0.730***
Observations	6699	6699	6699	6699	6699	6699	6699	6699	6699	6704	6704	6704
R ²	0.463	0.463	0.463	0.493	0.493	0.493	0.415	0.415	0.415	0.159	0.159	0.159
F	599.5***	554.2***	513.2***	372.1***	340.8***	320.8***	216.5***	199.1***	184.2***	116.6***	106.9***	99.00**
R ² Δ		0.000	0.000		0.000	0.000		0.000	0.000		0.000	0.000
FΔ		0.005	2.039		2.274	0.606		3.467*	0.894		0.337	1.138

Notes. Changes in the R² (R²Δ) and F-tests for joint significance of additional variables (FΔ) refer to a comparison of (2) vs. (1) in column (2) and (3) vs. (2) in column (3). Two-tailed p-values for t-tests and F-tests using robust standard errors clustered on the village level. *p < .1 **p < .05 ***p < .01

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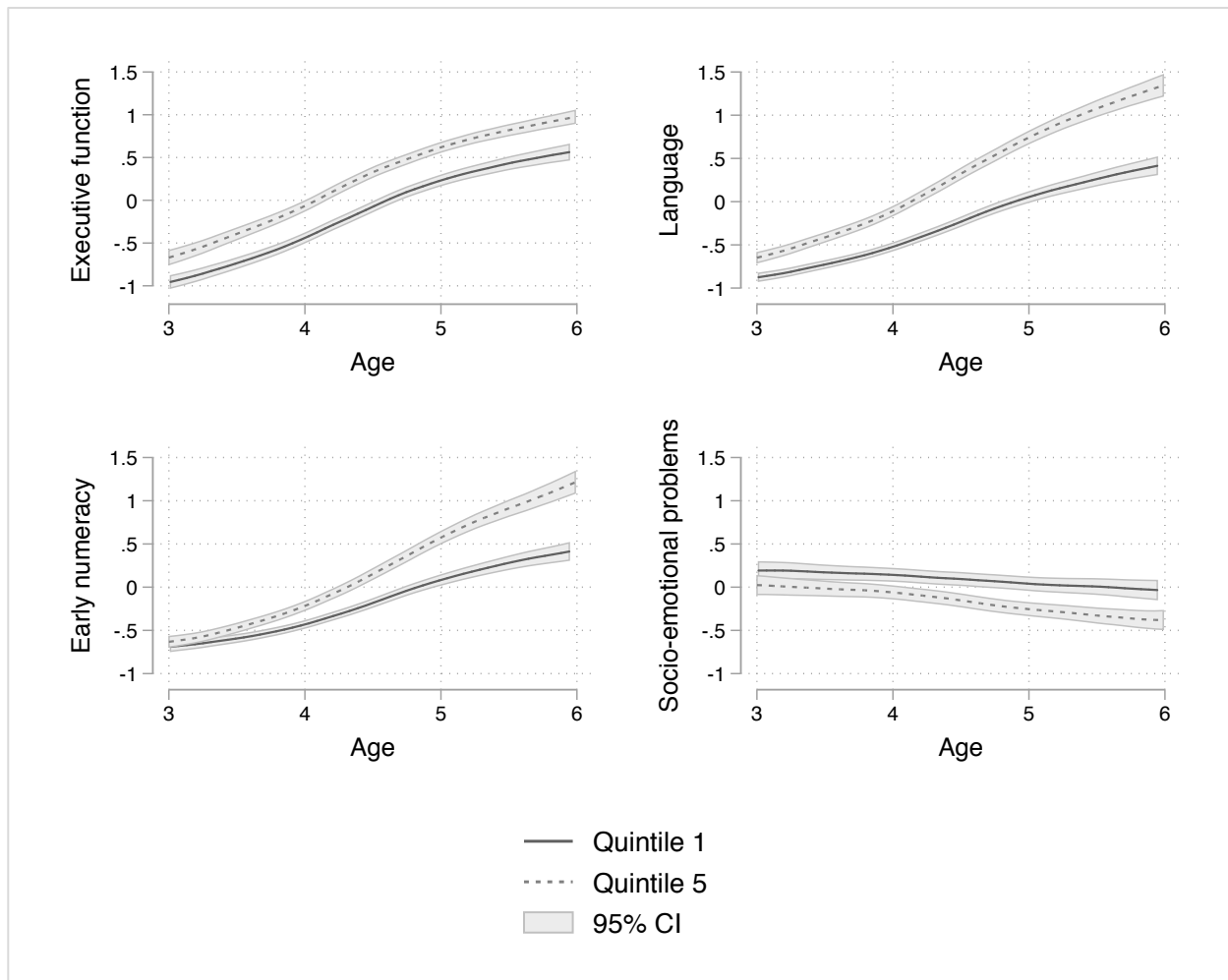


Figure 1. Nonparametric regressions of test scores on age using a bandwidth of 0.5 years.