amse
école d'économie d'aix-marseille
aix-marseille school of economics

Working Papers / Documents de travail

Formation of Children's Cognitive and Socio-Emotional Skills: Is All Parental Time Equal?

Hélène Le Forner

WP 2021 - Nr 17

Formation of Children's Cognitive and Socio-Emotional Skills: Is All Parental Time Equal?

Latest Version here

Hélène Le Forner *

February 27, 2021

Abstract

Although it is recognized that parental time is a strong determinant of child development, little is known about heterogeneity across the effects of parental time. Using the Longitudinal Survey of Australian Children, I model the cognitive and socio-emotional skills production functions for children born in 1999–2000, from 4 to 11 years old, using, among others, a cumulative value-added and a generalized method of moments model. I find that the effect on children's verbal and socio-emotional skills of time spent on educational activities with the father is smaller than that with the mother or both parents together. For socio-emotional skills, this difference seems to be driven by fathers who spend little time with their children.

JEL classification: I24, J13, J24

Keywords: Child development; Cognitive skills; Socio-emotional skills; Parental time investment.

*Aix-Marseille Univ., CNRS, EHESS, Centrale Marseille, AMSE, 5-9 Boulevard Maurice Bourdet, Office 2-53, 13205 Marseille Cedex 1, France. Email: helene.le-forner@univ-amu.fr. Tel: +33 6 78 46 70 79. ORCID Number: 0000-0003-0261-9889. This project has received funding from the "Investissements d'Avenir" French Government program managed by the French National Research Agency (reference: ANR-17-EURE-0020) and from the Excellence Initiative of Aix-Marseille University–A*MIDEX. I also acknowledge support from the French National Research Agency and NORFACE consortium through the Dynamic of Inequality across the Life Course (DIAL) programme (Grants number 462-16-020 / ANR-17-DIAL-0002). I am grateful to Hélène Couprie, Hippolyte d'Albis, Andrea Ichino, Markus Jäntti, Arnaud Lefranc, Eva Raiber, Lorenzo Rotunno, Avner Seror, Elena Stancanelli, Bertrand Verheyden, and François-Charles Wolff for helpful discussions. I also thank participants at the Aarhus University seminars, the UCLouvain seminars, the GUODLCCI (DIAL) workshop, the AMSE Ecolunch seminar, and the THEMA Gender and Family webinar, in particular Renaud Bourlès, Rozen Hotte, Stefania Marcassa, and Roberta Ziparo.

1 Introduction

This paper aims to improve our understanding of the formation of children's cognitive and socio-emotional skills, by allowing parental time to be multi-dimensional. Current literature has focused on maternal time or has considered parental time as a monolithic block, so far neglecting heterogeneity across the effects of parents' time investments. I estimate the production function of child development distinguishing the effect of time spent with the mother only, the father only, and both parents together. The question of heterogeneity across parental time is of particular interest, given the recent changes that have overturned the breakdown of parental time (Bianchi 2011). OECD (Organisation for Economic Co-operation and Development) countries have seen a dramatic increase in women's employment, rising from 40% in 1960 to 60% today. This may have translated into a substitution of maternal time by paternal time (Hsin & Felfe 2014). Conversely, divorce rates have also increased, leading to an increase in the proportion of children living in single-parent families. Those children spend on average less time with their non-custodial parent, generally the father, and more time with their custodial parent, who is generally the mother (Le Forner 2020b).

In the last few decades, a number of studies have shown that both cognitive and socio-emotional skills are strong predictors of later life outcomes.[1] Researchers have therefore investigated the potential determinants of these skills during childhood and point out that children's cognitive and socio-emotional skills are strongly influenced by their family background.[2] Given these large effects of family background, the growing interest in interactions between parents and their children suggests that parents' time investments could be even more productive than material investments (expenditures), especially in early childhood.[3] The literature has used indirect measures of time investments, such as childcare

[1] This includes Carneiro et al. (2003); Cawley et al. (2001); Cobb-Clark et al. (2019); Conti et al. (2010); Cunha & Heckman (2007); Flèche et al. (2019); Heckman et al. (2006); Layard et al. (2014); Lindqvist & Vestman (2011); Lundborg et al. (2014).

[2] See for example Aslund & Grönqvist (2010); Black et al. (2010, 2018); Briole et al. (2020); Carneiro et al. (2013); Dahl & Lochner (2017); Ermisch & Francesconi (2001); Fletcher & Wolfe (2016); Francesconi et al. (2010); Le Forner (2020a); Macmillan & Tominey (2019); Silles (2010).

[3] See for example Cunha & Heckman (2008); Cunha et al. (2010); Del Boca et al. (2014). See also Caucutt et al. (2020) for an estimation of the elasticity of substitution between mother's time and goods, along with determinants of the relative productivity between these two inputs.

reforms, preschool reforms, or maternal employment,[4] as well as direct measures of interactions through the time parents spend with their child (Attanasio, Cattan, et al. 2020; Del Boca et al. 2014, 2017; Del Bono et al. 2016; Fiorini & Keane 2014) or their parenting style, including the authoritarian behavior of a parent or the affection they show the child (Cobb-Clark et al. 2019; Doepke et al. 2019; Doepke & Zilibotti 2017; Fiorini & Keane 2014; Kim et al. 2018).

However, little is known about the potentially different effects of time spent with the mother, with the father or with both parents on children's development, despite evidence in the psychological literature of differences across the father's and mother's role in child development. Mothers tend to adopt the role of secure base, while fathers tend to adopt the role of the challenging companion (Craig 2006; Grossmann et al. 2002). Moreover, since mothers spend on average more time with their children than fathers, we would also expect that in the presence of a non-linear effect of parental time, the effect of time spent with the father should differ from that with the mother (Fort et al. 2020). Time spent with both parents together may also have a different effect from time spent with only one of them, which may increase the quality of relationships within the family (Cox & Paley 2003; Deal et al. 1999), and parents may adopt different behaviors toward the child when they are together (see Section 2 for further details).

The present paper makes several important contributions to the existing literature. First, I provide robust estimates of the distinct impacts of mother-only, father-only, and joint parental time investments on children's development, and test whether they significantly differ. Second, I explore whether the effects of mother's parenting style differ from the effects of father's. Third, I show how these effects are heterogeneous across parents' education levels, and child gender. Fourth, to properly compare the effects of maternal and paternal inputs—which differ significantly in their magnitude—I account for non-linear and complementarity effects. Such non-linear effects can emerge from the fact that the productivity of parental time may increase as trust is being built with the child, or as the parent learns by

[4]See for example Agostinelli & Sorrenti (2018); Bernal (2008); Cornelissen et al. (2018); Fort et al. (2020); Haaland et al. (2013); Nicoletti et al. (2020).

doing. Conversely, parental time may decrease because of fatigue or by frictions in the case of learning difficulties.

To the best of my knowledge, two papers are close to my analysis. Del Boca et al. (2017) considers both time spent with the mother and time spent with the father in estimating the effect of parental time on children's cognitive skills, but they focus on cognitive skills and ignore time spent with both parents together. Hence, their definition of time spent with the father partly reflects time spent with both parents together.[5] Cano et al. (2019) considers the multi-dimensional nature of parental time, but they focus on verbal skills and ignore the possibility of feedback effects (Andrabi et al. 2011; Del Bono et al. 2016; Nicoletti & Tonei 2020) – e.g. parents may adapt their investment to variation in their children's skills.

To investigate the potential heterogeneity across the effects of parental time on children's development, I exploit the rich information provided in the Longitudinal Study of Australian Children (LSAC). Since 2004, it has followed children born between March 1999 and February 2000. It collects time-use diaries for very young children, along with measures for both cognitive and socio-emotional skills, and a rich set of information on parental inputs and other socio-demographic controls. The main identification challenge is to distinguish a simple correlation between inputs and outcomes from a causal impact. According to Fiorini & Keane (2014), endogeneity has three sources: 1) omitted variables such as unobserved child ability; 2) reverse causality, – e.g., spending more time reading may foster a child's reading test score, but higher abilities (or a higher learning speed) in reading may also lead to a greater interest in reading; and 3) measurement errors in outcomes and amount of time spent on the activity. To tackle these issues, I consider three strategies commonly adopted in the literature: the fixed-effect model, the value-added model, and the cumulative value-added (CVA) model (Del Bono et al. 2016; Fiorini & Keane 2014; Todd & Wolpin 2003, 2007). I also use a generalized method of moments (GMM) framework to account for heterogeneity in children's learning speed and the response of parents' investments

[5] At ages 4–5 years, the time a child spends with the father only represents only 20% of the time the child spends with *at least* the father (see Table 3).

to improvement in their children's skills (feedback effects) (Andrabi et al. 2011; Del Bono et al. 2016). For each model, I summarize the assumptions under which the estimates identify the key parameters of the production functions for children's skills.

My estimation results reveal that there is heterogeneity across the effects of parents' investments. For verbal skills and socio-emotional skills, time spent on educational activities with the father has a smaller effect than time spent with the mother only or both parents together, and differences are statistically significant using the GMM model. While the estimations for cognitive skills do not suggest that the difference between the effects of the father's and mother's parenting style is statistically different from zero, the results indicate that children's socio-emotional skills respond more strongly to the mother's parenting style than to the father's.

Next, I investigate whether this arises from a non-linearity of the effect. The results suggest that the smaller effect found for time spent with fathers on children's socio-emotional skills, relative to mothers or both parents together, is partly driven by fathers who spend less than 30 minutes a day with their child. This indicates that parental time becomes more productive for children's socio-emotional skills after a certain amount of time spent with the child. The results do not suggest any complementarity across parental time inputs. The findings are robust to allow for complementarity across skills, to the inclusion of omitted inputs such as material inputs, school inputs, or child endowment.

I further look at whether these effects differ across sub-groups. I find heterogeneity across gender, but the results do not suggest any own-gender effect. I find little difference in the effects across the level of parents' education, except that time spent with both parents together has a more positive effect on children's verbal skills if at least one parent has an academic degree than if no parent has a degree.

The rest of the paper is organized as follows. Section 2 discusses why we would expect differences across the effects of parents' investments. Section 3 presents the data and some descriptive statistics. The estimation procedure is outlined in Section 4. Section 5 presents the main results. Section 6 provides further evidence. The heterogeneity analysis is provided in Section 7. Section 8 concludes.

2 Background

2.1 Paternal Versus Maternal Time

A society's gender norms may shape the behavior of men and women differently and value different characteristics for each gender. Because of gender socialization, we would expect that men and women may adopt different roles in their children's education. Extensions of the attachment theory (Ainsworth et al. 1978; Bowlby 1980) show that mothers and fathers have unique influences on their children's development that emerge at different stages of its development (see Palm 2014, for a review of the evolution of the father's place in the literature). Mothers tend to adopt the role of secure base and a source of comfort, while fathers tend to act as a stimulating and challenging play partner (Grossmann et al. 2002). When children are distressed, for example in the presence of a stranger, they turn to the mother. However, in distress-free situations, children tend to turn to the father (Lamb 1981). In most cultures, fathers are perceived to challenge children's competencies for adaptation to new elements, adopting the role of the trusted companion; they are reported to be more vigorous when they play. Both parents' could (and often do) serve both roles. The way parents balance their security and exploration roles is probably determined by gender norms and culture (Doepke & Zilibotti 2017; Grossmann et al. 2002). The contribution of time spent with each parent to children's skills might differ depending on the role each parent adopts in the socialization process of their children.

Even if parents adopt the same role in their children's education, we would expect the effect of time spent with each parent to differ if there exists a non-linearity in the effect of time spent with a particular parent. Because of gender norms, or discrimination against women in the labor market, women and men tend to specialize in domestic work and labor market work, respectively. Mothers spend on average 40 minutes per day on educational activities alone with the child when they are 4–5 years old, while fathers spend on average less than 10 minutes a day alone with their child (see Table 3). If there is a non-linearity in the effect, such differences might imply differences in the effect of time spent with the

mother relative to that with the father on the child's development. The effect of time spent with at least one parent may not be linear for at least four reasons.

First, Fort et al. (2020) suggest that a child learns faster when interacting with a trusted adult. A child must repeat an activity many times to assess its general or particular validity (Csibra & Gergely 2009, 2011), but an adult can, instead, inform the child about the general or particular validity of the activity. However, the child would be willing to believe this adult only if this adult can be trusted, and then the child would save time and be able to move on to other experiences. Trusting an adult is likely to depend on the amount of time spent with this adult; in this case, we expect that the child needs to spend a certain amount of time with the adult to be able to learn faster with this adult. Second, the more time an adult spends with children, the better the adult's knowledge of childcare. This is a common learning by doing effect. Third, the more a parent interacts with their child, the better the parent's knowledge of the child, and hence the better skilled they become in stimulating this particular child. In principal-agent models, the parent wants to maximize the child's effort, but they do not observe the child's ability or effort. As the interaction is repeated over time, parents learn about the child's ability, and it thus becomes easier for them to induce the desired effort in the child via better-targeted stimuli (Akabayashi 2006; Heckman & Mosso 2014; Seror 2019). Fourth, conversely, we would expect a concave relation if there exists a fatigue effect: after a certain amount of time spent with the child, we would anticipate that the parent might become too tired to be able to continue stimulating activities with the child. Studies exploring the effects of maternity leave reforms on children's outcomes suggest concavity in these effects, finding little impact on children's outcomes when analyzing extensions of already generous maternity leave benefits (Rasmussen 2010), but strong effects when maternity leave entitlements were increased from a very low level (Carneiro et al. 2015). As these effects are driven by maternal time investments, we would therefore expect a concave relation between such investments and children's outcomes.

2.2 Time Spent with Both Parents Together

We would expect that time spent with both parents together may have different effects on children's skills from time spent with only one parent for at least four reasons (Kalil et al. 2014). First, it may enhance the system of relationships throughout the family (Cox & Paley 2003; Deal et al. 1999). Second, parents may engage in different activities when they are together rather than alone with the child. For example, parents may be more willing to go to a park with the child when the other parent is involved. Third, parents may change their behavior in the presence of the other parent. For instance, they may use different vocabulary in the presence of another adult than when they are alone with the child. Fourth, it provides a unique opportunity for the child to learn how adults interact with each other and how they solve conflicts (Bandura & Walters 1977).

3 Data and Descriptive Statistics

3.1 The LSAC and Estimation Sample

[**Table** 1 about here.]

The LSAC began in 2004. It follows two cohorts of children, the "K cohort" born between March 1999 and February 2000 and "B cohort" of children born between March 2003 and February 2004. Both cohorts have been surveyed seven times, in 2004, 2006, 2008, 2010, 2014, 2016, and 2018. Table 1 summarizes the age at each wave and for each cohort.

The survey collects a rich set of information about children's and their parents' characteristics, along with measures of child development. Socio-emotional skills are measured through the Strength and Difficulty Questionnaire (SDQ), completed by the primary care-giver and by teachers for all waves. Children were administered cognitive skills tests: the Peabody Picture Vocabulary Test (PPVT) at ages 4 to 9 years and the Matrix Reasoning Test (MRT) at ages 6 to 11 years. The primary-care giver completes a time-use diary for both cohorts from waves 1 to 3, and children complete it themselves from

age 10 years onward. Table 1 summarizes the type of information that is collected for both cohorts in each wave.

To the best of my knowledge, the only other panel dataset combining time-use diaries and children's skills is the Panel Study of Income Dynamics–Child Development Supplement (PSID-CDS). However, the PSID-CDS is based on a smaller and older sample. The children in it were born between 1987 and 1997 and followed in 1997, 2002, and 2007. Since time spent with parents is likely to more deeply affect children in their childhood than in adolescence (Del Boca et al. 2017; Del Bono et al. 2016), the LSAC seems to be a more appropriate dataset to study the effect of time spent with parents on children's skills. My estimation sample therefore focuses on children before the age of 12 years. Since we do not have time-use diaries for this age window of interest for the B cohort, the analysis focuses on children from the K cohort.

Additionally, the estimation sample includes children who are observed at least one day in the week or in the weekend.[6] I keep only complete time-use diaries, following Fiorini & Keane (2014), and slots between 10 p.m. and 6 a.m. that are coded as missing or "not sure what the child is doing" are recoded as sleeping time. I also exclude outliers based on time spent sleeping or at school. Children who are declared as spending less than 6 hours on sleep and the top 1000-quantile are excluded. Children who go to school for less than 3 hours or more than 13 hours on a weekday are excluded. The sample is restricted to the observations of control variables. To avoid losing too much observation in single-parent families, I also include observations for whom we do not observe the father's age, his education, or his parenting style, and include a set of dummies controlling whether these variables are missing. I have 3022 children in the first wave, 2775 in the second wave, 2512 in the third wave, and 2457 in the fourth wave. My sample is similar to the initial sample. Second-borns are slightly less represented in my sample. Not surprisingly, children for whom the main language spoken at home is English are also more represented. I do not observe other sources of selection.[7]

[6] I also estimate for the first three waves a model including only those children who are observed two days a week, and this does not affect the results.

[7] To test whether my sample is selective relative to the initial sample, I estimate a logit regression with a dummy that

3.2 Measuring Child Development

3.2.1 Cognitive Skills

Cognitive skills measure the ability to perform in mental activities. I consider two types of cognitive skills: verbal and logical.

Verbal skills are measured through the PPVT. The child is asked to point to the picture that best fits the meaning of the verbalized word.[8] The test enables us to measure the child's knowledge of the meaning of spoken words and their receptive vocabulary. This measure can be assumed to be age-invariant as defined by Agostinelli & Wiswall (2016).[9] The PPVT is administered for children aged 4–5 years, 6–7 years, and 8–9 years.

Logical abilities are measured through the MRT, a test from the Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV) (Wechsler 2004).[10] It presents a child with an incomplete set of pictures (defined by geometric shapes) and asks them to select the picture that completes the set from five different options. The MRT is administered for children aged 6–7 years, 8–9 years, and 10–11 years. This measure can also be assumed to be age-invariant as defined by Agostinelli & Wiswall (2016).[11]

equals one if the individual is in my sample, or zero otherwise. Marginal effects are reported in Table A.1 in the Appendix.

[8] More precisely, the test consists of 40 items divided into a core set of 20 items, a basal set of 10 items for children who miss a minimum number of items on the core set, and a ceiling set of 10 items for children who correctly answer a minimum number of items on the core set. No child would take more than 30 items. This measure means that we avoid top and bottom coding issues, and hence it avoids truncated distribution of children's skills.

[9] A measure is age-invariant if two children at different ages would have the same expected level of measured skill if they have the same level of latent skill. Different versions of the PPVT containing different, although overlapping, sets of items of appropriate difficulty were used at ages 4–5, 6–7, and 8–9 years; therefore the scale can be assumed to be age-invariant (Agostinelli & Wiswall 2016; Attanasio, Meghir, & Nix 2020).

[10] The MRT comprises 35 items of increasing difficulty. Administration of the test should start at a point specific to a certain age. If a child incorrectly answers either of the first two items from the starting point, the interviewer asks the preceding items ("reversal items") in reverse sequence until the child correctly answers two consecutive items, and then goes back to the age-appropriate items and proceeds with the rest of the test ("reverse administration").

[11] Due to technical difficulties, reverse administration was not implemented in the LSAC MRT instrument for wave 4. Only 195 children (5%) from the K cohort did not answer either of the first two items from the starting point at wave 4, and in this case, all reversal items were assigned a raw score of 1, regardless of whether the first two administered items were answered correctly or not. Of them, 179 answered correctly either all items or two consecutive items defined for their age at wave 3. Therefore, I do not expect this measurement error to be large. I test the model controlling for a dummy indicating whether the child would have needed reverse administration in wave 4, and it does not change the results (results available upon request). More information is available at https://growingupinaustralia.gov.au/sites/default/files/data-issues.pdf.

3.2.2 Socio-Emotional Skills

Socio-emotional skills are measured through the SDQ, which is a behavioral-screening questionnaire for children aged about 4 to 17 years and consists of 25 questions. The LSAC provides the answers of the primary care-giver and the teacher. The answers to these questions can be used to produce five sub-scales (each consisting of five items) relating to emotional health, behavioral problems, hyperactivity issues, peer problems, and pro-social behavior. Three broader sub-scales are sufficient to capture heterogeneity among children: emotional skills, behavioral skills, and pro-social skills (Goodman et al. 2010). Emotional skills (or *internalizing* SDQ) are the sum of the scores of emotional and peer sub-scales; behavioral skills (or *externalizing* SDQ) are the sum of the scores of behavioral and hyperactivity issues. Pro-social behaviors can be used to measure social skills. See Figure A.1 for a detailed description of the questionnaire and of each sub-scale. Both measures of emotional and behavioral skills go from 0 to 20, and the measure of social skills goes from 0 to 10. I will additionally consider the total SDQ, which is the sum of behavioral and emotional skills.[12] Since recent studies have shown that socio-emotional skills based on the SDQ reported by the mother are the most important predictors of later life outcomes (Clark et al. 2019; Clark & Lepinteur 2019; Layard et al. 2014), I focus on socio-emotional skills reported by the primary care-giver, generally the mother. Moreover, I would lose a lot of observations by looking at socio-emotional skills measured by the teacher, raising concerns of selection regarding the remaining observations (see Cornelissen & Dustmann 2018). Scales have been reversed when relevant so that higher values indicate better outcomes. These measures of socio-emotional skills are based on the same questionnaire, and we can therefore assume that they are age-invariant as defined by Agostinelli & Wiswall (2016) (see above).

Table 2 reports descriptive statistics on children's outcomes in my sample, by wave. All outcomes increase with age, except socio-emotional skills, which are more stable across waves 2 to 4.

[12] Results for emotional and behavioral skills are similar; therefore, I report only the estimated coefficients for the total SDQ.

[**Table** 2 about here.]

3.3 Measuring Time Investments

Information about children's activities is obtained from time-use diaries that collect details of the activities of the studied child over a day. Compared with stylized measures, time-use diaries are less subject to recall errors or report biases due to overestimation of socially valuable activities (using stylized measures, the total amount of time often exceeds the 24 hours daily basis). However, this comes at the cost of day-to-day variation bias. Since completing a time-use diary takes a relatively large amount of time (18 minutes on average, according to Juster et al. (2003)), the dataset provides diaries for only one or two days, and therefore, except for routine activities, time-use information is subject to classical measurement errors due to transitory shocks. For example, if the family planned to go to Disneyland that day, it is unlikely to be representative of the child's daily time use. Fortunately, the data includes information on whether or not the entry was completed on an ordinary day. Controlling for that, results are similar.

For waves 1 to 3, the primary care-giver completes a light time-use diary. This contains a list of pre-coded activities from which the primary care-giver can choose when recording children's activity patterns in blocks of 15 minutes throughout the day.[13] In addition to recording activities, respondents report the child's location, mode of travel, if relevant, and other people who are present during the activity (co-present), also in 15-minute blocks of time.[14] From the age of 10 years, children themselves complete a diary by computer for one day.[15] I follow the typology of time investments given by Fiorini & Keane (2014) and use seven categories of activities:

1. Sleeping

[13] This type of diary is regarded as an effective way to collect information about daily activities (Lader et al. 2006).

[14] An example of a time-use diary can be found at https://growingupinaustralia.gov.au/sites/default/files/w5-w1-12-tudk.pdf.

[15] Changes in how time-use diaries are collected might make them unsuitable for comparisons. I use several models, and several samples, including the time-use diaries completed by children themselves on a computer, do not seem to be an issue.

2. Daycare or school

3. Educational activities

4. General care

5. Social activities

6. Media

7. Unknown

Note that the survey focuses on the child's primary activity. Following Fiorini & Keane (2014), if two activities are recorded at the same time, I follow the order of the typology above to define the main activity. For example, if the child is declared to be watching television (media) while they are eating (general care), this would be coded as general care. Figures A.2 and A.3 in the Appendix show the proportions of time spent on recorded activities according to each category of the typology, for waves 1 to 3 and wave 4, respectively.[16]

Table 3 shows the summary statistics for time spent on each activity for a day by age. Time spent sleeping decreases with age, as does time spent with at least one parent on educational activities and general care. In contrast, time spent on media and at school increases with age. Table A.2 in the Appendix reports the mean and the standard deviation for each activity by type of day (weekday/weekend). Time spent at school is close to zero on weekends. Children spend on average more time on social activities, educational activities, and general care with their parents on weekends. The variation for these activities is larger on weekends.

For educational activities and general care, time is additionally distinguished between that spent without any adult, with at least one parent, and with other adults. To look at the heterogeneity of parental time, time spent with at least one parent is broken down into time spent with the mother only, with the

[16] In wave 4, the time-use diary does not use pre-coded activities, and therefore the typology of activities is different.

father only, and with both parents together.[17] From Table 3, we can see that a large amount of time spent with at least one parent on educational activities or general care is time spent with at least the mother. For educational activities, time spent with the mother only is slightly larger than time spent with both parents together. The amount of time spent with the father only on educational activities and on general care is much smaller than time spent with the mother only. Figures A.4 and A.5 in the Appendix report the breakdown of educational activities and general care into a broader typology, as it is recorded in the diary, for waves 1 to 3 and wave 4, respectively. The amount of time spent on each activity as recorded in the diary is the same across parental time for educational activities and for general care. Mealtime seems to be more represented in time spent on general care with both parents together than with only one parent.

[**Table** 3 about here.]

3.4 Indicators of Parenting Style

Parents' time investments may be highly correlated with their parenting style, which may in turn directly affect children's development (Baumrind 1966; Cobb-Clark et al. 2019; Doepke et al. 2019; Doepke & Zilibotti 2017). The LSAC also includes questions to both parents describing their behavior toward their child. Following Fiorini & Keane (2014), I use a factor analysis to identify broader indicators of parenting style. Rotated loading coefficients are reported in Table A.4 for both parents. The first factor can be interpreted as parent's warmth, and the second factor as parent's authoritarian behavior. Since we are interested in the heterogeneity of parental time, we include parenting style for both parents.[18]

[17] Time spent with the father/mother only is time spent with at least the father/mother, possibly in the presence of other adults, but the other parent is absent.

[18] Results are qualitatively similar when not controlling for those indicators. Coefficients are more precisely estimated when parenting style is controlled for.

3.5 Demographic Variables

The controls include children's characteristics such as sex, age, birth order, and a dummy indicating whether the child is Indigenous, along with family characteristics such as the number of siblings, parents' ages, their education, and a dummy indicating whether the child lives with both parents and the main language at home is English. Parents' education level includes 11 categories, from year 8 or below to postgraduate degree. Table 4 shows the summary statistics for children's and their family's characteristics for my estimation sample, by wave. The sample is balanced according to the child's sex. The proportion of children living with both parents decreases with age, from around 85% when the child is 4–5 years old to 69% when the child is 10–11 years old. The number of siblings also increases with age, but does not go above 1.61 in wave 4. I also report parents' annual income in thousands of Australian dollars.[19] On average, fathers earn more than mothers. Few of the children are Indigenous, and 90% of them speak English as their main language at home.

I also control for dummies indicating the wave and the type of day (weekday/weekend).

[**Table** 4 about here.]

4 Estimation

The aim of this analysis is to assess potential heterogeneity across the effects of parent' time investments. I follow the approach developed by Todd & Wolpin (2003, 2007) and applied by Del Boca et al. (2017); Del Bono et al. (2016); Fiorini & Keane (2014), and estimate the time input production function under alternative estimators relying on different assumptions. Below, I present each model and its assumptions. Table A.3 in the Appendix summarizes the discussion.[20]

[19] In the main model, parents' incomes are not controlled for, but they are controlled for in a robustness checks (see Section 6).

[20] For a longer discussion of these assumptions, see Todd & Wolpin (2007).

4.1 Ordinary Least-Squares Model

I first estimate an ordinary least-squares (OLS) model:

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \Sigma_1^{K-1} \gamma_1^k TI_{it}^k + \epsilon_{it} \qquad \text{(Eq . 1)}$$

where Y_{it} is the child's skill, TI_{it}^k are the time inputs, and γ_1^k measures the effect of a one-hour increase per day in time spent on activity k relative to the omitted time input; here, the omitted time input is sleeping. β_1 measures the effect of other inputs X_{it} defined in Section 3.5: child's sex, age, birth order, a dummy indicating whether the child is Indigenous, along with family characteristics such as number of siblings, parents' ages, their education, and a dummy indicating whether the child lives with both parents and the main language spoken at home is English. Dummies for waves and the type of day are also included.

The OLS model relies on strong assumptions. **i)** The measurement errors in the child's skills are uncorrelated with inputs and unobserved ability. The measurement errors in the child's time investments are also assumed to be uncorrelated with the child's skills. As mentioned in section 3.3, the latter could arise from recall errors or report bias. The use of time-use diaries reduces these measurement errors, but our measures are subject to transitory shocks.[21] Unfortunately, there are only two panel datasets in the world that provide time-use diaries along with children's skills, and no one provides more detailed information. Obviously, asking for more frequent surveys would decrease the number of respondents willing to be surveyed, which leads to greater attrition.[22] **ii)** The production function is non-age-varying. **iii)** Any omitted input is uncorrelated with included input. **iv)** Unobserved abilities are not correlated with time inputs. Reverse causality is an issue; spending more time reading may foster a child's verbal skills, but higher verbal skills may also lead to a greater interest in reading. Moreover,

[21] Using one day in the week and one day in the weekend may reduce this measurement error due to day-to-day variation. To estimate the CVA with instrumented variable (CVA-IV) and GMM models (see below) for logical abilities, I need wave 4, for which time-use diaries are available for only one day. To check whether this affects my results, I constrain the sample to individuals who we observe one day in the week and one day in the weekend, and it leads to similar results for other models. Using time-investments by week rather than by day leads also to similar results.

[22] This is the main reason why the LSAC decided to request time-use diaries for only one day from wave 4 onward.

some studies have highlighted that parents' investments respond to their children's skills (Bharadwaj et al. 2018; Grätz & Torche 2016; Nicoletti & Tonei 2020; Rosenzweig & Zhang 2009). **v)** Unobserved learning speed is not correlated with time inputs.

This model is tested on the whole sample and on the sample used to estimate the value-added model, so as to compare both models.

4.2 Value-Added Model

Second, I estimate a value-added model:

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \Sigma_1^{K-1} \gamma_1^k TI_{it}^k + \lambda Y_{it-1} + \epsilon_{it} \quad \text{(Eq . 2)}$$

where Y_{it} is the child's skill, Y_{it-1} is the child's skill at $t-1$, TI_{it}^k are the time inputs, and γ_1^k measures the impact of a one-hour increase per day in time spent on activity k relative to the omitted time input; here, the omitted time input is sleeping. β_1 measures the effect of other inputs X_{it}, defined above.

The value-added model deals with omitted-variable bias by controlling for past test scores. It captures learning persistence and is also a proxy for unobserved ability. Reverse causality would be a problem only if an increase in a test score triggered an increase in time spent on a particular activity, which cannot be excluded.[23]

In the value-added model, we assume **i, ii, and v**. Assumptions **iii** and **iv** of the OLS model are replaced by: **iii)** the effect of inputs (observed or not) declines with age at a constant rate λ; **iv)** as does the effect of unobserved abilities.

The model is estimated on children for whom we observe the skill at $t-1$.

4.3 Individual Fixed-Effect Model

Third, I estimate an individual fixed-effect model:

[23] I deal with this issue using a GMM model.

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \Sigma_1^{K-1} \gamma_1^k TI_{it}^k + \alpha_i + \epsilon_{it} \quad \text{(Eq . 3)}$$

As defined earlier, Y_{it} is the child's skill, TI_{it}^k are the time inputs, measured in hours by day, and α_i is the individual fixed effect.

In the fixed-effect model, we assume **i, ii, and v**; assumptions **iii** and **iv** are replaced by **iii)** the effect of inputs (observed or not) is constant with age; **iv)** as is the effect of unobserved abilities.

Assumption **iii** does not hold in the presence of critical and sensitive periods (Cunha & Heckman 2007, 2008; Cunha et al. 2010). In this case, the assumptions of the value-added model are more credible.

4.4 Cumulative Model

Fourth, I estimate a cumulative model. In OLS, it is assumed that current inputs are sufficient statistics for previous inputs, and this is relaxed by including the past time inputs.

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \Sigma_1^{K-1} \gamma_1^k TI_{it}^k + \Sigma_1^{K-1} \gamma_2^k TI_{it-1}^k + \epsilon_{it} \quad \text{(Eq . 4)}$$

where Y_{it} is the child's skill, TI_{it}^k are the time inputs, TI_{it-1}^k are the time inputs at $t-1$, and γ_1^k measures the impact of a one-hour increase per day in time spent on activity k relative to sleeping. γ_2^k measures the persistence of the impact of a one-hour increase per day in time spent on activity k on the child's skills two years afterward relative to sleeping. β_1 measures the effect of other inputs X_{it}.

This model relies on the same assumptions as the OLS model, but we relax assumption **ii**: the production function is allowed to vary with age.

The model is estimated on children for whom we observe the time inputs at $t-1$.

4.5 The CVA Model

Fifth, I estimate a CVA model.

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \Sigma_1^{K-1} \gamma_1^k TI_{it}^k + \Sigma_1^{K-1} \gamma_2^k TI_{it-1}^k + \lambda Y_{it-1} + \epsilon_{it} \quad \text{(Eq . 5)}$$

where Y_{it} is the child's skill, Y_{it-1} is the child's skill at $t-1$, TI_{it}^k are the time inputs, TI_{it-1}^k are the time inputs at $t-1$, and γ_1^k measures the impact of a one-hour increase per day in time spent on activity k relative to sleeping. γ_2^k measures the persistence of the impact of a one-hour increase per day in time spent on activity k on the child's skills two years afterward relative to sleeping. β_1 measures the effect of other inputs X_{it}.

A key assumption of the value-added model is that the lagged test score is a sufficient statistic for historical inputs, and the effect of those inputs should decrease at a constant rate λ (assumption **iii**); if this is true, the CVA model should give similar results to the value-added model (Todd & Wolpin 2003). The CVA model relies on the same assumptions as the value-added model, but we relax assumption **ii**—the production function is allowed to vary with age—as well as assumption **iii**.

The model is estimated on children for whom we observe the time inputs and their skill at $t-1$.

4.6 CVA-IV Model

Finally, in all value-added models, the measurement error bias attenuates the persistence coefficient $\hat{\lambda}$ and can therefore bias the input coefficients $\hat{\gamma}_1$ or $\hat{\gamma}_2$. The standard way to solve this issue is to instrument the one-period lagged outcome Y_{it-1} by the two-period lagged outcome Y_{it-2} (Andrabi et al. (2011); Arellano & Bond (1991); see also Del Bono et al. (2016) for an application in the same context).

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \Sigma_1^{K-1} \gamma_1^k TI_{it}^k + \Sigma_1^{K-1} \gamma_2^k TI_{it-1}^k + \lambda \hat{Y}_{it-1} + \epsilon_{it} \quad \text{(Eq . 6)}$$

with a first stage:

$$Y_{it-1} = \delta Y_{it-2} + u_{it}$$

As defined earlier, Y_{it} is the child's skill, Y_{it-1} is the child's skill at $t-1$, TI_{it}^k are the time inputs, and γ_1^k measures the impact of a one-hour increase per day in time spent on activity k relative to sleeping. β_1 measures the effect of other inputs X_{it}. Y_{it-2} is the child's skill at $t-2$.

The model is estimated on children for whom we observe the time inputs at $t-2$.

4.7 GMM Model

In the previous models, we documented the effect of current and past parental time investments on child development. The value-added and the CVA models difference out the child's unobserved ability that might be correlated with the time input ("the better I am at reading, the more I spend time on reading"), but they do not difference out the heterogeneity in the learning speed ("the greater the increase in my reading skills, the greater the increase in my time spent on reading"). Parents and children may adapt their time investments to the child's improvement in the skill. This is what Del Bono et al. (2016) refer to as feedback effects. To account for such effects, I use an approach based on the "level and difference" GMM. This method was introduced by Arellano & Bover (1995) and extended by Blundell & Bond (1998). Andrabi et al. (2011) applied it to study the effect of private schooling on children's achievements. Del Bono et al. (2016) use it in a similar context, estimating the impact of maternal time on child development. This GMM framework estimates a system of two simultaneous equations (Eq . 7 and Eq . 8):

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \Sigma_{k=2}^{K} \gamma_1^k TI_{it}^k + \lambda Y_{it-1} + \epsilon_{it} \qquad \text{(Eq . 7)}$$

given by the value-added model, where TI_{it}^k are the time inputs, γ_1^k measures the impact of a one-hour increase per day in time spent on activity k relative to sleeping, and β_1 measures the effect of other

inputs X_{it}. The second component of the system is given by the following equation:

$$\Delta Y_{it} = \beta_1 \Delta X_{it} + \Sigma_{k=2}^{K} \gamma_1^k \Delta T I_{it}^k + \lambda \Delta Y_{it-1} + \Delta \epsilon_{it} \quad \text{(Eq . 8)}$$

where ΔZ_{it} denotes the first difference in Z_{it}. Following Del Bono et al. (2016), my instruments are past inputs for Eq . 7, and Y_{t-2} along with past inputs for Eq . 8.

This model relies on the same assumptions as the value-added model, but relaxes assumption **v**; unobserved learning speed is allowed to be correlated with time inputs. As this model requires weaker assumptions than the previous ones, it is our preferred model.

To look at whether parental time has a heterogeneous effect on child development, I break down time spent with parents on educational activities and general care into time spent with mother only, father only, and both parents together, and then compare each coefficient using a t-test.

It might be argued that socio-emotional skills measured by the primary care-giver may be subject to measurement errors due to the primary care-giver's subjectivity. Except for the OLS and the cumulative models, all of the models have the advantage of dealing with this measurement error if it is fixed over time. It is captured by Y_{it-1} in the value-added models and by α_i in the fixed-effect model. I will additionally consider socio-emotional skills, measured by the teachers (see Section 6.3).

Note that these estimates hold "at the margin", since the data varies in a limited range. We would not want to extrapolate the results beyond the range of variation in the data.

5 Estimation Results

Tables 5 to 8 present the estimation results for cognitive and socio-emotional skills for all of the models. Because time inputs measured as time spent on activities are collinear, I take time spent at sleeping as the reference category. The effect of the other inputs should be interpreted as relative to that of sleeping.

As mentioned in section 4, models include controls such as child's sex, age, birth order, whether they are Indigenous, number of siblings, parents' ages, parents' level of education, a dummy indicating whether the child lives with both parents, a dummy indicating whether the main language spoken at home is English, and indicators controlling for parenting style. Models also include dummies for each wave and for the type of day (weekday or weekend).[24]

The tables present the estimated coefficients for each parental time considered (mother only/father only/both parents together) and for both parents' parenting style. To address the question of heterogeneity across the effects of parents' investments, I also test whether the differences between the effect of each parental time are statistically different from zero. I do the same for parenting style. The p-values are reported at the bottom of each table for each outcome.

Column 1 shows the estimation results for the OLS model. Column 2 shows the estimation results for the OLS model, but including only those observations where we observe the skill in the previous wave (hence excluding wave 1), which gives a comparative sample for the value-added model, estimations of which are shown in column 3. The estimations using the individual fixed-effect model are shown in column 4. Columns 5 and 6 show the estimations for the cumulative model and the CVA model, respectively. To give a comparable sample for the CVA-IV model, estimations for the CVA model including only those children for whom we observe the skill at $t-2$ are shown in column 7. Correcting for attenuation bias due to measurement error in the children's skill, I estimate a CVA model, instrumenting the outcome at $t-1$ by the outcome at $t-2$ (CVA-IV); the results are shown in column 8. Finally, the estimations

[24] I also estimate the model using a representative day: a weighted average of weekdays and weekends (five times the duration spent during a weekday plus two times the duration spent during a weekend day, divided by seven). Using the same sample for both models, the results are similar; they are more precisely estimated in the model based on time investments measured for each type of day. Only a few differences are found: using measures of time investments for a representative day, time spent with fathers on educational activities seems to have a negative effect on logical abilities, but a positive effect on verbal skills. Besides, estimating the model looking at heterogeneity in the effect of parents' investment according to the type of day, few differences appear. Time spent on educational activities with the father or both parents together is less productive for cognitive skills when it takes place on the weekend, while it is more productive for social skills. Time spent on general care with the father also seems to be more productive for children's social skills when it takes place on the weekend. Using time investments by type of day rather than a representative day allows me to use diaries completed for only one day instead of two. Therefore, I am able to use wave 4, which enables the estimation of a GMM model for logical abilities.

of the GMM model are shown in column 9, addressing feedback effects.[25]

The preferred model is the GMM since it accounts for feedback effects, which enables us to interpret the estimates in a more causal way. I first discuss the effect of time investments on cognitive skills. Next, I consider the effect of time investments on socio-emotional skills.

5.1 Cognitive Skills

Two measures of cognitive skills are considered: verbal skills, measured as the PPVT score; and logical abilities, measured as the MRT score.

5.1.1 Verbal Skills (PPVT Score)

Table 5 shows the estimated coefficients for the verbal skills, measured as the PPVT score at ages 4–5, 6–7, and 8–9 years. It is important to note that in most of the models considered, time spent on educational activities with a parent or no adults is the most productive time input.

Using OLS, we can see that verbal skills are positively correlated with time spent at school, on educational activities with parents or with no adults, on social activities, and on media (Table 5, column 1). A one-hour increase per day in time spent on educational activities with the mother or the father is associated with a 0.05 standard deviation increase in verbal skills relative to one hour spent on sleeping. These positive correlations remain when the sample is constrained to children aged 6–7 and 8–9 years (column 2). The correlation with the time spent on educational activities with the father is no longer statistically different from zero. Using a value-added model, these correlations are lower, suggesting that the positive correlation found in the OLS model is partly explained by the fact that children who have higher verbal skills spend more time on social activities, media, and educational activities (reverse causality). The positive coefficients on educational activities remain positive and are statistically different from zero (except for time spent with the father only). Using an individual fixed-effect model, no effect of time investments is statistically different from zero. This is similar to the findings of Fiorini

[25] See Section 4 for more details on the assumptions of each model.

& Keane (2014). In cumulative models, we control for time inputs in the previous wave, and the effect of time investments is allowed to differ across age (columns 6 to 8). The results are similar. Previous estimations do not only reflect the effect of previous time investments.[26]

In all value-added models, it is well known that measurement error attenuates the coefficient on lagged achievement and can bias the input coefficients. A standard instrument in this context is the two-period lagged outcome.[27] Hence, the sample includes only those children for whom we observe the two-lagged outcome. In this sample, children are 8–9 years old. For comparison, we estimate the CVA model on this sample, and the results are shown in column 7 of Table 5. The effect of time spent with at least one parent is much smaller. This suggests that the effect found in column 6 is driven by children who are 6–7 years old. This is similar to estimates found in previous studies. Del Bono et al. (2016) also found a small effect or even a negative effect of time spent with the mother on educational or recreational activities at age 7 years on children's verbal skills, but the effect of maternal time at an earlier age is persistent. Indeed, time spent on educational activities at age 3 or 5 years still has a persistent effect on children's verbal skills at age 7 years. Where the measurement error is corrected by instrumenting the one-period lagged outcome by the two-period lagged outcome, the persistence coefficient increases, consistent with the existence of an attenuation bias, but the input coefficients remain similar, suggesting that the attenuation bias does not bias the input coefficients in our model (Table 5, column 8).

Accounting for the existence of feedback effects by using a method based on a "levels and differences" GMM framework[28] (our preferred model), we observe a reduction in the persistence coefficient $\hat{\lambda}$ and a large increase in the input coefficients $\hat{\gamma}_1^k$ (Table 5, column 9). This suggests a strong response of parents to the child's learning speed (feedback effects). If children's verbal skills increase, they seem to spend less time on educational activities (with a parent or no adults). This is consistent with Nicoletti & Tonei (2020), who found that parents' time investments increase (decrease) after a decrease (increase) in the

[26]The cumulative model should be compared to the OLS model, and the CVA model should be compared to the value-added model. Both the value-added and CVA models include only those children who are 6–7 or 8–9 years old.

[27]See Andrabi et al. (2011); Arellano & Bover (1995) for a more detailed discussion and Del Bono et al. (2016) for an application in the same context.

[28]See Del Bono et al. (2016) for an application in the same context

child's cognitive skills. Hence, the presence of feedback effects attenuates the effects of time investments in models that do not account for such effects. A one-hour increase per day in time spent on educational activities with the mother alone leads to a 0.13 standard deviation increase in verbal skills, relative to one hour spent on sleeping. This is equivalent to the effect of having a mother with a postgraduate degree, as opposed to having a mother with a high school degree or to be six months older.[29]

The results suggest that time spent with both parents together and time spent with the mother only are more productive than time spent with the father only. This is true for all models except the two models estimated on an older sample (Table 5, columns 7 and 8), which suggests that the heterogeneity in parental time may depend on children's age. Looking at the GMM model, the difference between the effects of time spent on educational activities with the father only, with the mother only, and with both parents together is statistically different from zero, at the 12% level and 5% level, respectively (see bottom of Table 5).[30] This does not seem to come from differences in the type of activity in which the child is involved with the parent (see Figure A.4).[31]

Looking at time spent on general care, using a GMM model, the effect of time spent with both parents together on verbal skills is smaller than with one parent only, and the differences are statistically significant using the GMM model. Again, differences in the type of activity in which the child is involved with the parent do not seem to drive the results (see Figure A.4).

I also estimate the effect of both parents' parenting style. None of the parents' warmth indicators seem to have an effect on children's verbal skills. However, parents' authoritarian behavior, especially the mother's, seems to have a positive effect on children's verbal skills, around 3% of a standard deviation. The results do not suggest a difference between the effects of father's and mother's authoritarian

[29] A natural question is whether children's trajectories will become parallel. If $\hat{\gamma}$ is the input effect, and $\hat{\lambda}$ the persistence effect, children's trajectories will become parallel when the achievement gap reaches $\frac{\hat{\gamma}}{1-\hat{\lambda}}$.

[30] This heterogeneity across the effects of parents' investments seems to be driven by differences in the effects at weekends.

[31] My results differ from those of Cano et al. (2019), which seem to be driven by differences in the sample criteria. Cano et al. (2019) kept children in the sample who were declared as sleeping very little—20 hours 45 minutes a week, that is, less than 3 hours a day on average. This may reflect measurement errors in the time-use diaries, following Fiorini & Keane (2014); I chose to drop these outliers from my estimation sample.

behavior.

[**Table** 5 about here.]

5.1.2 Logical Abilities (MRT Score)

Table 6 shows the estimated coefficients for the logical abilities, measured as the MRT score at ages 6–7, 8–9, and 10–11 years. The sample is therefore older than for verbal skills. However, the results are similar to those for verbal skills. In most of the models considered, time spent on educational activities with a parent or no adults is the most productive.

Like verbal skills, logical abilities are positively correlated with time spent on educational activities with parents or with no adults, on social activities, and on media (Table 6, column 1). This is also true when the sample is constrained to children aged 8–9 and 10–11 years (column 2). However, the correlation between time spent on educational activities with the father only and logical abilities is negative. Turning to the value-added models, the coefficients are smaller, suggesting that correlations from the OLS are partly explained by the fact that children who have higher logical abilities spend more time on social activities, media, and educational activities (column 3). The coefficients on educational activities with no adults, the mother only, or both parents together remain positive, but the effect of the time spent on educational activities with the mother is no longer statistically different from zero. The individual fixed-effect model estimates are not statistically significant, except for time spent on educational activities with both parents together (only at the 10% level). Similarly, Fiorini & Keane (2014) found no strong effect of allocation of time on logical abilities when they used an individual fixed-effect model. As mentioned in section 4, the assumptions on which this model relies may not be credible in the presence of critical and sensitive periods. The results are not affected by the inclusion of one-period lagged time inputs, suggesting that there is no heterogeneity in the effect of time inputs across age for this age window (8–11 years) (Table 6, columns 5 and 6). However, the effect of time spent on educational activities with parents on children's logical abilities becomes negative when the sample includes children only aged 10–11 years (column 7). Conversely, time spent on educational activities

with no adult has a positive effect on logical abilities. This suggests that later parental investment (at ages 10–11 years) has little effect on children's logical abilities, which is consistent with earlier findings (Del Boca et al. 2017). When correcting for the attenuation bias by instrumenting the one-period lagged outcome by the two-period lagged outcome (column 8), the persistence coefficient increases, but the input coefficients show little change. Again, the results suggest that the attenuation bias suspected in the value-added models does not bias our input coefficients here.

As for verbal skills, the estimated coefficients may reflect a lower investment of parents when their children's logical abilities increase. Using a GMM model (column 9), the persistence coefficient decreases, and the estimated effect of time spent on educational activities increases, again suggesting the existence of feedback effects. Parents seem to increase (decrease) their time investments in response to a decrease (increase) in their children's logical abilities.

Looking at heterogeneity across the effect of parent' time investments, whatever the model considered, time spent with only the father on educational activities has a smaller effect on children's logical abilities than time spent with both parents together or with only the mother (except in the CVA-IV model). Time spent with only the mother seems to have a similar effect to time spent with both parents together, but not when we consider the GMM model. However, differences across the effects of parents' investments are no longer statistically significant in the case of the GMM model, which might arise from the existence of feedback effects or from the selection of older children for this model. The results suggest that time spent on general care with parents has no effect on children's logical abilities once we have controlled for past abilities.

The estimated coefficients on time spent with parents on educational activities are smaller on logical abilities than on verbal skills. A one-hour increase per day in time spent on educational activities with both parents together leads to an increase in logical abilities of 0.07 standard deviations, but this effect is not statistically different from zero. For comparison, this is about half of the effect of having a mother with a postgraduate degree compared with having a mother with a high school degree. Nevertheless, recall that the GMM model estimates rely on the last wave, here wave 4, when children are 10–11 years

old, while for verbal skills, children are 8–9 years old when verbal skills are measured for the last time.[32] The effect of time spent on educational activities without any adult is larger, which might be driven by the inclusion of wave 4. As children grow up, we expect that time spent with parents becomes less productive than time spent alone (Del Boca et al. 2017).

Looking at parents' parenting style, the results go in the same direction as for verbal skills: both parents' warmth does not seem to have an effect on children's verbal skills, but parents' authoritarian behavior seems to contribute to increasing children's verbal skills. The results do not suggest any difference between the effects of father's and mother's authoritarian behavior.

[**Table** 6 about here.]

5.2 Socio-Emotional Skills

Socio-emotional skills are measured through the SDQ, completed by the primary care-giver.[33] Two measures are considered. First, I consider the total SDQ, which is the sum of the internalizing SDQ and the externalizing SDQ, which measure emotional skills and behavioral skills, respectively.[34] Second, I consider social skills, measured from five items of the SDQ (see Figure A.1). The results differ from those for cognitive skills.

5.2.1 Behavioral Skills and Emotional Skills (Total SDQ)

Table 7 shows the estimated coefficients for socio-emotional skills, measured as the total SDQ score provided by the primary care-giver, at ages 4–5, 6–7, 8–9, and 10–11 years.

Contrasting with my findings on cognitive skills, socio-emotional skills are not positively correlated

[32] See Table 1.

[33] Socio-emotional skills measured by the teachers are also available for a sub-sample of children. The results are similar: the effect of time spent with fathers on educational activities is less negative, but statistically different from the effect of time spent with mothers at the 6% level and from the effect of time spent with both parents together at the 16% level. See Section 6.3.

[34] I also estimate the time input production functions for these components, and all results for these two outcomes are consistent; therefore, I report estimates for only total SDQ, which is the sum of externalizing and internalizing SDQ. Estimations for externalizing and internalizing SDQ are available upon request.

with time spent on educational activities with a parent. However, socio-emotional skills are positively correlated with social activities and educational activities with no adult (Table 7, column 1). These positive correlations with social activities are no longer true when we constrain the sample to children for whom we observe the total SDQ at $t-1$, that is, children at ages 6–7, 8–9, and 10–11 years. The correlation with time spent on educational activities with both parents together becomes negative in this sample. When we account for total SDQ at $t-1$ (Table 7, column 3), allocation of time is no longer a determinant of socio-emotional skills, except for the effect of time spent on educational activities with the father, which remains negative and becomes statistically different from zero. Looking at the individual fixed-effect model, time spent on educational activities with both parents together has a positive effect on socio-emotional skills. Allowing for heterogeneity in the effect of parental time input according to the child's age does not change the results (Table 7, columns 5 and 6). The results are also similar when we include children at only ages 8–9 and 10–11 years (column 7), and allocation of time does not seem to be a determinant of socio-emotional skills. The results do not change either when the total SDQ at $t-1$ is instrumented by total SDQ at $t-2$ (Table 7, column 8). Finally, using a GMM model (column 9), there is no strong effect of allocation of time, except that time spent on educational activities with the father seems to have a strong and negative effect on socio-emotional skills, while time spent with the mother or both parents together has no effect on children's socio-emotional skills. Differences across the effects of parents' investments are statistically significant at the 5% level, and this is not driven by differences in the type of activity (see Figure A.4).

Whatever the model considered, the results do not suggest that the child's allocation of time is a strong determinant of socio-emotional skills, which is consistent with previous findings (Fiorini & Keane 2014). This suggests differences across the production functions of cognitive and socio-emotional outcomes, highlighting a possible trade-off between the two types of skill. This echoes previous findings on teachers' ability to improve children's cognitive and socio-emotional skills (Flèche 2017).

There is little evidence of any feedback effect for socio-emotional skills, measured by the total SDQ, except that fathers seem to decrease (increase) their time investment if the children's behavioral and

emotional skills decrease (increase). This emphasizes that fathers respond differently to a decrease in their children's behavioral or emotional skills than to a decrease in their cognitive skills. This is consistent with the findings on parental time of Nicoletti & Tonei (2020).

Looking at the effect of parenting style, the effects are large. In the case of the value-added models, a one standard deviation increase in mother's and father's warmth leads to an increase in socio-emotional skills of about 0.03 standard deviations. A one standard deviation increase in the authoritarian factor of the mother and father leads to an increase in the children's socio-emotional skills of 0.24 and 0.07 standard deviations, respectively. OLS estimates suggest that the difference between the effects of mother's warmth and father's warmth is statistically different from zero, while the value-added models do not reject homogeneity across these effects. Conversely, all of the models reject homogeneity across the effects of parents' authoritarian behaviors; mother's authoritarian behavior contributes more to children's socio-emotional skills than father's authoritarian behavior. Socio-emotional skills seem to be more determined by parenting style rather than time investment, which contrasts with my findings for cognitive skills.

[**Table** 7 about here.]

5.2.2 Social Skills

Table 8 shows the estimated coefficients for social skills, measured from the SDQ completed by the primary care-giver,[35] at ages 4–5, 6–7, 8–9, and 10–11 years.

For models 1 to 7, there is no strong correlation between children's social skills and their allocation of time. Using the GMM model, the effect of time spent with other adults on children's social skills is strong and positive, in particular on educational activities. The results do not suggest any heterogeneity across the effects of parents' investments.

Again, parenting style has strong effects on social skills. In the case of the value-added and GMM

[35]Social skills measured by teachers are also available for a sub-sample of children. The results are different, but again no heterogeneity across the effects of parents' investments appears when using the teachers' assessment (see Section 6.3).

models, a one standard deviation increase in mother's warmth and authoritarian behavior leads to an increase in social skills of 0.13–0.18 and 0.18–0.23 standard deviations, respectively, and an even larger increase when using the OLS models. The effect of father's authoritarian behavior is 0.05–0.07 standard deviations increase, while father's warmth does not seem to have an effect on children's social skills. For both indicators of parenting style—warmth and authoritarian behaviors—the results reject homogeneity across the effects of father's and mother's parenting style, suggesting that mother's parenting style is a stronger determinant of children's social skills than father's.

[**Table** 8 about here.]

Children's cognitive and socio-emotional skills respond differently to parents' investments (Fiorini & Keane 2014). Children's verbal skills are strongly determined by parents' time investments, but parenting style is not a strong determinant of cognitive skills. Children's socio-emotional skills, measured by the total SDQ, do not seem to benefit from parents' time investments. Conversely, a one standard deviation increase in time spent with the father leads to a decrease of 0.18 standard deviations in children's socio-emotional skills. Social skills do not seem to be affected by parents' time investments. Children's socio-emotional skills seem to be more dependent on parents' parenting style; authoritarian parents especially seem to have a large and positive effect on their children's socio-emotional skills.

These results reveal that there is heterogeneity across the effects of parents' investments. For verbal skills and socio-emotional skills (total SDQ), time spent on educational activities with the father has a smaller effect than time spent with the mother only or both parents together, and the differences are statistically significant when using the GMM model. While the results for cognitive skills do not suggest that the difference between the effects of the father's and mother's parenting style is statistically different from zero, the results do suggest that children's socio-emotional skills respond more strongly to mother's parenting style than to father's parenting style.

Mothers spend on average more time with their children than fathers do (Table 3). In the next section, I investigate whether the heterogeneity that I find across parents' time investments arise from a non-

linearity in the effect of time investments.

6 Further Evidence

In this section, I perform several robustness checks. I first test the model's specification allowing for: i) non-linearity in the effect of parents' time investment, ii) complementarity in the effect of parents' time investments, and iii) complementarity across children's skills. Second, I test whether my results are robust to the inclusion of other inputs such as child endowment, parents' material investments, and school inputs. Third, I investigate measurement errors issues. Fourth, I perform a sensitivity analysis.

6.1 Non-linearity and Complementarity

6.1.1 Allowing for Non-linearity in the Effect of Time Inputs

Here, I explore non-linearity in the effect of parental time investments. I interact the parental time investment with a dummy indicating whether the parent spends more time with the child than the median amount of time in the sample. The sample might not be large enough to draw strong conclusions, but it gives first insights on the linearity of parental time inputs. The median is computed on non-zero values for mothers only, fathers only, and both parents together, separately.[36] Table 9 reports the results for each outcome using the GMM model.

Looking at non-linearity in the effect of time spent with the mother on educational activities, the results suggest a concave relation between maternal time investments and children's skills, especially for logical abilities. The interaction term is barely statistically significant, but this is consistent with a fatigue effect hypothesis (see Section 2). The results also suggest concavity in the effect of time spent on educational activities with both parents together for social skills. Regarding non-linearity in the effect of time spent with the father on educational activities, the results are consistent with a concave relation for children's cognitive skills, in particular logical abilities, but a convex relation for children's socio-

[36] I also consider an alternative model with a quadratic term, and both models lead to similar conclusions.

emotional skills, measured by the total SDQ; however, the interaction term is not statistically significant. This is consistent with the hypothesis that children's socio-emotional skills develop faster with trusted parents with whom they spend more time, or with the hypothesis that parents who spend more time with their children are more able to foster their children's socio-emotional skills. This suggests that the negative effect of time spent on educational activities with a father on children's socio-emotional skills is partly driven by fathers who spend too little time with their children.

I do not find any evidence of non-linearity in the effect of time spent on general care with any parent, except a concavity for time spent on general care with the father for logical abilities.

In the case of socio-emotional skills, the results differ when we consider non-linearity in the effect of time spent with the mother or father. However, the thresholds we take also differ, depending on the median of the sample for each parent. The median for time spent with the mother is 45 minutes a day: mothers below the median spend on average 10 minutes a day with their children, while mothers above the median spend on average 1 hour 45 minutes a day with their children. The median amount of time spent with the father is 30 minutes: those who are below the median spend on average 2 minutes a day with their children, while those who are above the median spend on average 1 hour 18 minutes with their children. Hence when looking at non-linearity in the effect of time spent with fathers, we compare fathers who spend very little (close to zero) time with their children and fathers who spend a certain amount of time that is sufficient to foster child development without having a fatigue effect. We cannot extrapolate these effects beyond the range of variation in the data, but it seems that targeting intervention that increases the time fathers spend with their children would have strong implications for children's socio-emotional skills, measured by the total SDQ.[37]

[37] I consider another model, in which I distinguish time spent with a parent of less than 4 hours a day (whatever the activity), between 4 and 8 hours a day, and more than 8 hours a day. The results do not suggest non-linearity in the effect of maternal time, but they do suggest an inverse u-shape in the effect of time spent with fathers on children's cognitive skills and a convexity for socio-emotional skills measured by the total SDQ. I break down the effect of time spent with both parents together according to the time spent with the parent who spends the largest amount of time with the child. Time spent with both parents together when neither of the parents spends more than 4 hours a day with the child has a negative effect on children's logical abilities and children's socio-emotional skills, measured by the total SDQ or social skills. Again, there is no evidence of non-linearity in the effect of time spent on general care.

[**Table** 9 about here.]

6.1.2 Allowing for Complementarity Between Parental Time Inputs

I also explore the substitutability and complementarity of parental time inputs. Table 10 reports the results for each outcome when using the GMM model. We would expect, for instance, that for a given amount of time spent with each parent, a child would benefit more from time spent with a parent, if they also spend more time with the other parent; that is, time spent with one parent is more productive if the child is exposed to a larger variety of stimuli (Craig 2006; Lamb 2010). Interacting the amount of time spent with the father and the mother using a GMM model, the results are consistent with this hypothesis for time spent on educational activities for cognitive skills, but the estimates are not statistically significant, and the results of the other models do not suggest any complementarity between parental time inputs. The results for socio-emotional skills go in the opposite direction. There is little evidence of such complementarities for general care.

The second assumption I investigate is whether time spent with a parent is more productive if this parent spends more time with their child jointly with the other parent. In other words, does time spent with a parent complement time spent with both parents together? For example, joint time could provide an opportunity to learn how the other parent interacts with the child, hence contributing to a "learning by observing" effect (Van Egeren & Hawkins 2004). However, although I find little evidence of complementarity for mothers' time on educational activities, time spent with the father on educational activities seems to have a stronger effect on children's verbal skills and socio-emotional skills, measured by the total SDQ and social skills, when he spends more time with the mother and the child together. There is little evidence of complementarities across parental time in the case of general care. Similarly, I do not find any evidence of complementarity across parenting style.

Allowing both for complementarity across parental time investments and for non-linearity leads to similar conclusions, but the estimates are reduced and no longer statistically significant when both non-linearity

and complementarity are allowed.[38]

[**Table** 10 about here.]

6.1.3 Allowing for Complementarity Across Skills

Several studies have highlighted the existence of complementarity across skills (Cunha & Heckman 2007, 2008; Cunha et al. 2006, 2010). Therefore, I also test whether allowing for complementarity across skills affects my results. I include social skills and total SDQ in estimating the production function of cognitive skills, and I include verbal skills in estimating the production function of socio-emotional skills.[39] The results are available upon request.

I find complementarities across skills. Using the GMM model, a one standard deviation increase in children's socio-emotional skills leads to a 0.05 and 0.09 standard deviation increase in verbal skills and logical abilities, respectively. However, social skills have no effect on either of these cognitive skills. I also find that cognitive skills foster socio-emotional skills. A one standard deviation increase in children's verbal skills leads to a 0.13 and 0.08 standard deviation increase in children's socio-emotional skills, measured by the total SDQ and social skills, respectively. However, the estimates on time inputs are similar when we allow for complementarity between skills.

6.2 Omitted Inputs

Until now we have assumed that our lagged measure of the child's skills is a sufficient statistic for unobserved endowment as well as unobserved input histories. We have also assumed that there are no missing contemporaneous relevant inputs that are correlated with parental time inputs. This is not true if parents adapt their time investments to the level (or the variation) in other inputs or characteristics that affect child development (Todd & Wolpin 2003). Hence, the effect of the time input variables may

[38]The results are available upon request.

[39]Since logical abilities are available for only wave 2 onward, I choose to estimate the models on the first three waves including only verbal skills.

reflect the effect of omitted inputs, or the response of parents, given an increase or decrease in other inputs. To make certain that this is not an issue, I control for a set of potential unobserved variables that have been found to be relevant in explaining parents' investments and child development: i) child's endowment, ii) material investments, iii) school inputs, and iv) number of parents' working hours.[40]

It is well established that in-utero circumstances have persistent effects (Almond & Currie 2011; Almond et al. 2018), and there is also some evidence that parents' investments respond to child's endowment (Almond & Mazumder 2013; Bharadwaj et al. 2018; Grätz & Torche 2016; Rosenzweig & Zhang 2009) or to variation in the child's skills (Nicoletti & Tonei 2020). To check whether this is an issue in my model, I first control for a dummy indicating whether the child's birth weight was below 2.5 kg. Low birth weight negatively affects child development, but I find similar results regarding time investments. Although birth weight is a relevant measure of health at the starting gate of life, Grätz & Torche (2016) find that parents may react more strongly to other endowments than birth weight, such as early cognitive ability. Hence, I also control for a variable indicating whether the parent thinks that the child was late in starting to talk: the effect is negative, but it does not affect the estimates on parental time investments, suggesting that lagged skills are a sufficient proxy to capture the relation between endowment and parents' investments.

Previous studies have also shown that material investments are important inputs for children's development (Agostinelli & Sorrenti 2018; Attanasio, Cattan, et al. 2020; Nicoletti et al. 2020). Parents who spend more time with their children may also provide more material investments to their children, such as books. I first control for the number of children's books present in the home, and it does not affect my results. I also consider both parents' income that may capture a broader set of material investments; again, my results are not affected by the inclusion of parents' income.

Parents who spend more time with their children may also be more willing to spend time looking for a good school or to invest more money on schooling. Moreover, parents may adapt their investments to school inputs and compensate for a lower quality school. I include two dummies indicating whether the

[40]The results are available upon request.

child is enrolled in a private school or a catholic school; I also include the teacher's level of qualification and the ratio of number of pupils to teacher. The results are robust to the inclusion of these controls. The time parents spend with their children may also reflect time spent managing activities (Kalil et al. 2012). To test for that, I include the number of working hours of both parents. The total amount of time a parent can invest in child development is 24 hours minus the number of working hours. Hence, the number of working hours would capture the rest of the time a parent can allocate to their children, even if not present with them. This provides a proxy for time spent on other activities that are not specified or for time spent managing activities. The effect of working hours is very small (<0.01 standard deviations) and negative (and sometimes statistically significant, especially for the mother) for children's cognitive skills, and positive for children's socio-emotional skills. However, the results on time investments remain similar, suggesting that we have already included all of the relevant time inputs.

6.3 Measurement Errors

Another concern is the measurement error in outcomes and in parental time inputs. In particular, children's socio-emotional skills, measured by the mother, may be correlated with parents' time inputs. Hence, I consider an alternative measure of socio-emotional skills, measured by the teacher.[41] The results are qualitatively similar and lead to a similar conclusion: the effect of time spent on educational activities with the father remains smaller than the effect of time spent with the mother only or both parents together. The former is negative and statistically different from zero at the 6% level, while the latter is only statistically significant at the 16% level. The results for social skills measured by the teacher are different, but no heterogeneity across the effects of parents' investments appears when using both mother's and teacher's assessment.

[41] The correlation between the two measures of socio-emotional skills by the teacher and the mother is about 0.3, similar to other datasets. In wave 1, 98% of teachers are women; this proportion decreases over the waves, but it is still around 71% in wave 4. It could be argued that the estimates I find for socio-emotional skills may arise from the assessments by women; however, if there is a gender bias in the assessment, it is unlikely to vary over time, and hence, it would be caught by Y_{it-1}. While part of the difference between these two measures might be due to measurement errors, it is also likely that they measure different types of skill (Papageorge et al. 2019).

Measurement errors in time investments may also be an issue. The results are robust to the inclusion of controls indicating whether the time-use diary was completed on an ordinary day and whether it was filled by the mother. Using a sample of children for whom we observe two days rather than one day would also reduce the measurement error issue.[42] Unfortunately, in wave 4, the time-use diary was completed for only one day for all children. Constraining the sample to the first three waves, I find similar results when children for whom we observe only one day are excluded. Since logical abilities are available from only wave 2 onward, I cannot check whether this is the case for the CVA model instrumenting logical abilities at $t-1$ by logical abilities at $t-2$ (CVA-IV) and for the GMM model. I also use a model by week rather than by day and find qualitatively similar results, even if some activities seem to have a greater effect when more weight is given to a weekday.[43]

6.4 Sensitivity

In this section, I test whether my results are sensitive to the sample. I first check whether I find similar results when single-parent families are excluded. Second, I test whether my results are similar for the balanced panel.

Including single-parent families might be an issue for at least two reasons. First, the time-use diary does not distinguish between parent and step-parent,[44] which could lead to a measurement error where time spent with fathers may in fact reflect time spent with step-fathers. Second, these families might behave differently. Fathers may anticipate the separation and, because they do not have custody, decrease their investment in their children. In addition, time spent with both parents together may have little effect because of conflict between the parents. Constraining the sample to children who remain in two-parent families throughout the first four waves leads to less efficient estimates, but similar results.[45]

In our sample, we have 1507 children for whom we observe verbal skills in waves 1–3, 1371 children for

[42] The results are available upon request.

[43] This is also confirmed by a heterogeneity analysis according to the type of day (weekday/weekend).

[44] An example of the time-use diary can be found at https://growingupinaustralia.gov.au/sites/default/files/w5-w1-12-tudk.pdf.

[45] The results are available upon request.

whom we observe logical abilities in waves 2–4, and 1150 children for whom we observe socio-emotional skills throughout the first four waves. Attrition is not random. I build a variable equal to zero when the children's skill is observed during all waves where it is intended to be collected (Table 1) and equal to one otherwise. Determinants of attrition are described in Table A.1 and are similar. Children whose main language spoken at home is not English or who are Indigenous are more likely to leave the sample, which may reflect a higher cost of completing the survey for them and their parents. Children who leave the sample are less likely to be first born relative to other birth orders and less likely to live with both parents. Children whose mother is less educated are more likely to not be observed throughout the survey relative to those whose mother has a high school degree. Father's education has a more ambiguous effect. Children whose parents are more authoritarian are less likely to leave the sample, while children whose parents have a higher indicator of warmth and affection are slightly more likely to leave the sample.

I already control for these variables, so attrition on the observed variables should not be an issue, except in the case of heterogeneity in the effects according to these variables (Solon et al. 2015).[46] To test whether attrition is an issue because of selection on observed variables, I estimate the models based on the balanced panel. The results are similar and available upon request. A small change is that the effect of time spent on educational activities with both parents together on children's socio-emotional skills, measured by total SDQ, is smaller for the balanced panel and now different from time spent with only the mother; the ranking of time spent with at least one parent on children's socio-emotional skills, from the most productive to the least productive, is the following: time spent with the mother only, time spent with both parents, and time spent with the father only. This suggests that unobserved variables that explain attrition may be slightly positively correlated with the productivity of time spent on educational activities with both parents together, once the observed variables have been controlled

[46]Heterogeneity according to parents' education is reported in the next section, and the results are similar when single-parent families are excluded (see above). I also investigate heterogeneity in the results according to child's birth order and to parenting style, but do not find strong evidence of heterogeneity according to these variables. There are too few observations to investigate heterogeneity according to the main language spoken at home or Indigenous status.

for.[47]

7 Heterogeneity

In this section, I ask whether the effect of parental time investments differ across different groups. I here focus on the GMM model.

7.1 According to Gender

I first consider the effect of parental investments according to gender. A common belief is that there would be an own-gender effect: girls would benefit more from being with their mothers, while boys would benefit from being with their fathers. Also, because the literature indicates that family background affects children differently according to their gender (Autor et al. 2019; Briole et al. 2020; Chetty et al. 2016; Dustmann & Landersø 2018), I check whether this is the case for time investments. The results using the GMM model are shown in Table 11.

Heterogeneity across genders is not clear-cut and depends on which skill is considered. Looking at verbal skills and social skills, time spent with parents is less fruitful for boys than for girls. However, the difference between genders is not statistically significant at conventional levels, and in the case of logical abilities and socio-emotional skills, time spent with parents is more fruitful for boys. Parents may adopt different behaviors intended to foster different skills for each gender. Because of this, research devoted to analyzing inequalities across genders in childhood should consider children's skills as being multi-dimensional.

Looking at heterogeneity across the effects of parents' investments spent on educational activities, the effect of time spent with only the father on children's socio-emotional skills is smaller than that with only the mother or both parents together for both girls and boys. We reject homogeneity across the effects of parental time on socio-emotional skills for both genders, the differences are however stronger

[47] The results are available upon request.

for girls. Boys' verbal skills seem to benefit more from time spent with both parents together rather than time spent with only one of them, and the differences are statistically significant at the 5% level. No heterogeneity across the effects of parents' investments on educational activities is found for girls' other skills.

Looking at general care, time spent with the mother seems to be more fruitful for boys' verbal and social skills relative to time spent with both parents together, and the difference is statistically significant at the 10% level. Time spent on general care with the father is more beneficial for girls' cognitive skills relative to time spent with the mother or both parents together. This effect is reversed in the case of socio-emotional skills measured by total SDQ. The differences are statistically significant at the 10% level.

It is interesting that I find no own-gender effect: boys do not benefit more from being with their fathers, and girls do not benefit more from being with their mothers.

[**Table** 11 about here.]

7.2 According to Parents' Education

I now consider the effect of parental investments according to parents' education. More educated parents may be more aware of activities that foster child development, and their beliefs on the returns of time investment may also differ (Attanasio 2015; Attanasio, Cattan, et al. 2020). Moreover, they may be able to invest more in material investments, and because of complementarity between these inputs would devote more time to their children's development (Caucutt et al. 2020). I interact parents' time investment with a dummy indicating whether at least one parent has an academic degree (bachelor or higher). The results are shown in Table 12.

I do not find strong differences according to parents' education. The main difference appears for verbal skills. Time spent with both parents together is more productive for children's verbal skills if at least one parent has a degree relative to families where no parent has a degree. This is true for all models,

and using a GMM, the difference is around 0.18 standard deviations, statistically significant at the 1% level. Differences across parental time on educational activities are statistically significant only for this latter group. Conversely, for logical abilities, time spent with both parents together on logical abilities is more productive for children where neither parent has a degree, and the differences between the effects of time spent with only one parent are statistically significant at the 10% level for this group only. The smaller effect of time spent on educational activities with fathers on children's socio-emotional skills is found for both groups.

In the case of general care, I find little evidence of heterogeneity across these two groups.

[**Table** 12 about here.]

8 Concluding Discussion

While a burgeoning literature has focused on the effects of parental time, and especially of maternal time on children's outcomes, no studies have analyzed heterogeneity across the effects of parents' investments. In this paper, I have estimated the production function for children's cognitive and socio-emotional skills using a variety of models: OLS, cumulative models, value-added models, an individual fixed-effect model, and a GMM model. A GMM model allows past inputs and unobserved abilities to be correlated with current inputs, but their effect is assumed to decrease at a constant rate (λ). It also deals with endogeneity due to heterogeneity in the learning speed.

This paper reveals that there is heterogeneity between the effects of parents' investments. Time spent on educational activities with only the father has a smaller effect than time spent with both parents together or with only the mother on children's verbal skills and emotional and behavioral skills. The difference is statistically different from zero when using the GMM model. I also show that there is heterogeneity across the effects of parenting style. All of the models reject homogeneity across the effects of parents' authoritarian behaviors on socio-emotional skills, measured by total SDQ or social skills; mother's authoritarian behavior contributes more to children's socio-emotional skills than father's

authoritarian behavior. For social skills, the effect of mother's warmth is also larger than the effect of father's warmth. Accounting for omitted variables such as child's endowment, material inputs, school inputs, and the number of working hours does not change the results.

A heterogeneity analysis highlights differences across genders, but I do not find any evidence of an own-gender effect. Time spent with both parents together has a greater effect on children's verbal skills when at least one parent has an academic degree.

Many mechanisms could explain why there exists some heterogeneity across the effects of parents' investments, but one relevant candidate I find is the inequalities across time spent with each parent, combined with non-linearity in the effect of parental time investments. Investigating the non-linearity of the effect suggests that the smaller effect of time spent with fathers is driven by fathers who spend less than 30 minutes a day on educational activities with their child.

These findings have strong policy implications. Reforms that encourage fathers to spend more time with their children are likely to increase the productivity of time spent with those fathers, and would therefore be beneficial both to children's socio-emotional and cognitive skills. Moreover, this may mean that mothers' time investments do not reach a certain threshold where mothers tend to become too tired to spend the time efficiently for their child's development. Paternity-leave reforms are likely to go in this direction (Patnaik 2019). Home-visiting programs have also been shown to be effective at increasing time investments (Attanasio, Cattan, et al. 2020; Doyle et al. 2017; Gertler et al. 2014; Heckman et al. 2017; Mayer et al. 2019), and these programs may be even more productive when targeted at fathers.

References

Agostinelli, F., & Sorrenti, G. (2018). Money vs. time: family income, maternal labor supply, and child development. *Working paper series/Department of Economics*(273).

Agostinelli, F., & Wiswall, M. (2016). *Estimating the technology of children's skill formation* (Tech. Rep.). National Bureau of Economic Research.

Ainsworth, M. D., Blehar, M., Waters, E., & Wall, S. (1978). *Patterns of attachment.* Hillsdale, NJ: Erlbaum.

Akabayashi, H. (2006). An equilibrium model of child maltreatment. *Journal of Economic Dynamics and Control*, *30*(6), 993–1025. doi: 10.1016/j.jedc.2005.03.010

Almond, D., & Currie, J. (2011). Killing Me Softly: The Fetal Origins Hypothesis. *Journal of Economic Perspectives*, *25*(3), 153–172. doi: 10.1257/jep.25.3.153

Almond, D., Currie, J., & Duque, V. (2018). Childhood Circumstances and Adult Outcomes: Act II. *Journal of Economic Literature*, *56*(4), 1360–1446. doi: 10.1257/jel.20171164

Almond, D., & Mazumder, B. (2013). Fetal origins and parental responses. *Annu. Rev. Econ.*, *5*(1), 37–56. doi: 10.1146/annurev-economics-082912-110145

Andrabi, T., Das, J., Zajonc, T., & Khwaja, A. I. (2011). Do Value-Added Estimates Add Value? Accounting for Learning Dynamics. *American Economic Journal: Applied Economics*, *3*(3), 27. doi: DOI:10.1257/app.3.3.29

Arellano, M., & Bond, S. (1991). Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *Review of Economic Studies*, *58*(2), 277-297. doi: 10.2307/2297968

Arellano, M., & Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics*, *68*(1), 29–51. doi: 10.1016/0304-4076(94)01642-D

Aslund, O., & Grönqvist, H. (2010). Family size and child outcomes: Is there really no trade-off? *Labour Economics*, *17*(1), 130–139. doi: 10.1016/j.labeco.2009.05.003

Attanasio, O. (2015). The determinants of human capital formation during the early years of life: Theory, measurement, and policies. *Journal of the European Economic Association*, *13*(6), 949–997. doi: 10.1111/jeea.12159

Attanasio, O., Cattan, S., Fitzsimons, E., Meghir, C., & Rubio-Codina, M. (2020). Estimating the Production Function for Human Capital: Results from a Randomized Controlled Trial in Colombia. *American Economic Review*, *110*(1), 48–85. doi: 10.1257/aer.20150183

Attanasio, O., Meghir, C., & Nix, E. (2020). Human capital development and parental investment in india. *The Review of Economic Studies*, *87*(6), 2511–2541. doi: 10.1093/restud/rdaa026

Autor, D., Figlio, D., Karbownik, K., Roth, J., & Wasserman, M. (2019). Family Disadvantage and the Gender Gap in Behavioral and Educational Outcomes. *American Economic Journal: Applied Economics*, *11*(3), 338–381. doi: 10.1257/app.20170571

Bandura, A., & Walters, R. H. (1977). *Social learning theory* (Vol. 1). Prentice-hall Englewood Cliffs, NJ.

Baumrind, D. (1966). Effects of Authoritative Parental Control On Child Behavior. *Child Development*, 887–907. doi: 10.2307/1126611

Bernal, R. (2008). The effect of maternal employment and child care on children's cognitive development. *International Economic Review*, *49*(4), 1173–1209. doi: 10.1111/j.1468-2354.2008.00510.x

Bharadwaj, P., Eberhard, J. P., & Neilson, C. A. (2018). Health at Birth, Parental Investments, and Academic Outcomes. *Journal of Labor Economics*, *36*(2), 349–394. doi: 10.1086/695616

Bianchi, S. M. (2011). Family change and time allocation in american families. *The Annals of the American Academy of Political and Social Science*, *638*(1), 21–44. doi: 10.1177/0002716211413731

Black, S. E., Devereux, P. J., & Salvanes, K. G. (2010). Small Family, Smart Family?: Family Size and the IQ Scores of Young Men. *Journal of Human Resources*, *45*, 33–58. doi: 10.3368/jhr.45.1.33

Black, S. E., Grönqvist, E., & Öckert, B. (2018). Born to lead? the effect of birth order on noncognitive abilities. *Review of Economics and Statistics*, *100*(2), 274–286. doi: 10.1162/REST_a_00690

Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, *87*(1), 115–143. doi: 10.1016/S0304-4076(98)00009-8

Bowlby, J. (1980). *Attachment and loss: Vol. 3: Loss*. Hogarth Press and the Institute of Psycho-Analysis.

Briole, S., Le Forner, H., & Lepinteur, A. (2020). Children's socio-emotional skills: Is there a quantity–quality trade-off? *Labour Economics*, *64*, 101811. doi: 10.1016/j.labeco.2020.101811

Cano, T., Perales, F., & Baxter, J. (2019). A matter of time: Father involvement and child cognitive outcomes. *Journal of Marriage and Family*, *81*(1), 164–184. doi: 10.1111/jomf.12532

Carneiro, P., Cunha, F., & Heckman, J. (2003). Interpreting the evidence of family influence on child development. *The economics of early childhood development: lessons for economic Policy*.

Carneiro, P., Løken, K. V., & Salvanes, K. G. (2015). A Flying Start? Maternity Leave Benefits and Long-Run Outcomes of Children. *Journal of Political Economy*, *123*(2), 365–412. doi: 10.1086/679627

Carneiro, P., Meghir, C., & Parey, M. (2013). Maternal Education, Home Environments, and the Development of Children and Adolescents. *Journal of the European Economic Association*, *11*, 123–160. doi: 10.1111/j.1542-4774.2012.01096.x

Caucutt, E. M., Lochner, L., Mullins, J., & Park, Y. (2020). *Child skill production: Accounting for parental and market-based time and goods investments* (Tech. Rep.). National Bureau of Economic Research.

Cawley, J., Heckman, J., & Vytlacil, E. (2001). Three observations on wages and measured cognitive ability. *Labour Economics*, *8*(4), 419 - 442. doi: https://doi.org/10.1016/S0927-5371(01)00039-2

Chetty, R., Hendren, N., Lin, F., Majerovitz, J., & Scuderi, B. (2016). Childhood Environment and Gender Gaps in Adulthood. *American Economic Review*, *106*(5), 282–288. doi: 10.1257/aer.p20161073

Clark, A. E., Flèche, S., Layard, R., Powdthavee, N., & Ward, G. (2019). *The origins of happiness: the science of well-being over the life course*. Princeton University Press.

Clark, A. E., & Lepinteur, A. (2019). The causes and consequences of early-adult unemployment: Evidence from cohort data. *Journal of Economic Behavior and Organization*, *166*, 107–124. doi: 10.1016/j.jebo.2019.08.020

Cobb-Clark, D. A., Salamanca, N., & Zhu, A. (2019). Parenting style as an investment in human development. *Journal of Population Economics*, *32*(4), 1315–1352. doi: 10.1007/s00148-018-0703-2

Conti, G., Heckman, J., & Urzua, S. (2010). The education-health gradient. *American Economic Review*, *100*, 234–238. doi: 10.1257/aer.100.2.234

Cornelissen, T., & Dustmann, C. (2018). Early school exposure, test scores, and non-cognitive outcomes. *American Economic Journal: Economic Policy*.

Cornelissen, T., Dustmann, C., Raute, A., & Schönberg, U. (2018). Who benefits from universal child care? estimating marginal returns to early child care attendance. *Journal of Political Economy*, *126*(6), 2356–2409. doi: 10.1086/699979

Cox, M. J., & Paley, B. (2003). Understanding families as systems. *Current directions in psychological science*, *12*(5), 193–196. doi: 10.1111/1467-8721.01259

Craig, L. (2006). Does Father Care Mean Fathers Share?: A Comparison of How Mothers and Fathers in Intact Families Spend Time with Children. *Gender & Society*, *20*(2), 259–281. doi: 10.1177/0891243205285212

Csibra, G., & Gergely, G. (2009). Natural Pedagogy. *Trends in Cognitive Sciences*, *13*(4). doi: 10.1016/j.tics.2009.01.005

Csibra, G., & Gergely, G. (2011). Natural pedagogy as evolutionary adaptation. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *366*(1567), 1149–1157. doi: 10.1098/rstb.2010.0319

Cunha, F., & Heckman, J. (2007). The Technology of Skill Formation. *The American Economic Review*, *97*(2), 31–47. doi: 10.1257/aer.97.2.31

Cunha, F., & Heckman, J. J. (2008). Formulating, Identifying and Estimating the Technology of Cognitive and Noncognitive Skill Formation. *Journal of Human Resources*, *43*, 738–782. doi: 10.3368/jhr.43.4.738

Cunha, F., Heckman, J. J., Lochner, L., & Masterov, D. V. (2006). Interpreting the evidence on life cycle skill formation. *Handbook of the Economics of Education*, *1*, 697–812. doi: 10.1016/S1574-0692(06)01012-9

Cunha, F., Heckman, J. J., & Schennach, S. M. (2010). Estimating the Technology of Cognitive and Noncognitive Skill Formation. *Econometrica*, *78*, 883–931. doi: 10.3982/ECTA6551

Dahl, G. B., & Lochner, L. (2017). The impact of family income on child achievement: Evidence from the earned income tax credit. *American Economic Review*, *107*(2), 629–31. doi: 10.1257/aer.102.5.1927

Deal, J. E., Halverson Jr, C. F., & Wampler, K. S. (1999). Parental similarity on child-rearing orientations: Effects of stereotype similarity. *Journal of Social and Personal Relationships*, *16*(1), 87–102. doi: 10.1177/0265407599161005

Del Boca, D., Flinn, C., & Wiswall, M. (2014). Household choices and child development. *Review of Economic Studies*, *81*(1), 137–185. doi: 10.1093/restud/rdt026

Del Boca, D., Monfardini, C., & Nicoletti, C. (2017). Parental and Child Time Investments and the Cognitive Development of Adolescents. *Journal of Labor Economics*, *35*, 565–608. doi: 10.1086/689479

Del Bono, E., Francesconi, M., Kelly, Y., & Sacker, A. (2016). Early Maternal Time Investment and Early Child Outcomes. *The Economic Journal*, *126*(596), F96–F135. doi: 10.1111/ecoj.12342

Doepke, M., Sorrenti, G., & Zilibotti, F. (2019). The Economics of Parenting. , *11*(1), 55-84. doi: 10.1146/annurev-economics-080218-030156

Doepke, M., & Zilibotti, F. (2017). Parenting With Style: Altruism and Paternalism in Intergenerational Preference Transmission. *Econometrica*, *85*(5), 1331–1371. doi: 10.3982/ECTA14634

Doyle, O., Harmon, C., Heckman, J. J., Logue, C., & Moon, S. H. (2017). Early skill formation and the efficiency of parental investment: a randomized controlled trial of home visiting. *Labour Economics*, *45*, 40–58. doi: 10.1016/j.labeco.2016.11.002

Dustmann, C., & Landersø, R. (2018). Child's gender, young fathers' crime, and spillover effects in criminal behavior. *Centre for Research and Analysis of Migration (CReAM)*.

Ermisch, J. F., & Francesconi, M. (2001). Family structure and children's achievements. *Journal of population economics*, *14*(2), 249–270. doi: 10.1007/s001480000028

Fiorini, M., & Keane, M. P. (2014). How the allocation of children's time affects cognitive and noncognitive development. *Journal of Labor Economics*, *32*(4), 787–836. doi: 10.1086/677232

Flèche, S. (2017). Teacher quality, test scores and non-cognitive skills: Evidence from primary school teachers in the uk. cep discussion paper no. 1472. *Centre for Economic Performance*.

Fletcher, J. M., & Wolfe, B. (2016). The importance of family income in the formation and evolution of non-cognitive skills in childhood. *Economics of education review*, *54*, 143–154. doi: 10.1016/j.econedurev.2016.07.004

Flèche, S., Lekfuangfu, W. N., & Clark, A. E. (2019). The long-lasting effects of family and childhood on adult wellbeing: Evidence from British cohort data. *Journal of Economic Behavior & Organization*. doi: 10.1016/j.jebo.2018.09.018

Fort, M., Ichino, A., & Zanella, G. (2020). Cognitive and noncognitive costs of day care at age 0–2 for children in advantaged families. *Journal of Political Economy*, *128*(1), 158–205. doi: 10.1086/704075

Francesconi, M., Jenkins, S. P., & Siedler, T. (2010). Childhood family structure and schooling outcomes: Evidence for Germany. *Journal of Population Economics*, *23*(3), 1073–1103. doi: 10.1007/s00148-009-0242-y

Gertler, P., Heckman, J., Pinto, R., Zanolini, A., Vermeersch, C., Walker, S., ... Grantham-McGregor, S. (2014). Labor market returns to an early childhood stimulation intervention in jamaica. *Science*, *344*(6187), 998–1001. doi: 10.1126/science.1251178

Goodman, A., Lamping, D. L., & Ploubidis, G. B. (2010). When to use broader internalising and externalising subscales instead of the hypothesised five subscales on the strengths and difficulties questionnaire (sdq): data from british parents, teachers and children. *Journal of Abnormal Child Psychology*, *38*, 1179–1191.

Grossmann, K., Grossmann, K. E., Fremmer-Bombik, E., Kindler, H., Scheuerer-Englisch, H., & Zimmermann, a. P. (2002). The Uniqueness of the Child-Father Attachment Relationship: Fathers' Sensitive and Challenging Play as a Pivotal Variable in a 16-year Longitudinal Study. *Social Development*, *11*(3), 301–337. doi: 10.1111/1467-9507.00202

Grätz, M., & Torche, F. (2016). Compensation or Reinforcement? The Stratification of Parental Responses to Children's Early Ability. *Demography*, *53*(6), 1883–1904. doi: 10.1007/s13524-016-0527-1

Haaland, V., Rege, M., & Votruba, M. (2013). Nobody Home: The Effect of Maternal Labor Force Participation on Long-Term Child Outcomes. *CESifo Working Papers*.

Heckman, J. J., Holland, M. L., Makino, K. K., Pinto, R., & Rosales-Rueda, M. (2017). *An analysis of the memphis nurse-family partnership program* (Tech. Rep.). National Bureau of Economic Research.

Heckman, J. J., & Mosso, S. (2014). The Economics of Human Development and Social Mobility. *Annual Review of Economics*, *6*(1), 689–733. doi: 10.1146/annurev-economics-080213-040753

Heckman, J. J., Stixrud, J., & Urzua, S. (2006). The effects of cognitive and noncognitive abilities on labor market outcomes and social behavior. *Journal of Labor Economics*, *24*, 411–482. doi: 10.1086/504455

Hsin, A., & Felfe, C. (2014). When Does Time Matter? Maternal Employment, Children's Time With Parents, and Child Development. *Demography*, *51*(5), 1867–1894. doi: 10.1007/s13524-014-0334-5

Juster, F. T., Ono, H., & Stafford, F. P. (2003). An Assessment of Alternative Measures of Time Use. *Sociological Methodology*, *33*(1), 19–54. doi: 10.1111/j.0081-1750.2003.t01-1-00126.x

Kalil, A., Ryan, R., & Chor, E. (2014). Time investments in children across family structures. *The Annals of the American Academy of Political and Social Science*, *654*(1), 150–168. doi: 10.1177/0002716214528276

Kalil, A., Ryan, R., & Corey, M. (2012). Diverging Destinies: Maternal Education and the Developmental Gradient in Time With Children. *Demography*, *49*(4), 1361–1383. doi: 10.1007/s13524-012-0129-5

Kim, J. H., Schulz, W., Zimmermann, T., & Hahlweg, K. (2018). Parent–child interactions and child outcomes: Evidence from randomized intervention. *Labour Economics*, *54*, 152–171. doi: 10.1016/j.labeco.2018.08.003

Lader, D., Short, S., & Gershuny, J. (2006). *The time use survey, 2005* (Tech. Rep.). Office for National Statistics, London.

Lamb, M. E. (1981). The development of father–infant relationships. In *The role of the father in child development* (pp. 229–266). J. Wiley.

Lamb, M. E. (2010). How do fathers influence children's development? let me count the ways. In *The role of the father in child development* (pp. 1–26). John Wiley & Sons Inc. Hoboken.

Layard, R., Clark, A. E., Cornaglia, F., Powdthavee, N., & Vernoit, J. (2014). What predicts a successful life? a life-course model of well-being. *Economic Journal*, *124*, F720–F738. doi: 10.1111/ecoj.12170

Le Forner, H. (2020a). Age at parents' separation and children achievement: Evidence from france using a sibling approach. *Annals of Economics and Statistics*. doi: 10.15609/annaeconstat2009.138.0107

Le Forner, H. (2020b). Parents' separation: What is the effect on parents' and children's time investments? *AMSE Working Papers*.

Lindqvist, E., & Vestman, R. (2011). The labor market returns to cognitive and noncognitive ability: Evidence from the swedish enlistment. *American Economic Journal: Applied Economics*, *3*, 101-128. doi: 10.1257/app.3.1.101

Lundborg, P., Nystedt, P., & Rooth, D.-O. (2014). Height and Earnings: The Role of Cognitive and Noncognitive Skills. *Journal of Human Resources*, *49*(1), 27. doi: 10.3368/jhr.49.1.141

Macmillan, L., & Tominey, E. (2019). Parental inputs and socio-economic gaps in early child development. *IZA Discussion Paper*.

Mayer, S. E., Kalil, A., Oreopoulos, P., & Gallegos, S. (2019). Using behavioral insights to increase parental engagement the parents and children together intervention. *Journal of Human Resources*, *54*(4), 900–925. doi: 10.3368/jhr.54.4.0617.8835R

Nicoletti, C., Salvanes, K. G., & Tominey, E. (2020). Mothers working during preschool years and child skills. does income compensate? *IZA Discussion Paper*.

Nicoletti, C., & Tonei, V. (2020). Do parental time investments react to changes in child's skills and health? *European Economic Review*, *127*, 103491. doi: 10.1016/j.euroecorev.2020.103491

Palm, G. (2014). Attachment Theory and Fathers: Moving From "Being There" to "Being With": Attachment Theory and Fathers. *Journal of Family Theory & Review*, *6*(4), 282–297. doi: 10.1111/jftr.12045

Papageorge, N. W., Ronda, V., & Zheng, Y. (2019). *The economic value of breaking bad: Misbehavior, schooling and the labor market* (Tech. Rep.). National Bureau of Economic Research.

Patnaik, A. (2019). Reserving time for daddy: The consequences of fathers' quotas. *Journal of Labor Economics*, *37*(4), 1009–1059. doi: 10.1086/703115

Rasmussen, A. W. (2010). Increasing the length of parents' birth-related leave: The effect on children's long-term educational outcomes. *Labour Economics*, *17*(1), 91–100. doi: 10.1016/j.labeco.2009.07.007

Rosenzweig, M. R., & Zhang, J. (2009). Do Population Control Policies Induce More Human Capital Investment? Twins, Birth Weight and China's "One-Child" Policy. *Review of Economic Studies*, *76*(3), 1149–1174. doi: 10.1111/j.1467-937X.2009.00563.x

Seror, A. (2019). Human Development, Social Interactions, and Identity Formation. *AMSE Working Paper*.

Silles, M. A. (2010). The implications of family size and birth order for test scores and behavioral development. *Economics of Education Review*, *29*, 795–803. doi: 10.1016/j.econedurev.2010.02.004

Solon, G., Haider, S. J., & Wooldridge, J. M. (2015). What are we weighting for? *Journal of Human resources*, *50*(2), 301–316. doi: 10.3368/jhr.50.2.301

Todd, P. E., & Wolpin, K. I. (2003). On the Specification and Estimation of the Production Function for Cognitive Achievement. *The Economic Journal*, *113*(485), F3–F33. doi: 10.1111/1468-0297.00097

Todd, P. E., & Wolpin, K. I. (2007). The Production of Cognitive Achievement in Children: Home, School, and Racial Test Score Gaps. *Journal of Human Capital*, *1*(1), 91–136. doi: 10.1086/526401

Van Egeren, L. A., & Hawkins, D. P. (2004). Coming to terms with coparenting: Implications of definition and measurement. *Journal of Adult Development*, *11*(3), 165–178. doi: 10.1023/B:JADE.0000035625.74672.0b

Wechsler, D. (2004). *Wisc-iv: Wechsler intelligence scale for children: Technical and interpretive manual*. Psychological Corporation.

9 Tables and Figures

Table 1: Summary of Data Collection for Both Cohorts in Each Wave

Cohort	Wave 1 2004	Wave 2 2006	Wave 3 2008	Wave 4 2010	Wave 5 2012	Wave 6 2014	Wave 7 2016
B cohort	0-1 yrs	2-3 yrs	4-5 yrs	6-7 yrs	8-9 yrs	10-11 yrs	12-13 yrs
Peabody Picture Vocabulary Test	-	-	Yes	Yes	Yes	-	-
Matrix Reasoning Test	-	-	-	Yes	Yes	Yes	-
Strengths and Difficulty Questionnaire	Yes	Yes	Yes	Yes	Yes	Yes	Yes
TUD (paper), completed by parent	Yes	Yes	Yes	-	-	-	-
TUD (computer), completed by study child	-	-	-	-	-	Yes	Yes
K cohort	**4-5 yrs**	**6-7 yrs**	**8-9 yrs**	**10-11 yrs**	12-13 yrs	14-15 yrs	16-17 yrs
Peabody Picture Vocabulary Test	Yes	Yes	Yes	-	-	-	-
Matrix Reasoning Test	-	Yes	Yes	Yes	-	-	-
Strengths and Difficulty Questionnaire	Yes	Yes	Yes	Yes	Yes	Yes	Yes
TUD (paper), completed by parent	Yes	Yes	Yes	-	-	-	-
TUD (computer), completed by study child	-	-	-	Yes	Yes	Yes	Yes

Notes: This table reports the wave in which the information on child development and time-use diaries are collected for each cohort. "TUD" is time-use diary.

Table 2: Summary Statistics of Outcomes

	1st wave (4-5 y-o)					2nd wave (6-7 y-o)					3rd wave (8-9 y-o)					4th wave (10-11 y-o)				
	mean	sd	min	max	count	mean	sd	min	max	count	mean	sd	min	max	count	mean	sd	min	max	count
Math Skills	.	.	.	.	0	13.57	4.62	0.00	28.00	2756	19.43	4.99	0.00	33.00	2487	22.85	4.57	6.00	35.00	2452
Verbal Skills	64.65	5.93	32.49	84.78	2778	74.30	4.90	46.44	91.58	2696	78.73	4.80	47.20	100.74	2487	.	.	.	.	0
Social Skills	7.73	1.79	0.00	10.00	3022	8.26	1.70	0.00	10.00	2773	8.26	1.70	0.00	10.00	2510	8.53	1.67	1.00	10.00	2456
Total SDQ	30.87	5.20	12.00	40.00	3022	32.42	4.87	8.00	40.00	2773	32.64	5.18	5.00	40.00	2510	31.76	5.74	8.00	40.00	2456
Exter SDQ	14.09	3.73	0.00	20.00	3022	15.39	3.19	3.00	20.00	2773	15.58	3.29	3.00	20.00	2510	15.35	3.43	2.00	20.00	2456
Inter SDQ	16.77	2.57	4.00	20.00	3022	17.03	2.67	1.00	20.00	2773	17.07	2.77	2.00	20.00	2510	16.40	3.23	1.00	20.00	2456

Notes: Verbal skills are measured through the PPVT. Logical abilities are measured through the MRT. Socio-emotional skills are measured through the SDQ, completed by the primary care-giver. Total SDQ is the sum of externalizing SDQ and internalizing SDQ. Internalizing SDQ measures emotional skills and is the sum of the scores of emotional and peer sub-scales. Externalizing SDQ measures behavioral skills and is the sum of the scores of conduct and hyperactivity sub-scales. See Figure A.1 for more details on the SDQ variables.

Source: Estimation Sample drawn from the Longitudinal Study of Australian Children. Weighting is used to ensure the sample to be representative of the Australian population.

Table 3: Summary Statistics of Time Use (Hours Per Day)

	1st wave (4-5 y-o)				2nd wave (6-7 y-o)				3rd wave (8-9 y-o)				4th wave (10-11 y-o)			
	mean	sd	min	max	mean	sd	min	max	mean	sd	min	max	mean	sd	min	max
Bed	11.62	1.30	5.75	19.75	11.15	1.15	5.75	17.50	10.97	1.21	5.75	16.75	10.34	1.13	5.75	17.25
School	2.25	2.88	0.00	12.00	3.57	3.44	0.00	13.00	3.50	3.50	0.00	12.50	2.42	2.37	0.00	7.22
Educational Activities - Other Adults	0.09	0.42	0.00	12.50	0.03	0.21	0.00	5.75	0.02	0.19	0.00	6.00	0.16	0.44	0.00	5.10
Educational Activities - Parents	1.29	1.57	0.00	12.75	0.65	0.77	0.00	9.00	0.62	0.79	0.00	9.50	0.26	0.62	0.00	5.75
Educational Activities - No Adults	0.23	0.59	0.00	11.00	0.15	0.36	0.00	4.50	0.19	0.44	0.00	4.50	0.65	0.89	0.00	7.42
General Care - Other Adults	0.31	1.00	0.00	10.50	0.23	0.83	0.00	11.50	0.21	0.76	0.00	8.75	1.20	1.20	0.00	11.60
General Care - Parents	3.69	2.23	0.00	14.25	3.03	1.85	0.00	13.75	2.96	1.86	0.00	14.50	2.03	1.69	0.00	13.42
General Care - No Adults	0.72	1.26	0.00	11.50	0.71	1.03	0.00	7.75	0.71	0.94	0.00	7.50	1.17	0.91	0.00	9.70
Social Activities	2.35	2.07	0.00	11.25	2.90	2.37	0.00	14.25	2.88	2.43	0.00	13.25	2.66	1.84	0.00	10.28
Media	1.38	1.25	0.00	9.50	1.52	1.37	0.00	9.75	1.87	1.61	0.00	10.50	2.96	2.28	0.00	14.17
Unknown	0.08	0.60	0.00	11.25	0.07	0.44	0.00	8.25	0.07	0.37	0.00	7.50	0.14	0.47	0.00	5.50
Educational Activities - Mother	0.64	1.09	0.00	11.75	0.29	0.51	0.00	5.00	0.26	0.51	0.00	7.75	0.18	0.51	0.00	5.42
Educational Activities - Father	0.14	0.43	0.00	8.50	0.09	0.31	0.00	5.00	0.08	0.31	0.00	6.00	0.05	0.26	0.00	3.92
Educational Activities - Both Parents	0.51	0.98	0.00	12.50	0.27	0.53	0.00	7.25	0.28	0.55	0.00	6.00	0.03	0.19	0.00	2.93
General Care - Mother	1.72	1.86	0.00	14.00	1.22	1.35	0.00	10.25	1.18	1.38	0.00	10.25	1.09	1.40	0.00	10.03
General Care - Father	0.41	0.89	0.00	9.25	0.35	0.82	0.00	12.50	0.34	0.82	0.00	8.25	0.28	0.71	0.00	9.67
General Care - Both Parents	1.56	1.85	0.00	13.00	1.46	1.69	0.00	11.25	1.44	1.66	0.00	13.00	0.66	1.17	0.00	13.42
Observations	5528				4664				4146				2457			

Notes: This table reports children's time use by day and by wave. In the first three waves, children may appear twice in a wave if they completed a time-use diary for a day during the week and the weekend. Time spent with the mother and with the father denotes time spent alone with the parent, possibly with other adults, but without the other parent. Table A.2 in the Appendix reports the mean and the standard deviation for each activity for weekday and weekends separately. See Figures A.2 and A.3 for more details on the typology of time use.

Source: Estimation Sample drawn from the Longitudinal Study of Australian Children. Weighting is used to ensure the sample to be representative of the Australian population.

Table 4: Summary Statistics of Demographic Variables

	1st wave (4-5 y-o)					2nd wave (6-7 y-o)					3rd wave (8-9 y-o)					4th wave (10-11 y-o)				
	mean	sd	min	max	count	mean	sd	min	max	count	mean	sd	min	max	count	mean	sd	min	max	count
Boy	0.52	0.50	0.00	1.00	3022	0.52	0.50	0.00	1.00	2775	0.52	0.50	0.00	1.00	2512	0.50	0.50	0.00	1.00	2457
First Born	0.43	0.50	0.00	1.00	3022	0.43	0.50	0.00	1.00	2775	0.44	0.50	0.00	1.00	2512	0.44	0.50	0.00	1.00	2457
Second Born	0.35	0.48	0.00	1.00	3022	0.36	0.48	0.00	1.00	2775	0.34	0.47	0.00	1.00	2512	0.35	0.48	0.00	1.00	2457
Third Born	0.16	0.36	0.00	1.00	3022	0.15	0.36	0.00	1.00	2775	0.16	0.37	0.00	1.00	2512	0.15	0.36	0.00	1.00	2457
Fourth Born	0.05	0.22	0.00	1.00	3022	0.04	0.19	0.00	1.00	2775	0.04	0.20	0.00	1.00	2512	0.04	0.21	0.00	1.00	2457
Fifth Born and more	0.02	0.12	0.00	1.00	3022	0.01	0.11	0.00	1.00	2775	0.01	0.11	0.00	1.00	2512	0.02	0.12	0.00	1.00	2457
Child's age (months)	56.96	2.56	51.00	67.00	3022	81.92	2.89	75.00	94.00	2775	105.53	2.85	95.00	116.00	2512	129.97	3.54	121.00	140.00	2457
Mother's age	35.49	5.06	20.00	55.00	3022	37.87	4.96	23.00	62.00	2775	39.85	4.97	25.00	64.00	2512	41.40	5.48	18.00	82.00	2457
Father's age	33.25	13.88	0.00	70.00	3022	35.25	14.56	0.00	72.00	2775	37.54	14.50	0.00	71.00	2512	34.75	18.74	0.00	76.00	2457
Mother Education	6.68	2.50	1.00	11.00	3022	6.85	2.45	1.00	11.00	2775	6.99	2.44	1.00	11.00	2512	6.99	2.42	1.00	11.00	2457
Father Education	6.22	3.21	0.00	11.00	3022	6.28	3.23	0.00	11.00	2775	6.44	3.19	0.00	11.00	2512	5.70	3.63	0.00	11.00	2457
Live with Two Parents	0.85	0.36	0.00	1.00	3022	0.84	0.36	0.00	1.00	2775	0.82	0.38	0.00	1.00	2512	0.69	0.46	0.00	1.00	2457
No. of Siblings	1.45	0.97	0.00	8.00	3022	1.51	0.95	0.00	8.00	2775	1.56	0.99	0.00	8.00	2512	1.61	1.10	0.00	8.00	2457
Main language spoken at home is English	0.91	0.29	0.00	1.00	3022	0.90	0.30	0.00	1.00	2775	0.90	0.31	0.00	1.00	2512	0.89	0.31	0.00	1.00	2457
Indigenous	0.03	0.16	0.00	1.00	3022	0.02	0.15	0.00	1.00	2775	0.02	0.15	0.00	1.00	2512	0.04	0.19	0.00	1.00	2457
Weekend	0.48	0.50	0.00	1.00	3022	0.58	0.49	0.00	1.00	2775	0.62	0.49	0.00	1.00	2512	0.21	0.40	0.00	1.00	2457
Mother's Income (in thousands)	20.15	19.88	0.00	208.00	3000	26.89	25.99	0.00	249.14	2774	30.90	27.96	0.00	269.07	2511	35.14	33.40	0.00	498.28	2453
Father's Income (in thousands)	41.53	40.37	0.00	398.63	3013	56.41	49.45	0.00	348.79	2773	63.91	58.52	0.00	597.93	2512	58.59	71.77	0.00	1245.69	2455

Notes: This table reports the summary statistics for each control for each wave, separately.

Source: Estimation Sample drawn from the Longitudinal Study of Australian Children. Weighting is used to ensure the sample to be representative of the Australian population.

Table 5: Time Input Production Function—Verbal Skills (PPVT)

	(1) OLS	(2) OLS 2	(3) VA	(4) FE	(5) Cumulative Model	(6) CVA	(7) CVA 2	(8) CVA-IV	(9) GMM
School	0.01*	0.00	−0.00	−0.00	0.00	−0.00	−0.00	0.00	0.03
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)
Educational Activities - Other Adults	0.02	0.04	0.04	−0.01	0.04	0.04	0.06	0.05	0.11+
	(0.02)	(0.04)	(0.04)	(0.02)	(0.04)	(0.04)	(0.06)	(0.06)	(0.06)
Educational Activities - Mother	0.05***	0.07***	0.03*	−0.00	0.06***	0.03*	−0.01	−0.03	0.13***
	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.02)	(0.03)
Educational Activities - Father	0.05**	0.03	0.03	0.02	0.03	0.03	0.04+	0.05+	0.05
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.04)
Educational Activities - Both Parents	0.04***	0.06***	0.04**	0.01	0.05**	0.04*	−0.02	−0.04+	0.16***
	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.02)	(0.03)
Educational Activities - No Adults	0.04**	0.09***	0.05**	0.02	0.08***	0.05**	0.02	−0.01	0.16**
	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.03)	(0.03)	(0.05)
General Care - Other Adults	0.01	0.01	0.00	−0.00	0.01	0.00	−0.00	−0.01	0.03
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
General Care - Mother	0.01*	0.00	−0.01	−0.01	0.00	−0.01	−0.02	−0.03*	0.04*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
General Care - Father	0.03**	0.02	0.01	−0.00	0.02	0.01	−0.03*	−0.04**	0.07**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
General Care - Both Parents	0.01	−0.00	−0.01	−0.00	−0.00	−0.01	−0.01	−0.02	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
General Care - No Adults	−0.00	−0.00	−0.01	−0.01	−0.00	−0.01	−0.03+	−0.04*	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
Social Activities	0.02***	0.02*	0.01	0.00	0.02*	0.01	−0.00	−0.01	0.06***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
Media	0.02***	0.02*	0.01	0.01	0.02*	0.01	0.01	0.00	0.05*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
Unknown	0.02+	0.04*	0.03+	−0.00	0.04*	0.03+	−0.02	−0.04	0.06+
	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)
Mother Warmth and Affection	−0.01	−0.02+	−0.02	0.01	−0.02+	−0.02	−0.02	−0.01	−0.02+
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
Authoritarian Mother	0.07***	0.05***	0.03*	0.01	0.05***	0.03*	0.04*	0.02+	0.04**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
Father Warmth and Affection	0.01	−0.00	0.01	0.06***	−0.00	0.01	−0.00	0.01	−0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Authoritarian Father	0.04**	0.04**	0.02+	−0.01	0.03**	0.02+	0.02	−0.00	0.03*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
Verbal Skills (Lag)			0.38***			0.38***	0.43***	0.80***	0.14***
			(0.01)			(0.01)	(0.02)	(0.04)	(0.04)
Observations	13744	7010	7010	13744	7010	7010	2827	2827	7010
R^2	0.614	0.285	0.411	0.781	0.288	0.412	0.304	0.172	
Ed: Mother vs Father	0.98	0.14	0.97	0.25	0.17	0.97	0.10	0.02	0.12
Ed: Mother vs Both Parents	0.91	0.61	0.70	0.33	0.63	0.70	0.63	0.78	0.47
Ed: Father vs Both Parents	0.93	0.27	0.74	0.63	0.29	0.73	0.03	0.01	0.03
Care: Mother vs Father	0.08	0.23	0.24	0.73	0.20	0.21	0.42	0.27	0.17
Care: Mother vs Both Parents	0.15	0.57	0.56	0.49	0.63	0.61	0.55	0.49	0.03
Care: Father vs Both Parents	0.01	0.11	0.11	0.91	0.10	0.11	0.21	0.10	0.00
Warmth: Mother vs Father	0.17	0.40	0.19	0.00	0.36	0.17	0.52	0.31	0.29
Authoritarian: Mother vs Father	0.07	0.50	0.72	0.15	0.53	0.74	0.33	0.23	0.53

Notes: Verbal skills are measured as the PPVT score at ages 4–5, 6–7, and 8–9 years. Scores are standardized for a mean of zero and a standard deviation of one. Time spent on each activity is measured in number of hours per day. The estimates of the effect of time spent on each activity should be interpreted as relative to time spent sleeping. All models include controls such as child's sex, age, birth order, a dummy indicating whether the child is Indigenous, along with family characteristics such as number of siblings, parents' ages, their education, and a dummy indicating whether the child lives with both parents and the main language spoken at home is English. Dummies for waves and the type of day are also included. Models also control for both parents' parenting style. To avoid losing too much observation in single-parent families, I also include observations for whom we do not observe the father's age, his education, or his parenting style, and include a set of dummies controlling whether these variables are missing. Column 1 shows the estimation results for the OLS model. Column 2 shows the estimation results for the OLS model, but including only those observations where we observe the skill in the previous wave (hence excluding wave 1), which gives a comparative sample for the value-added model, estimations of which are shown in column 3. The estimations using the individual fixed-effect model are shown in column 4. Columns 5 and 6 show the estimations for the cumulative model and the CVA model, respectively. To give a comparable sample for the CVA-IV model, estimations for the CVA model including only those children for whom we observe the skill at $t-2$ are shown in column 7. The results for the CVA-IV model are shown in column 8. Estimations of the GMM model are shown in column 9, addressing feedback effects. I test whether the differences between the effect of each parental time are statistically different from zero. I do the same for parenting style. The p-values are reported at the bottom of the table for each outcome. + p<0.10, * p<0.05, ** p<0.01, *** p<0.001. Standard errors are in parentheses.

Source: Estimation Sample drawn from the Longitudinal Study of Australian Children.

Table 6: Time Input Production Function—Logical Abilities (MRT)

	(1) OLS	(2) OLS 2	(3) VA	(4) FE	(5) Cumulative Model	(6) CVA	(7) CVA 2	(8) CVA-IV	(9) GMM
School	0.01	0.01	−0.00	0.00	0.01	−0.00	−0.01	−0.03	−0.04
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.04)
Educational Activities - Other Adults	0.04	0.01	−0.02	−0.01	0.01	−0.02	−0.02	−0.05	−0.41+
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.05)	(0.21)
Educational Activities - Mother	0.06***	0.08**	0.03	−0.01	0.07**	0.03	0.00	−0.03	−0.01
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.05)
Educational Activities - Father	0.00	−0.07+	−0.05+	0.01	−0.07+	−0.05+	−0.04	−0.01	0.00
	(0.03)	(0.04)	(0.03)	(0.03)	(0.04)	(0.03)	(0.06)	(0.06)	(0.09)
Educational Activities - Both Parents	0.07***	0.07**	0.05*	0.03+	0.07*	0.05*	−0.05	−0.04	0.07
	(0.02)	(0.03)	(0.02)	(0.02)	(0.03)	(0.02)	(0.09)	(0.10)	(0.08)
Educational Activities - No Adults	0.11***	0.09***	0.04*	0.02	0.08***	0.04*	0.05*	0.02	0.15*
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.07)
General Care - Other Adults	0.02*	0.03+	0.01	0.00	0.03+	0.01	0.00	−0.00	−0.03
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.05)
General Care - Mother	0.02*	0.02*	0.02	0.01	0.03*	0.02	0.01	−0.00	−0.05
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.04)
General Care - Father	0.01	0.03+	0.01	0.00	0.03+	0.01	0.00	−0.02	−0.02
	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.03)	(0.03)	(0.06)
General Care - Both Parents	0.01	0.01	0.00	0.00	0.01	0.00	0.02	0.01	−0.06
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.03)	(0.04)
General Care - No Adults	0.00	0.02	0.00	0.00	0.02	0.01	−0.00	−0.02	−0.11*
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.05)
Social Activities	0.02**	0.02*	0.01	0.00	0.02*	0.01	−0.00	−0.01	−0.03
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.04)
Media	0.03***	0.03**	0.01	0.00	0.03**	0.01	0.00	−0.01	−0.03
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.04)
Unknown	0.02	0.05	0.03	0.01	0.05+	0.04	−0.04	−0.04	−0.03
	(0.02)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)	(0.04)	(0.04)	(0.08)
Mother Warmth and Affection	−0.02	−0.03	−0.03+	−0.00	−0.03	−0.03+	−0.02	−0.02	−0.02
	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)
Authoritarian Mother	0.04**	0.04*	0.02	−0.00	0.04*	0.02	0.02	0.01	0.02
	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Father Warmth and Affection	−0.02	−0.01	−0.00	0.01	−0.02	−0.00	−0.02	−0.01	−0.01
	(0.01)	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)
Authoritarian Father	0.04**	0.06**	0.04*	−0.01	0.06**	0.03*	0.01	−0.01	0.04*
	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)
Math Skills (Lag)			0.46***			0.46***	0.44***	0.79***	0.22***
			(0.02)			(0.02)	(0.02)	(0.05)	(0.07)
Observations	11189	5346	5346	11189	5346	5346	1584	1584	5346
R^2	0.442	0.200	0.362	0.660	0.203	0.364	0.324	0.189	
Ed: Mother vs Father	0.05	0.00	0.02	0.68	0.00	0.02	0.57	0.74	0.87
Ed: Mother vs Both Parents	0.71	0.93	0.49	0.10	0.93	0.47	0.58	0.92	0.30
Ed: Father vs Both Parents	0.03	0.00	0.01	0.39	0.00	0.01	0.88	0.76	0.55
Care: Mother vs Father	0.58	0.82	0.73	0.43	0.77	0.78	0.79	0.45	0.52
Care: Mother vs Both Parents	0.07	0.13	0.12	0.21	0.15	0.13	0.67	0.55	0.92
Care: Father vs Both Parents	0.48	0.21	0.44	0.94	0.21	0.42	0.60	0.30	0.50
Warmth: Mother vs Father	0.90	0.65	0.32	0.58	0.67	0.33	0.84	0.72	0.56
Authoritarian: Mother vs Father	0.90	0.44	0.57	0.72	0.47	0.59	0.71	0.67	0.44

Notes: Logical abilities are measured as the MRT score at ages 6–7, 8–9, and 10–11 years. Scores are standardized for a mean of zero and a standard deviation of one. Time spent on each activity is measured in number of hours per day. The estimates of the effect of time spent on each activity should be interpreted as relative to time spent sleeping. All models include controls such as child's sex, age, birth order, a dummy indicating whether the child is Indigenous, along with family characteristics such as number of siblings, parents' ages, their education, and a dummy indicating whether the child lives with both parents and the main language spoken at home is English. Dummies for waves and the type of day are also included. Models also control for both parents' parenting style. To avoid losing too much observation in single-parent families, I also include observations for whom we do not observe the father's age, his education, or his parenting style, and include a set of dummies controlling whether these variables are missing. Column 1 shows the estimation results for the OLS model. Column 2 shows the estimation results for the OLS model, but including only those observations where we observe the skill in the previous wave (hence excluding wave 1), which gives a comparative sample for the value-added model, estimations of which are shown in column 3. The estimations using the individual fixed-effect model are shown in column 4. Columns 5 and 6 show the estimations for the cumulative model and the CVA model, respectively. To give a comparable sample for the CVA-IV model, estimations for the CVA model including only those children for whom we observe the skill at $t-2$ are shown in column 7. The results for the CVA-IV model are shown in column 8. Estimations of the GMM model are shown in column 9, addressing feedback effects. I test whether the differences between the effect of each parental time are statistically different from zero. I do the same for parenting style. The p-values are reported at the bottom of the table for each outcome. + p<0.10, * p<0.05, ** p<0.01, *** p<0.001. Standard errors are in parentheses.

Source: Estimation Sample drawn from the Longitudinal Study of Australian Children.

Table 7: Time Input Production Function—Emotional and Behavioral Skills (Total SDQ)

	(1) OLS	(2) OLS 2	(3) VA	(4) FE	(5) Cumulative Model	(6) CVA	(7) CVA 2	(8) CVA-IV	(9) GMM
School	0.01	0.00	0.01	0.01	0.00	0.01	0.01	0.01	−0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)
Educational Activities - Other Adults	−0.00	−0.03	−0.03	−0.00	−0.03	−0.03	0.01	0.01	−0.08
	(0.02)	(0.04)	(0.03)	(0.02)	(0.04)	(0.03)	(0.03)	(0.03)	(0.07)
Educational Activities - Mother	0.00	−0.01	−0.01	0.01	−0.01	−0.01	−0.03	−0.02	0.01
	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.04)
Educational Activities - Father	−0.01	−0.05	−0.05*	0.03	−0.04	−0.05+	−0.00	−0.01	−0.18**
	(0.02)	(0.03)	(0.03)	(0.02)	(0.03)	(0.02)	(0.03)	(0.03)	(0.06)
Educational Activities - Both Parents	0.02	−0.04*	−0.01	0.03*	−0.04+	−0.00	0.03	0.04+	−0.01
	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.04)
Educational Activities - No Adults	0.04**	0.02	0.01	0.02	0.01	0.01	−0.01	−0.01	0.03
	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.05)
General Care - Other Adults	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)
General Care - Mother	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.01	0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)
General Care - Father	−0.00	−0.01	0.00	0.00	−0.01	0.00	0.01	0.01	−0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.03)
General Care - Both Parents	−0.01	−0.01	0.00	0.00	−0.01	0.00	−0.00	0.00	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
General Care - No Adults	−0.01	−0.01	0.00	−0.00	−0.01	0.00	0.00	0.00	0.04
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)
Social Activities	0.02*	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.03
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
Media	−0.00	−0.01	−0.00	−0.00	−0.01	−0.00	−0.00	−0.00	0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)
Unknown	0.00	−0.00	0.01	0.01	0.00	0.01	−0.04	−0.04	−0.01
	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.03)	(0.03)	(0.04)
Mother Warmth and Affection	0.12***	0.11***	0.04***	0.08***	0.11***	0.04***	0.04**	0.02	0.07***
	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Authoritarian Mother	0.49***	0.47***	0.24***	0.26***	0.46***	0.24***	0.24***	0.16***	0.32***
	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)
Father Warmth and Affection	0.07***	0.06***	0.03*	0.03**	0.06***	0.03*	0.00	−0.01	0.04**
	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Authoritarian Father	0.13***	0.15***	0.07***	0.09***	0.15***	0.07***	0.08***	0.06***	0.10***
	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)
Total SDQ (Lag)			0.57***			0.57***	0.64***	0.82***	0.38***
			(0.01)			(0.01)	(0.02)	(0.02)	(0.04)
Observations	16787	9198	9198	16787	9198	9198	4621	4621	9198
R^2	0.331	0.306	0.539	0.146	0.307	0.540	0.607	0.585	
Ed: Mother vs Father	0.66	0.29	0.15	0.41	0.33	0.17	0.40	0.56	0.00
Ed: Mother vs Both Parents	0.22	0.22	0.89	0.23	0.25	0.80	0.05	0.02	0.48
Ed: Father vs Both Parents	0.22	0.84	0.13	0.99	0.87	0.12	0.38	0.13	0.01
Care: Mother vs Father	0.92	0.25	0.71	0.93	0.24	0.70	0.79	0.87	0.19
Care: Mother vs Both Parents	0.35	0.29	0.49	0.75	0.26	0.45	0.30	0.55	0.43
Care: Father vs Both Parents	0.64	0.66	0.97	0.91	0.67	0.94	0.65	0.58	0.43
Warmth: Mother vs Father	0.01	0.09	0.44	0.00	0.09	0.42	0.13	0.14	0.24
Authoritarian: Mother vs Father	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes: Socio-emotional skills are measured as the total SDQ score, provided by the primary care-giver, at ages 4–5, 6–7, 8–9, and 10–11 years. Scores are standardized for a mean of zero and a standard deviation of one. The scale has been reversed so that higher values indicate better outcomes. Time spent on each activity is measured in number of hours per day. The estimates of the effect of time spent on each activity should be interpreted as relative to time spent sleeping. All models include controls such as child's sex, age, birth order, a dummy indicating whether the child is Indigenous, along with family characteristics such as number of siblings, parents' ages, their education, and a dummy indicating whether the child lives with both parents and the main language spoken at home is English. Dummies for waves and the type of day are also included. Models also control for both parents' parenting style. To avoid losing too much observation in single-parent families, I also include observations for whom we do not observe the father's age, his education, or his parenting style, and include a set of dummies controlling whether these variables are missing. Column 1 shows the estimation results for the OLS model. Column 2 shows the estimation results for the OLS model, but including only those observations where we observe the skill in the previous wave (hence excluding wave 1), which gives a comparative sample for the value-added model, estimations of which are shown in column 3. The estimations using the individual fixed-effect model are shown in column 4. Columns 5 and 6 show the estimations for the cumulative model and the CVA model, respectively. To give a comparable sample for the CVA-IV model, estimations for the CVA model including only those children for whom we observe the skill at $t-2$ are shown in column 7. The results for the CVA-IV model are shown in column 8. Estimations of the GMM model are shown in column 9, addressing feedback effects. I test whether the differences between the effect of each parental time are statistically different from zero. I do the same for parenting style. The p-values are reported at the bottom of the table for each outcome. + p<0.10, * p<0.05, ** p<0.01, *** p<0.001. Standard errors are in parentheses.

Source: Estimation Sample drawn from the Longitudinal Study of Australian Children.

Table 8: Time Input Production Function—Social Skills

	(1) OLS	(2) OLS 2	(3) VA	(4) FE	(5) Cumulative Model	(6) CVA	(7) CVA 2	(8) CVA-IV	(9) GMM
School	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.04
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)
Educational Activities - Other Adults	0.03	0.02	−0.00	0.00	0.02	−0.00	−0.02	−0.03	0.28***
	(0.02)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)	(0.04)	(0.04)	(0.08)
Educational Activities - Mother	0.02	0.03	0.01	0.01	0.03	0.01	0.01	−0.01	0.04
	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.04)
Educational Activities - Father	−0.01	−0.02	−0.02	0.00	−0.02	−0.02	0.01	0.02	−0.01
	(0.02)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)	(0.03)	(0.04)	(0.06)
Educational Activities - Both Parents	0.01	0.02	0.01	0.02+	0.02	0.01	0.02	0.02	0.00
	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.03)	(0.03)	(0.04)
Educational Activities - No Adults	0.01	0.00	−0.01	0.01	0.00	−0.00	−0.00	−0.01	−0.01
	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.06)
General Care - Other Adults	−0.00	0.02	0.02	0.00	0.02	0.02	0.01	0.01	0.05+
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.03)
General Care - Mother	−0.00	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)
General Care - Father	−0.01	0.00	−0.00	−0.01	0.00	−0.00	0.00	−0.00	0.01
	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.02)	(0.03)
General Care - Both Parents	−0.01	−0.00	−0.01	0.01	−0.00	−0.01	−0.00	−0.00	−0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)
General Care - No Adults	−0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.03)
Social Activities	−0.00	0.00	−0.00	0.00	0.00	−0.00	−0.00	−0.00	0.03
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
Media	−0.01	−0.00	0.00	0.00	−0.00	0.00	0.00	0.00	0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)
Unknown	−0.00	0.01	0.02	0.01	0.01	0.02	0.03	0.02	−0.01
	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.05)
Mother Warmth and Affection	0.26***	0.23***	0.13***	0.16***	0.23***	0.13***	0.11***	0.05**	0.18***
	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)
Authoritarian Mother	0.30***	0.30***	0.18***	0.19***	0.30***	0.18***	0.18***	0.11***	0.23***
	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)
Father Warmth and Affection	0.03*	0.02	0.01	0.01	0.02	0.01	0.00	−0.01	0.02
	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)
Authoritarian Father	0.07***	0.09***	0.05***	0.05***	0.09***	0.05**	0.05**	0.03+	0.07***
	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Social Skills (Lag)			0.45***			0.45***	0.49***	0.77***	0.26***
			(0.01)			(0.01)	(0.02)	(0.03)	(0.04)
Observations	16787	9200	9200	16787	9200	9200	4622	4622	9200
R^2	0.217	0.211	0.389	0.116	0.213	0.390	0.423	0.357	
Ed: Mother vs Father	0.29	0.14	0.33	0.75	0.15	0.34	0.88	0.58	0.41
Ed: Mother vs Both Parents	0.47	0.66	0.93	0.43	0.68	0.88	0.64	0.39	0.37
Ed: Father vs Both Parents	0.62	0.26	0.30	0.42	0.26	0.29	0.80	0.89	0.85
Care: Mother vs Father	0.34	0.60	0.57	0.60	0.61	0.56	0.49	0.55	0.70
Care: Mother vs Both Parents	0.55	0.27	0.06	0.43	0.28	0.05	0.19	0.20	0.27
Care: Father vs Both Parents	0.59	0.83	0.53	0.31	0.84	0.52	0.80	0.77	0.67
Warmth: Mother vs Father	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Authoritarian: Mother vs Father	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes: Social skills are measured as the pro-social SDQ score, provided by the primary care-giver, at ages 4–5, 6–7, 8–9, and 10–11 years. Scores are standardized for a mean of zero and a standard deviation of one. Time spent on each activity is measured in number of hours per day. The estimates of the effect of time spent on each activity should be interpreted as relative to time spent sleeping. All models include controls such as child's sex, age, birth order, a dummy indicating whether the child is Indigenous, along with family characteristics such as number of siblings, parents' ages, their education, and a dummy indicating whether the child lives with both parents and the main language spoken at home is English. Dummies for waves and the type of day are also included. Models also control for both parents' parenting style. To avoid losing too much observation in single-parent families, I also include observations for whom we do not observe the father's age, his education, or his parenting style, and include a set of dummies controlling whether these variables are missing. Column 1 shows the estimation results for the OLS model. Column 2 shows the estimation results for the OLS model, but including only those observations where we observe the skill in the previous wave (hence excluding wave 1), which gives a comparative sample for the value-added model, estimations of which are shown in column 3. The estimations using the individual fixed-effect model are shown in column 4. Columns 5 and 6 show the estimations for the cumulative model and the CVA model, respectively. To give a comparable sample for the CVA-IV model, estimations for the CVA model including only those children for whom we observe the skill at $t-2$ are shown in column 7. The results for the CVA-IV model are shown in column 8. Estimations of the GMM model are shown in column 9, addressing feedback effects. I test whether the differences between the effect of each parental time are statistically different from zero. I do the same for parenting style. The p-values are reported at the bottom of the table for each outcome. + p<0.10, * p<0.05, ** p<0.01, *** p<0.001. Standard errors are in parentheses.

Source: Estimation Sample drawn from the Longitudinal Study of Australian Children.

Table 9: Time Input Production Function—Non-Linearity

	Verbal Skills	Logical Abilities	Total SDQ	Social Skills
	GMM	GMM	GMM	GMM
Educational Activities - Mother	0.17**	0.14	0.08	0.04
	(0.06)	(0.11)	(0.06)	(0.07)
Educational Activities - Mother X Above the Median	−0.04	−0.18+	−0.07	0.01
	(0.06)	(0.11)	(0.06)	(0.07)
Educational Activities - Father	0.11	0.13	−0.25*	−0.04
	(0.11)	(0.21)	(0.12)	(0.13)
Educational Activities - Father X Above the Median	−0.06	−0.20	0.07	0.03
	(0.11)	(0.22)	(0.13)	(0.14)
Educational Activities - Both Parents	0.19**	0.05	−0.05	0.05
	(0.07)	(0.12)	(0.07)	(0.08)
Educational Activities - Both Parents X Above the Median	−0.03	0.04	0.06	−0.05
	(0.06)	(0.11)	(0.06)	(0.07)
General Care - Mother	0.04	−0.03	−0.02	0.02
	(0.03)	(0.06)	(0.04)	(0.04)
General Care - Mother X Above the Median	0.00	−0.03	0.04	0.00
	(0.03)	(0.04)	(0.03)	(0.03)
General Care - Father	0.10	0.13	0.08	0.02
	(0.07)	(0.14)	(0.07)	(0.08)
General Care - Father X Above the Median	−0.03	−0.15	−0.08	−0.01
	(0.06)	(0.13)	(0.06)	(0.08)
General Care - Both Parents	0.04	−0.11	0.00	−0.02
	(0.04)	(0.07)	(0.04)	(0.05)
General Care - Both Parents X Above the Median	−0.02	0.05	0.01	0.02
	(0.03)	(0.05)	(0.03)	(0.03)
Observations	7010	5346	9198	9200
Ed: Mother vs Father	0.63	0.97	0.01	0.60
Ed: Mother vs Both Parents	0.78	0.52	0.10	0.89
Ed: Father vs Both Parents	0.51	0.72	0.15	0.55
Care: Mother vs Father	0.42	0.26	0.18	0.97
Care: Mother vs Both Parents	0.89	0.27	0.60	0.43
Care: Father vs Both Parents	0.38	0.11	0.30	0.62

Notes: Verbal skills are measured as the PPVT score at ages 4–5, 6–7, and 8–9 years. Logical abilities are measured as the MRT score at ages 6–7, 8–9, and 10–11 years. Socio-emotional skills are measured as the total SDQ score, provided by the primary care-giver, at ages 4–5, 6–7, 8–9, and 10–11 years. The GMM estimates are reported for each skill. Scores are standardized for a mean of zero and a standard deviation of one. Time spent on each activity is measured in number of hours per day. The estimates of the effect of time spent on each activity should be interpreted as relative to time spent sleeping. All models include controls such as child's sex, age, birth order, a dummy indicating whether the child is Indigenous, along with family characteristics such as number of siblings, parents' ages, their education, and a dummy indicating whether the child lives with both parents and the main language spoken at home is English. Dummies for waves and the type of day are also included. Models also control for both parents' parenting style. To avoid losing too much observation in single-parent families, I also include observations for whom we do not observe the father's age, his education, or his parenting style, and include a set of dummies controlling whether these variables are missing. $p<0.10$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$.

Source: Estimation Sample drawn from the Longitudinal Study of Australian Children.

Table 10: Time Input Production Function—Complementarity

	Verbal Skills	Logical Abilities	Total SDQ	Social Skills
	GMM	GMM	GMM	GMM
Educational Activities - Mother	0.13***	−0.05	0.03	0.06
	(0.04)	(0.06)	(0.04)	(0.05)
Educational Activities - Father	−0.02	−0.06	−0.17*	−0.02
	(0.06)	(0.11)	(0.08)	(0.08)
Educational Activities - Both Parents	0.15***	0.06	−0.02	0.02
	(0.04)	(0.08)	(0.04)	(0.04)
General Care - Mother	0.04+	−0.05	0.04	0.03
	(0.02)	(0.05)	(0.03)	(0.03)
General Care - Father	0.05+	0.02	−0.02	0.02
	(0.03)	(0.08)	(0.04)	(0.04)
General Care - Both Parents	0.01	−0.07	0.02	−0.00
	(0.02)	(0.05)	(0.03)	(0.03)
Educ. Act. Mother X Father	0.15	0.23	−0.09	0.04
	(0.12)	(0.25)	(0.15)	(0.13)
General Care Mother X Father	0.01	−0.05	−0.01	−0.03
	(0.02)	(0.04)	(0.02)	(0.02)
Educ. Act. Mother X Both Parents	−0.05	0.04	−0.03	−0.05
	(0.06)	(0.05)	(0.04)	(0.06)
General Care Mother X Both Parents	−0.00	0.00	−0.02*	−0.00
	(0.01)	(0.02)	(0.01)	(0.01)
Educ. Act. Father X Both Parents	0.09	−0.05	0.04	0.04
	(0.08)	(0.15)	(0.10)	(0.10)
General Care Father X Both Parents	0.01	0.00	0.02	0.01
	(0.01)	(0.02)	(0.01)	(0.01)
Mother Warmth and Affection	−0.02+	−0.03+	0.06***	0.18***
	(0.01)	(0.02)	(0.01)	(0.02)
Father Warmth and Affection	−0.00	−0.01	0.04**	0.02
	(0.01)	(0.02)	(0.01)	(0.01)
Mother's X Father's Warmth	−0.00	−0.03	−0.03	0.03
	(0.02)	(0.03)	(0.02)	(0.03)
Authoritarian Mother	0.04**	0.02	0.32***	0.24***
	(0.01)	(0.02)	(0.02)	(0.02)
Authoritarian Father	0.03*	0.04*	0.10***	0.06***
	(0.01)	(0.02)	(0.02)	(0.02)
Mother's X Father's Authoritarian	−0.01	−0.02	0.00	0.02
	(0.02)	(0.04)	(0.03)	(0.03)
Observations	7010	5346	9198	9200
Ed: Mother vs Father	0.03	0.96	0.01	0.30
Ed: Mother vs Both Parents	0.57	0.18	0.26	0.36
Ed: Father vs Both Parents	0.01	0.33	0.04	0.63
Care: Mother vs Father	0.58	0.22	0.09	0.66
Care: Mother vs Both Parents	0.06	0.72	0.17	0.09
Care: Father vs Both Parents	0.06	0.16	0.30	0.56

Notes: Verbal skills are measured as the PPVT score at ages 4–5, 6–7, and 8–9 years. Logical abilities are measured as the MRT score at ages 6–7, 8–9, and 10–11 years. Socio-emotional skills are measured as the total SDQ score, provided by the primary care-giver, at ages 4–5, 6–7, 8–9, and 10–11 years. The GMM estimates are reported for each skill. Scores are standardized for a mean of zero and a standard deviation of one. Time spent on each activity is measured in number of hours per day. The estimates of the effect of time spent on each activity should be interpreted as relative to time spent sleeping. All models include controls such as child's sex, age, birth order, a dummy indicating whether the child is Indigenous, along with family characteristics such as number of siblings, parents' ages, their education, and a dummy indicating whether the child lives with both parents and the main language spoken at home is English. Dummies for waves and the type of day are also included. Models also control for both parents' parenting style. To avoid losing too much observation in single-parent families, I also include observations for whom we do not observe the father's age, his education, or his parenting style, and include a set of dummies controlling whether these variables are missing. p<0.10, * p<0.05, ** p<0.01, *** p<0.001.

Source: Estimation Sample drawn from the Longitudinal Study of Australian Children.

Table 11: Time Input Production Function—According to Gender

	Verbal Skills	Logical Abilities	Total SDQ	Social Skills
	GMM	GMM	GMM	GMM
Educational Activities - Mother	0.16**	−0.08	−0.05	0.10
	(0.06)	(0.09)	(0.06)	(0.07)
Educational Activities - Father	0.14+	−0.23	−0.28**	0.04
	(0.08)	(0.16)	(0.11)	(0.10)
Educational Activities - Both Parents	0.12*	−0.21+	−0.03	0.01
	(0.06)	(0.12)	(0.06)	(0.07)
General Care - Mother	0.04	−0.15*	−0.04	0.02
	(0.04)	(0.07)	(0.05)	(0.05)
General Care - Father	0.11*	−0.02	−0.09+	0.01
	(0.05)	(0.09)	(0.05)	(0.05)
General Care - Both Parents	0.02	−0.14+	−0.04	0.04
	(0.04)	(0.08)	(0.05)	(0.05)
Educational Activities - Mother X Boy	−0.12	0.13	0.10	−0.14
	(0.10)	(0.14)	(0.10)	(0.11)
Educational Activities - Father X Boy	−0.16	0.34	0.17	−0.11
	(0.11)	(0.22)	(0.14)	(0.14)
Educational Activities - Both Parents X Boy	0.01	0.52**	0.01	−0.04
	(0.10)	(0.18)	(0.10)	(0.11)
General Care - Mother X Boy	−0.03	0.16	0.09	−0.05
	(0.08)	(0.11)	(0.08)	(0.09)
General Care - Father X Boy	−0.10	0.00	0.14+	−0.04
	(0.08)	(0.14)	(0.08)	(0.09)
General Care - Both Parents X Boy	−0.05	0.12	0.07	−0.10
	(0.08)	(0.11)	(0.08)	(0.09)
Observations	7010	5346	9198	9200
For Girls:				
Ed: Mother vs Father	0.86	0.31	0.02	0.52
Ed: Mother vs Both Parents	0.49	0.32	0.72	0.17
Ed: Father vs Both Parents	0.79	0.87	0.02	0.76
Care: Mother vs Father	0.04	0.08	0.07	0.60
Care: Mother vs Both Parents	0.24	0.70	0.89	0.60
Care: Father vs Both Parents	0.01	0.15	0.08	0.38
For Boys:				
Ed: Mother vs Father	0.38	0.70	0.02	0.74
Ed: Mother vs Both Parents	0.06	0.02	0.23	0.76
Ed: Father vs Both Parents	0.01	0.19	0.16	0.58
Care: Mother vs Father	0.87	0.74	0.93	0.95
Care: Mother vs Both Parents	0.06	0.60	0.27	0.09
Care: Father vs Both Parents	0.18	0.97	0.48	0.21

Notes: Verbal skills are measured as the PPVT score at ages 4–5, 6–7, and 8–9 years. Logical abilities are measured as the MRT score at ages 6–7, 8–9, and 10–11 years. Socio-emotional skills are measured as the total SDQ score, provided by the primary care-giver, at ages 4–5, 6–7, 8–9, and 10–11 years. The GMM estimates are reported for each skill. Scores are standardized for a mean of zero and a standard deviation of one. Time spent on each activity is measured in number of hours per day. The estimates of the effect of time spent on each activity should be interpreted as relative to time spent sleeping. All models include controls such as child's sex, age, birth order, a dummy indicating whether the child is Indigenous, along with family characteristics such as number of siblings, parents' ages, their education, and a dummy indicating whether the child lives with both parents and the main language spoken at home is English. Dummies for waves and the type of day are also included. Models also control for both parents' parenting style. To avoid losing too much observation in single-parent families, I also include observations for whom we do not observe the father's age, his education, or his parenting style, and include a set of dummies controlling whether these variables are missing. p<0.10, * p<0.05, ** p<0.01, *** p<0.001.

Source: Estimation Sample drawn from the Longitudinal Study of Australian Children.

Table 12: Time Input Production Function—According to Parents' Education

	Verbal Skills	Logical Abilities	Total SDQ	Social Skills
	GMM	GMM	GMM	GMM
Educational Activities - Mother	0.09+	−0.00	0.02	0.04
	(0.05)	(0.07)	(0.04)	(0.05)
Educational Activities - Father	0.04	−0.15	−0.19**	−0.09
	(0.06)	(0.16)	(0.07)	(0.08)
Educational Activities - Both Parents	0.07+	0.22*	0.02	−0.00
	(0.04)	(0.11)	(0.04)	(0.05)
General Care - Mother	0.04+	−0.06	0.02	0.00
	(0.02)	(0.04)	(0.02)	(0.03)
General Care - Father	0.07*	−0.02	−0.01	0.02
	(0.03)	(0.07)	(0.03)	(0.03)
General Care - Both Parents	0.02	−0.06	−0.01	−0.01
	(0.02)	(0.04)	(0.02)	(0.02)
Educational Activities - Mother X Parent has a degree	0.08	0.03	−0.04	−0.02
	(0.06)	(0.08)	(0.05)	(0.06)
Educational Activities - Father X Parent has a degree	0.03	0.21	0.02	0.15
	(0.08)	(0.18)	(0.10)	(0.10)
Educational Activities - Both Parents X Parent has a degree	0.18***	−0.21	−0.07	0.00
	(0.05)	(0.13)	(0.06)	(0.07)
General Care - Mother X Parent has a degree	−0.00	0.07+	−0.03	0.00
	(0.02)	(0.04)	(0.02)	(0.03)
General Care - Father X Parent has a degree	−0.00	0.02	−0.04	−0.04
	(0.03)	(0.08)	(0.04)	(0.04)
General Care - Both Parents X Parent has a degree	−0.01	0.05	0.01	−0.00
	(0.02)	(0.04)	(0.02)	(0.02)
Observations	7010	5346	9198	9200
For Parents without an academic degree:				
Ed: Mother vs Father	0.54	0.39	0.01	0.12
Ed: Mother vs Both Parents	0.82	0.07	0.99	0.51
Ed: Father vs Both Parents	0.65	0.05	0.01	0.29
Care: Mother vs Father	0.33	0.53	0.37	0.60
Care: Mother vs Both Parents	0.13	0.86	0.17	0.54
Care: Father vs Both Parents	0.04	0.45	0.96	0.33
For Parents with an academic degree:				
Ed: Mother vs Father	0.21	0.77	0.07	0.60
Ed: Mother vs Both Parents	0.13	0.85	0.56	0.81
Ed: Father vs Both Parents	0.01	0.70	0.18	0.51
Care: Mother vs Father	0.25	0.94	0.13	0.32
Care: Mother vs Both Parents	0.10	0.54	0.66	0.40
Care: Father vs Both Parents	0.01	0.77	0.07	0.65

Notes: Verbal skills are measured as the PPVT score at ages 4–5, 6–7, and 8–9 years. Logical abilities are measured as the MRT score at ages 6–7, 8–9, and 10–11 years. Socio-emotional skills are measured as the total SDQ score, provided by the primary care-giver, at ages 4–5, 6–7, 8–9, and 10–11 years. The GMM estimates are reported for each skill. Scores are standardized for a mean of zero and a standard deviation of one. Time spent on each activity is measured in number of hours per day. The estimates of the effect of time spent on each activity should be interpreted as relative to time spent sleeping. All models include controls such as child's sex, age, birth order, a dummy indicating whether the child is Indigenous, along with family characteristics such as number of siblings, parents' ages, their education, and a dummy indicating whether the child lives with both parents and the main language spoken at home is English. Dummies for waves and the type of day are also included. Models also control for both parents' parenting style. To avoid losing too much observation in single-parent families, I also include observations for whom we do not observe the father's age, his education, or his parenting style, and include a set of dummies controlling whether these variables are missing. p<0.10, * p<0.05, ** p<0.01, *** p<0.001.

Source: Estimation Sample drawn from the Longitudinal Study of Australian Children.

10 Appendix

10.1 Additional Descriptive Statistics

[**Fig.** 1 about here.]

[**Table** 13 about here.]

[**Table** 14 about here.]

[**Table** 15 about here.]

[**Fig.** 2 about here.]

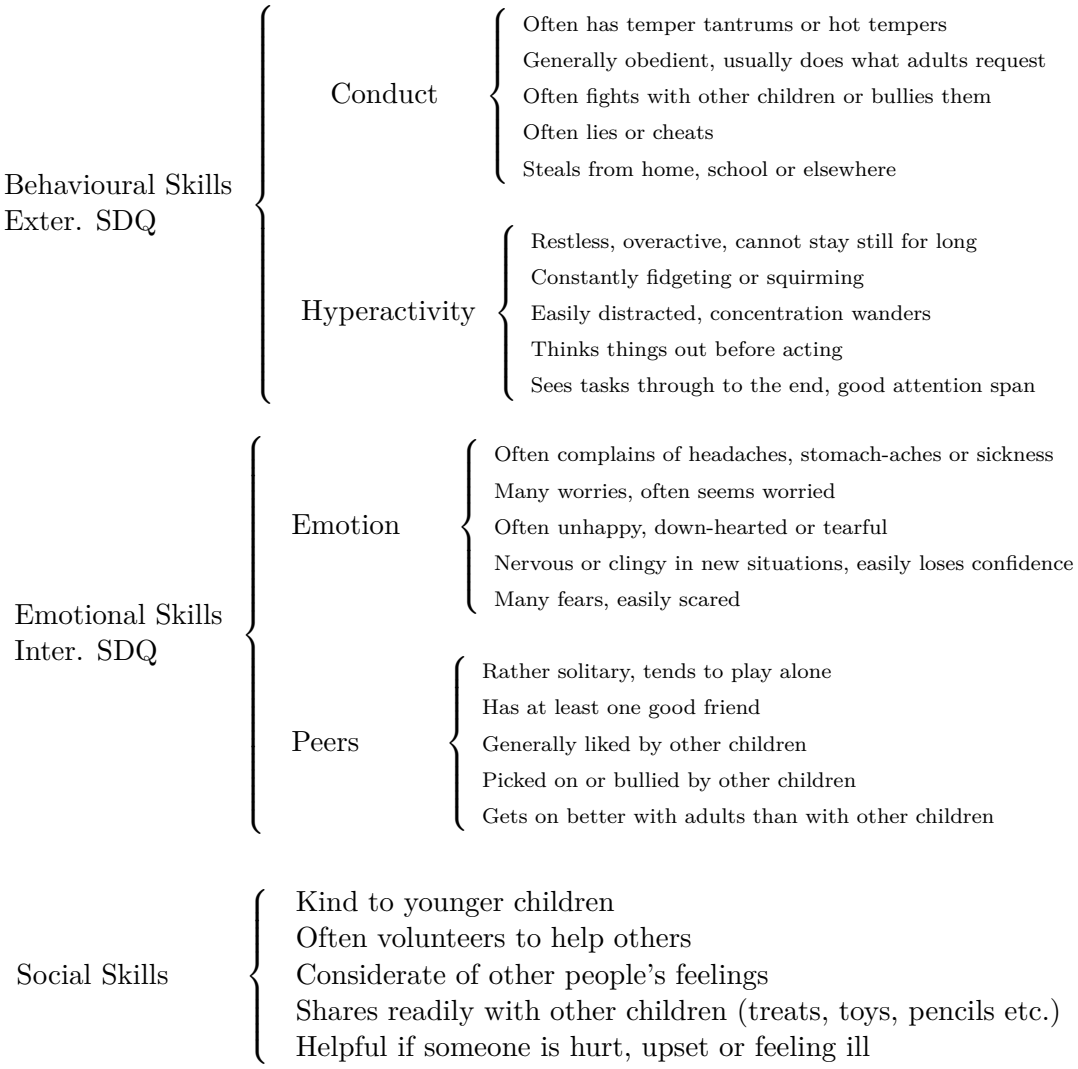
[**Fig.** 3 about here.]

[**Fig.** 4 about here.]

[**Fig.** 5 about here.]

[**Table** 16 about here.]

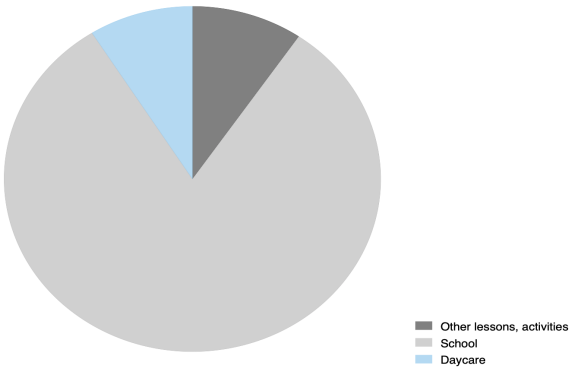
Fig. A.1: Strength and Difficulty Questionnaire



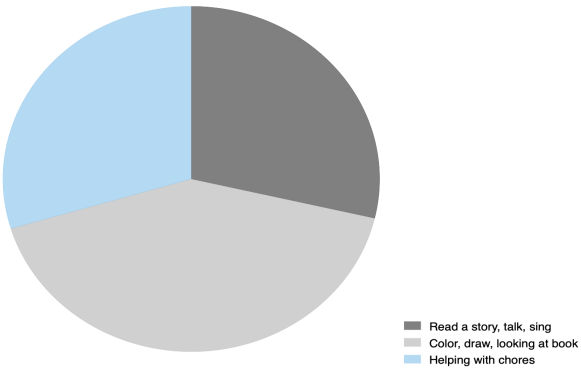
Notes: For each question, the parent or the teacher must assess whether it is not true, somewhat true, or certainly true for the child's behavior over the last six months.

Fig. A.2: Typology—breakdown of time spent on each activity into the category recorded—waves 1–3

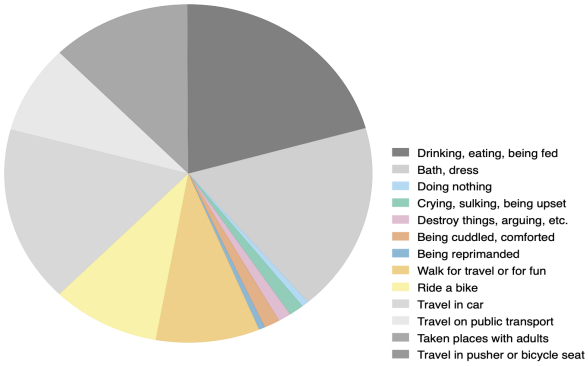
(a) Daycare or School



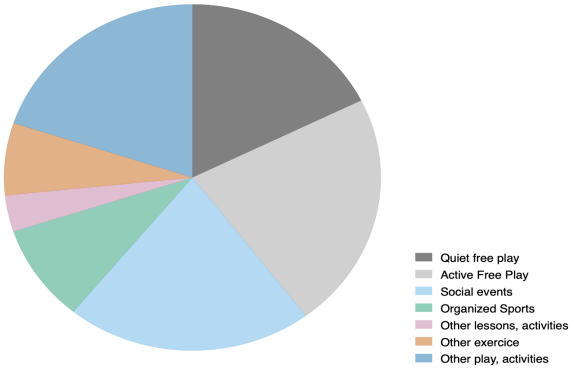
(b) Educational Activities



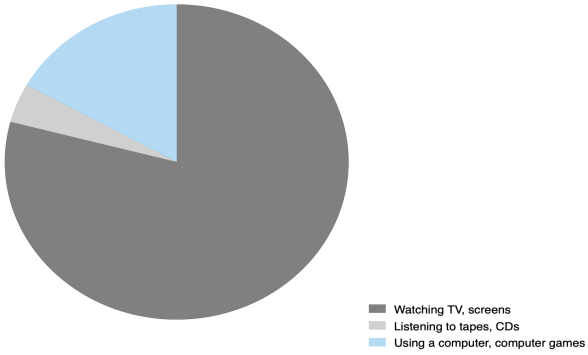
(c) General Care



(d) Social Activities



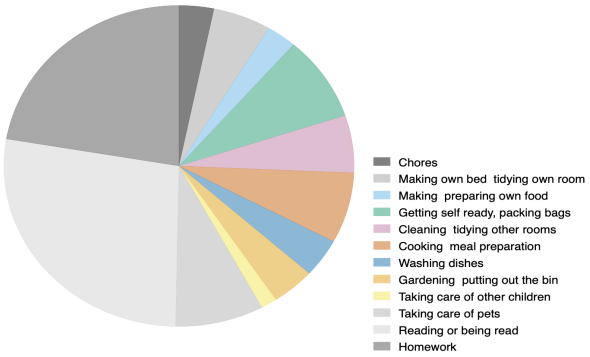
(e) Media



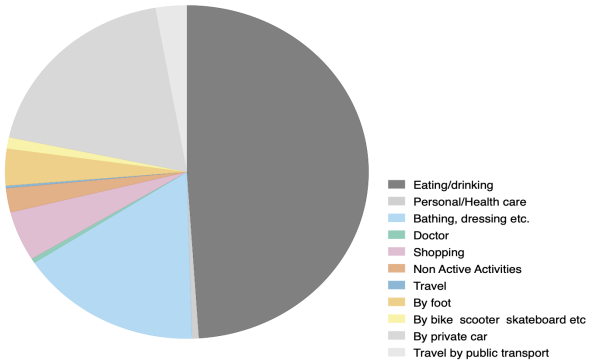
Notes: The pie graphs show the breakdown of each activity across the different categories of the typology, as it was recorded in the time-use diary for each day, from waves 1 to 3.
Source: Estimation Sample drawn from the Longitudinal Study of Australian Children.

Fig. A.3: Typology—breakdown of time spent on each activity into the category recorded—wave 4

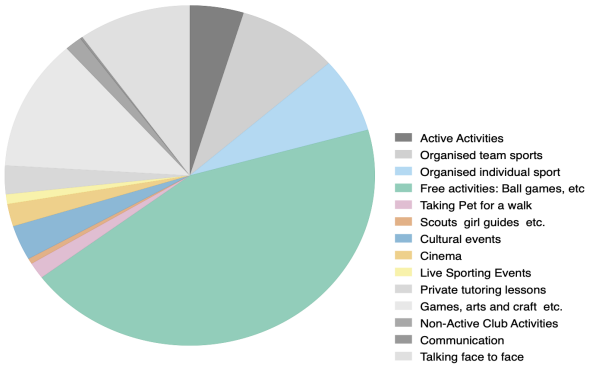
(a) Educational Activities



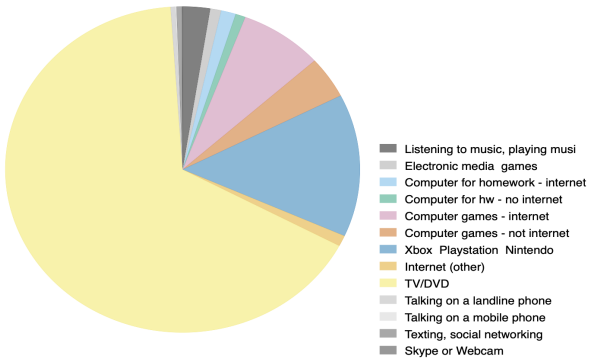
(b) General Care



(c) Social Activities



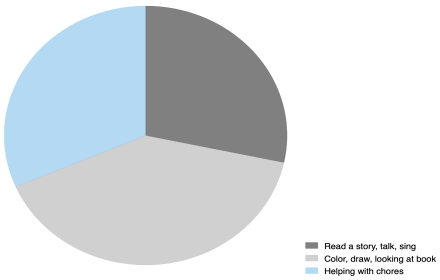
(d) Media



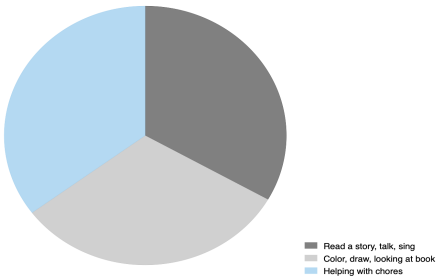
Notes: The pie graphs show the breakdown of each activity across the different categories of the typology, as it was recorded in the time-use diary for each day, in wave 4. For this wave, the breakdown of school time is not reported since it is time spent wholly at school.
Source: Estimation Sample drawn from the Longitudinal Study of Australian Children.

Fig. A.4: Typology—breakdown parental time into the activity recorded—waves 1–3

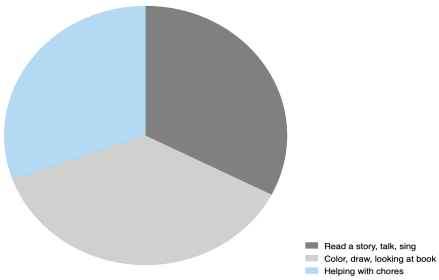
(a) Time spent on educational activities with the mother only



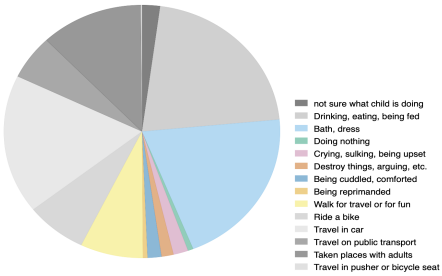
(b) Time spent on educational activities with the father only



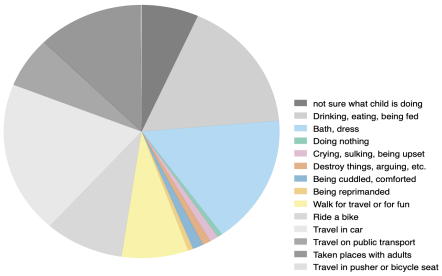
(c) Time spent on educational activities with both parents together



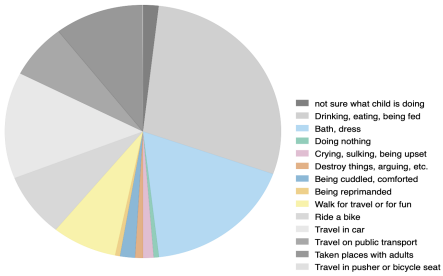
(d) Time spent on general care with the mother only



(e) Time spent on general care with the father only



(f) Time spent on general care with both parents together

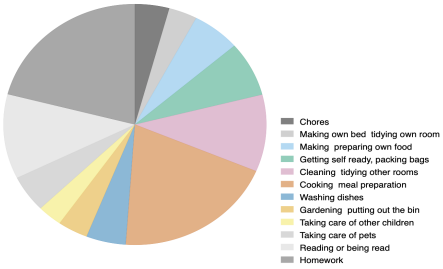


Notes: The pie graphs show the breakdown of each parental category of time spent on educational activities and general care across all the different activities, as it was recorded in the time-use diary for each day, in waves 1 to 3.

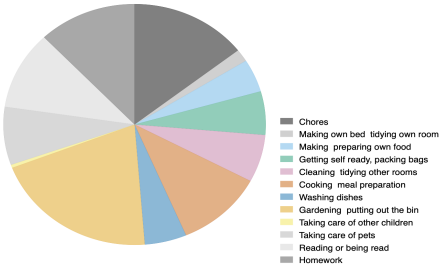
Source: Estimation Sample drawn from the Longitudinal Study of Australian Children.

Fig. A.5: Typology—breakdown of parental time into the activity recorded—wave 4

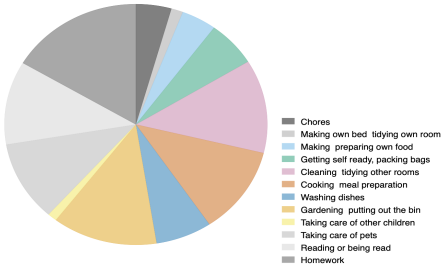
(a) Time spent on educational activities with the mother only



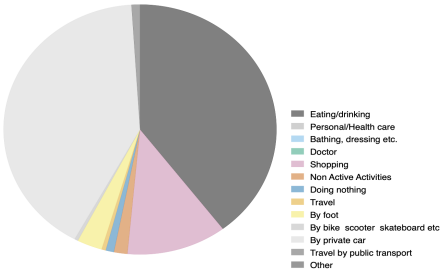
(b) Time spent on educational activities with the father only



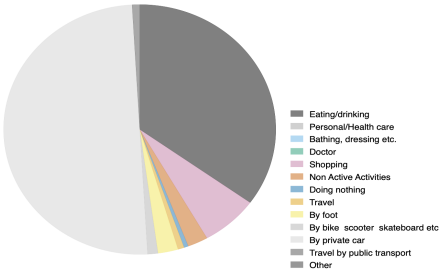
(c) Time spent on educational activities with both parents together



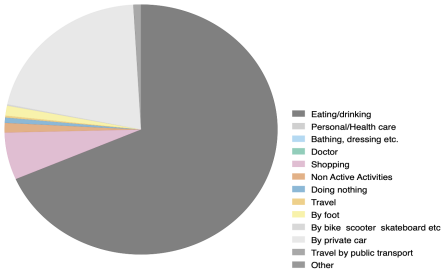
(d) Time spent on general care with the mother only



(e) Time spent on general care with the father only



(f) Time spent on general care with both parents together



Notes: The pie graphs show the breakdown of each parental category of time spent on educational activities and general care across all the different activities, as it was recorded in the time-use diary for each day, in wave 4.

Source: Estimation Sample drawn from the Longitudinal Study of Australian Children.

Table A.1: Description of Sample Selection and Attrition

	(1) Being in the sample	(2) Attrition for Verbal Skills	(3) Attrition for Logical Abilities	(4) Attrition for Socio-Emotional Skills
Boy	0.00	−0.01	−0.01	−0.01
	(0.01)	(0.01)	(0.01)	(0.01)
Indigenous	0.02	0.19***	0.12**	0.19***
	(0.02)	(0.04)	(0.04)	(0.04)
Second Born	−0.01+	0.03**	0.03*	0.04***
	(0.01)	(0.01)	(0.01)	(0.01)
Third Born	0.00	0.05*	0.01	0.03+
	(0.01)	(0.02)	(0.02)	(0.02)
Fourth Born	−0.01	0.10**	0.09**	0.07*
	(0.02)	(0.03)	(0.03)	(0.03)
Fifth Born and more	0.03	0.17**	0.13*	0.12*
	(0.03)	(0.06)	(0.06)	(0.05)
Child's age (months)	0.00***	−0.00***	−0.00**	−0.00***
	(0.00)	(0.00)	(0.00)	(0.00)
Mother's age	−0.00	−0.00***	−0.01***	−0.00***
	(0.00)	(0.00)	(0.00)	(0.00)
Father's age	−0.00	0.00	−0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Live with Two Parents	−0.01	−0.14***	−0.07**	−0.09***
	(0.02)	(0.03)	(0.02)	(0.02)
No. of Siblings	−0.01	0.00	0.01+	0.01*
	(0.00)	(0.01)	(0.01)	(0.01)
Mother Education: Year 8/below	−0.03	0.30***	0.37***	0.32***
	(0.03)	(0.08)	(0.08)	(0.07)
Mother Education: Year 9	0.00	0.14***	0.02	0.06
	(0.03)	(0.04)	(0.05)	(0.04)
Mother Education: Year 10	−0.02	0.05*	0.13***	0.13***
	(0.01)	(0.02)	(0.03)	(0.02)
Mother Education: Year 11	0.00	0.01	0.05	0.04+
	(0.02)	(0.03)	(0.03)	(0.02)
Mother Education: Other Degree	−0.04	0.07	0.13**	0.06
	(0.02)	(0.04)	(0.05)	(0.04)
Mother Education: Certificate	−0.01	0.06**	0.04*	0.07***
	(0.01)	(0.02)	(0.02)	(0.02)
Mother Education: Advanced diploma	−0.01	0.04+	0.05*	0.05**
	(0.01)	(0.02)	(0.02)	(0.02)
Mother Education: Bachelor degree	0.00	−0.05**	−0.02	−0.02
	(0.01)	(0.02)	(0.02)	(0.02)
Mother Education: Graduate diplome/certificate	−0.00	0.02	0.02	0.03
	(0.01)	(0.02)	(0.03)	(0.02)
Mother Education: Posgraduate degree	0.01	−0.01	−0.04+	−0.02
	(0.02)	(0.03)	(0.03)	(0.02)
Father Education: Year 8/below	−0.02	−0.03	−0.01	0.02
	(0.03)	(0.07)	(0.06)	(0.06)
Father Education: Year 9	−0.02	−0.06	−0.06	−0.13**
	(0.03)	(0.05)	(0.06)	(0.05)
Father Education: Year 10	0.02	0.03	0.01	−0.00
	(0.02)	(0.03)	(0.03)	(0.02)
Father Education: Year 11	0.04+	0.10**	0.09*	0.06+
	(0.02)	(0.04)	(0.04)	(0.03)
Father Education: Other Degree	−0.00	−0.01	−0.02	−0.05
	(0.02)	(0.04)	(0.04)	(0.03)
Father Education: Certificate	0.01	0.02	0.00	−0.01
	(0.01)	(0.02)	(0.02)	(0.02)
Father Education: Advanced diploma	0.01	−0.02	−0.04	−0.04+
	(0.02)	(0.03)	(0.03)	(0.02)
Father Education: Bachelor degree	0.01	0.05*	0.01	0.02
	(0.01)	(0.02)	(0.02)	(0.02)
Father Education: Graduate diplome/certificate	0.01	0.07*	0.07*	0.05*
	(0.02)	(0.03)	(0.03)	(0.03)
Father Education: Posgraduate degree	0.02	0.01	−0.07*	−0.07**
	(0.02)	(0.03)	(0.03)	(0.02)
Main language spoken at home is English	0.04***	−0.18***	−0.18***	−0.20***
	(0.01)	(0.02)	(0.02)	(0.02)
Mother Warmth and Affection	0.00	0.01	0.02***	0.02***
	(0.00)	(0.01)	(0.01)	(0.01)
Authoritarian Mother	0.01*	−0.04***	−0.03***	−0.04***
	(0.00)	(0.01)	(0.01)	(0.01)
Father Warmth and Affection	−0.00	0.02**	0.02**	0.02***
	(0.00)	(0.01)	(0.01)	(0.01)
Authoritarian Father	0.00	−0.03***	−0.02**	−0.02**
	(0.00)	(0.01)	(0.01)	(0.01)
Observations	12634	8309	7744	10766

Notes: The first column reports the marginal effects of a logit regression, where the dependent variable is a dummy equal to one if the child is in the sample and zero otherwise. Columns 2–4 report the marginal effects of a logit regression with a dependent variable equal to one if the child's skill is not observed throughout the survey, and zero otherwise. For verbal skills and logical abilities, the samples include only waves 1–3 and 2–4, respectively.

Source: Estimation Sample drawn from the Longitudinal Study of Australian Children.

Table A.2: Summary Statistics of Time Use (Hours Per Day), By Type of Day (Weekday/Weekend)

	1st wave (4-5 y-o)				2nd wave (6-7 y-o)				3rd wave (8-9 y-o)				4th wave (10-11 y-o)			
	Weekday		Weekend		Weekday		Weekend		Weekday		Weekend		Weekday		Weekend	
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
Bed	11.57	1.20	11.68	1.39	11.00	0.94	11.27	1.28	10.76	0.96	11.12	1.35	10.25	1.05	10.70	1.34
School	3.71	3.19	0.75	1.37	7.11	1.09	0.69	1.41	7.24	1.21	0.68	1.37	3.05	2.27	0.00	0.06
Educational Activities - Other Adults	0.10	0.43	0.08	0.40	0.02	0.12	0.04	0.27	0.01	0.11	0.03	0.24	0.16	0.42	0.16	0.51
Educational Activities - Parents	1.21	1.43	1.37	1.69	0.54	0.55	0.73	0.90	0.50	0.58	0.70	0.91	0.25	0.59	0.33	0.74
Educational Activities - No Adults	0.22	0.56	0.23	0.62	0.13	0.33	0.16	0.39	0.16	0.37	0.21	0.49	0.65	0.86	0.65	0.97
General Care - Other Adults	0.34	1.06	0.28	0.92	0.17	0.48	0.28	1.02	0.16	0.50	0.25	0.91	1.31	1.18	0.77	1.17
General Care - Parents	3.21	2.09	4.17	2.26	2.19	1.17	3.71	2.02	2.15	1.16	3.58	2.04	1.80	1.45	2.92	2.19
General Care - No Adults	0.74	1.27	0.70	1.24	0.68	0.90	0.73	1.13	0.70	0.84	0.72	1.01	1.17	0.90	1.14	0.95
Social Activities	1.54	1.57	3.18	2.18	1.21	0.98	4.28	2.27	1.20	1.03	4.15	2.41	2.54	1.74	3.12	2.13
Media	1.25	1.19	1.51	1.31	0.90	0.80	2.02	1.52	1.07	0.95	2.48	1.73	2.68	2.13	4.02	2.51
Unknown	0.11	0.73	0.05	0.41	0.06	0.39	0.08	0.48	0.05	0.33	0.08	0.40	0.14	0.45	0.17	0.55
Educational Activities - Mother	0.74	1.13	0.54	1.04	0.29	0.42	0.29	0.57	0.26	0.43	0.27	0.56	0.18	0.50	0.19	0.56
Educational Activities - Father	0.11	0.35	0.17	0.49	0.06	0.20	0.11	0.38	0.05	0.19	0.10	0.38	0.04	0.23	0.09	0.35
Educational Activities - Both Parents	0.36	0.68	0.66	1.19	0.19	0.35	0.33	0.64	0.19	0.38	0.34	0.64	0.03	0.16	0.06	0.29
General Care - Mother	1.99	1.86	1.45	1.82	1.25	1.04	1.20	1.57	1.18	1.05	1.18	1.59	1.09	1.29	1.10	1.75
General Care - Father	0.30	0.74	0.52	1.02	0.20	0.47	0.46	1.00	0.21	0.51	0.44	0.98	0.23	0.57	0.46	1.08
General Care - Both Parents	0.93	1.20	2.20	2.15	0.74	0.82	2.04	1.97	0.75	0.82	1.96	1.93	0.48	0.83	1.37	1.83
Observations	2790		2738		2085		2579		1777		2369		1947		510	

Notes: This table reports children's time use (hours per day) by wave. In the first three waves, children may appear twice in a wave if they completed a time-use diary for a day during the week and at the weekend. Time spent with the mother and with the father denotes time spent alone with the parent, possibly with other adults, but without the other parent. See Figures A.2 and A.3 for more details on the typology of time use.

Source: Estimation Sample drawn from the Longitudinal Study of Australian Children. Weighting is used to ensure the sample to be representative of the Australian population.

Table A.3: Summary of Assumptions For Each model

	OLS	VA	FE	Cumulative	Cumulative VA	CVA - IV	GMM
Control for Y_{it-1}		✓			✓	✓	✓
Control for individual FE			✓				
Control for past time inputs				✓	✓	✓	
Measurement error in the child's skill are uncorrelated with input and child's unobserved ability	X	X	X	X	X	X	X
Any omitted input is uncorrelated with included input	X	X	X	X	X	X	X
The production function is non age varying	X	X	X			X	
The effect of past input / unobs. ability is constant by age	ignored		X	ignored			
The effect of past input / unobs. ability is decreasing by age at a constant rate λ		X			X	X	X
Heterogeneity of learning speed is uncorrelated with included inputs	X	X	X	X	X	X	

Notes: This table summarizes the assumptions for the Ordinary Least Square (OLS), the value-added (VA), the individual fixed-effect (FE), the cumulative, the cumulative value-added, the cumulative value-added model with instrument (CVA-IV) and the generalized method of moments (GMM) models.

Table A.4: Parenting Style—Factor Loadings

Panel A: Mother Parenting Style								
	Wave 1		Wave 2		Wave 3		Wave 4	
	Factor 1	Factor 2	Factor 1	Factor 2	Factor 1	Factor 2	Factor 2	Factor 2
Display Physical Affection	0.59	0.07	0.72	0.06	0.75	0.09	0.76	0.12
Hug the child	0.65	0.03	0.67	0.05	0.68	0.07	0.72	0.12
Express hapiness to the child	0.69	0.08	0.69	0.11	0.75	0.11	0.74	0.15
Warm encounters with the child	0.69	0.06	0.76	0.09	0.78	0.12	0.79	0.15
Enjoy doing things with the child	0.66	0.12	0.68	0.13	0.72	0.18	0.71	0.22
Close when the child is happy or upset	0.64	0.13	0.71	0.13	0.70	0.18	0.70	0.22
Explains corrections	0.50	0.12	0.47	0.07	0.48	0.04	0.50	0.01
Reasons when misbehaves	0.52	0.09	0.51	0.06	0.51	0.06	0.54	0.02
Make sure complete requests	0.24	0.27	0.21	0.22	0.21	0.23	0.16	0.20
Punish the child	0.05	0.29	0.08	0.29	0.05	0.29	0.07	0.26
The child does not get away unpunished	-0.01	0.65	0.01	0.69	0.02	0.66	0.00	0.67
The child does not get out of punishment	-0.04	0.64	-0.02	0.66	-0.01	0.64	0.00	0.64
The child does not ignore punishment	0.07	0.68	0.02	0.70	0.06	0.70	0.06	0.71
Praise Behaviour	0.40	0.17	0.44	0.13	0.47	0.25	0.43	0.29
Rarely Disapprove of Behaviour	0.14	0.41	0.14	0.48	0.25	0.45	0.19	0.48
Rarely Angry when punishing	0.13	0.36	0.13	0.41	0.14	0.39	0.15	0.48
Rarely Have problems managing	0.16	0.55	0.13	0.61	0.15	0.61	0.15	0.65
Panel B: Father Parenting Style								
	Wave 1		Wave 2		Wave 3		Wave 4	
	Factor 1	Factor 2	Factor 1	Factor 2	Factor 1	Factor 2	Factor 2	Factor 2
Display Physical Affection	0.68	0.02	0.77	0.05	0.76	0.08	0.75	0.15
Hug the child	0.70	-0.02	0.72	0.04	0.69	0.07	0.71	0.13
Express happiness to the child	0.68	0.06	0.72	0.05	0.74	0.10	0.74	0.14
Warm encounters with the child	0.72	0.04	0.78	0.04	0.77	0.12	0.75	0.18
Enjoy doing things with the child	0.64	0.08	0.71	0.11	0.69	0.20	0.69	0.21
Close when the child is happy or upset	0.66	0.10	0.73	0.11	0.72	0.22	0.70	0.21
Explains corrections	0.41	0.24	0.47	0.18	0.48	0.08	0.47	0.01
Reasons when misbehaves	0.47	0.20	0.54	0.20	0.52	0.08	0.53	-0.00
Make sure complete requests	0.10	0.41	0.11	0.36	0.12	0.24	0.15	0.17
Punish the child	-0.03	0.53	-0.02	0.42	0.03	0.27	0.05	0.25
The child does not get away unpunished	0.05	0.65	0.02	0.67	0.06	0.64	0.08	0.68
The child does not get out of punishment	0.02	0.63	0.01	0.64	-0.00	0.61	-0.00	0.65
The child does not ignore punishment	0.17	0.58	0.14	0.62	0.08	0.70	0.08	0.71
Praise Behaviour	0.47	0.11	0.53	0.22	0.48	0.26	0.54	0.26
Rarely Disapprove of Behaviour	0.28	0.20	0.36	0.30	0.23	0.40	0.30	0.46
Rarely Angry when punishing	0.23	0.18	0.19	0.34	0.11	0.39	0.10	0.42
Rarely Have problems managing	0.29	0.43	0.23	0.50	0.15	0.60	0.14	0.61

Notes: I use a factor analysis to identify broader indicators of parenting style. This table reports the rotated loading coefficients for both parents.

Source: Estimation Sample drawn from the Longitudinal Study of Australian Children.