A Matter of Time

Father Involvement and Child Cognitive Outcomes*

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Abstract

Fathers in Western countries allocate progressively more time to childcare. However, most research on how parental time inputs affect child development focuses on maternal time, and it remains empirically unclear how paternal involvement in the child's upbringing influences child outcomes. This study provides the first systematic account of how father-child time (in total and across activity types) relates to children's cognitive development, measured using the Peabody Picture Vocabulary Test. In addition, it examines whether and how paternal education moderates these associations. To accomplish this, the study uses unique, longitudinal, time-diary data from an Australian sample of children aged 4-8 years (Longitudinal Study of Australian Children; n=3,273 children/6,960 observations). Results show that the total amount of father-child time is associated with small improvements in children's cognitive functioning, whereas the amount of father-child time in educational activities is associated with moderate-to-large improvements. Such associations are similar for highly and less-highly educated fathers.

Keywords

Child development; cognitive development; social stratification, time diaries; panel data; Australia

INTRODUCTION

During the past few decades many Western countries have witnessed a rise in fathers' involvement in childcare –defined as the time father and child spend together (Gauthier et al., 2004). This shift has

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been attributed to increasing maternal labour force participation and the spread of gender egalitarian and intensive parenting ideologies (Esping-Andersen, 2009). In this emerging model of involved fatherhood, fathers are not only expected to act as income providers, but also to actively engage with the day-to-day caring and upbringing of their children (Barbeta and Cano, 2017).

The importance of fathers' involvement in childcare is twofold. First, it can be a precursor to increasing gender equality within families, by 'freeing up' time for mothers to develop their skills, (re-)enter the labour market, and realise their economic potential (Hook, 2006). Second, theoretical perspectives in sociology, psychology and economics suggest that fathers' time in childcare should be positively associated with child development (Cabrera, Shannon and Tamis-LeMonda, 2007; Pleck, 2010). For instance, children with involved fathers are exposed to more varied stimuli, resulting from interacting with two parents with different values, behaviors, vocabulary and parenting styles, and this can lead to better cognitive outcomes for the child (Lamb, 2010).

The increasing availability of quality time-use data on families has spurred a wave of research and academic debate on whether and how parental time investments contribute to child development. Recent studies have focused on the time allotments made by mothers (e.g. Hsin and Felfe, 2014; Milkie et al., 2015; Fomby and Musick, 2017) or parents, in general (Fiorini and Keane, 2014). The findings are mixed. While some authors find that maternal time is an important determinant of children's cognitive functioning (Del Bono et al., 2016), others report very small associations (Fomby and Musick, 2017) and no relationship (Milkie et al., 2015). This research has motivated a lively discussion on the topic (see Waldfogel, 2016; Kalil and Mayer, 2016; Nomaguchi et al, 2016; Wolfers, 2015). Importantly, some studies suggest that not all types of parental time are beneficial for children (Hsin and Felfe, 2014; Fiorini and Keane, 2014). Activity content matters and parent-child time spent in educational activities is comparatively more productive than parent-child time spent in other activities (Hsin, 2009). However, this literature has largely neglected how the time children spend with their *fathers* (as opposed to their mothers or any parent) influences child outcomes. This study fills this gap in knowledge by considering father-child time in its own right.

We contribute to the literature on father's involvement in childrearing and the incipient literature on parental time investments and child outcomes in two main ways. First, we use detailed time-use information on the amount of time fathers spend with their children, and the nature of their joint activities. This contrasts with previous research relying on coarse proxy measures for parental time investments, such as employment hours (Bernal, 2008), or considering certain types of time in isolation, such as educational or recreational time (Del Bono et al., 2016). Second, we consider effect heterogeneity by paternal education (Lareau, 2011). Time-use research indicates that more educated parents spend more time with their children than less educated parents, and also allocate more time to shared activities that enhance child development (Guryan et al., 2008). This time expenditure gap is widening over time (Putnam, 2015; Altintas, 2015). Hence, if fathers' time in childcare has positive impacts on children's cognitive capacities, it could be a contributing factor to the intergenerational (re)production of inequalities and the 'diverging destinies' of children from more and less advantaged families (McLanahan, 2004; Kalil, Ryan and Corey 2012).

The goal of this paper is therefore to provide the first encompassing empirical account of the associations between father-child time and children's cognitive outcomes, focusing on two-parent families. To accomplish this, we use high quality, time-diary, panel data from the *Longitudinal Study of Australian Children* (LSAC) on the amount of time that fathers spend with their children.

THEORETICAL FRAMEWORK

Cognitive skills are core skills that relate to individual learning and problem solving, and encompass aspects such as attention, memory, reasoning and thinking. These crucial skills enable individuals to process sensory information (e.g. evaluate, analyze, remember, make comparisons, etc.), and are important precursors of academic success (Duncan et al., 2007) and labor-market outcomes (Heckman, 2006). Cognitive skills develop at a faster rate during childhood, when brain plasticity is greatest, and through children's interactions with their parents, relatives and peers in their school, neighborhood and family home (Shonkoff et al., 2000). Hence, such skills are socially reproduced, transmitted from generation to generation, and highly dependent on the socio-economic context in

which childhood takes place. In the following sections, we draw on principles from developmental psychology, economics and social stratification research, and previous empirical evidence, to develop testable hypotheses about how father-child time contributes to shaping children's cognitive outcomes. Although father and child may undertake activities that also involve the child's mother, here we focus on the time that fathers spend with their children without maternal involvement. During that time, it is safe to assume that the sole (or chief) responsibility for the child rests upon the father. We take this course of action because, when the child shares time with both mother and father, parents tend to adopt gender-typical roles: mothers can act as 'gatekeepers' to father-child interactions and decision making, while fathers often enact a secondary role as 'helpers', taking direction from mothers (Coltrane, 1996; Pleck, 2010). More importantly, we are interested in the effect of paternal time in its own right, as it remains unclear whether and how this type of time is related to children's cognitive outcomes. This separates our study from previous research focusing on mother-child time (see e.g. Del Bono et al., 2016; Milkie et al., 2015; Fomby and Musick, 2017) or time spent between the child and any parent (see e.g. Fiorini and Keane, 2014). We consider two separate components of father-child time: (i) the quantity of time that fathers spend with their children, and (ii) the content of the joint activities undertaken during that time.

Father-child time quantity

To our knowledge, no previous study has provided an encompassing empirical account of how the amount of time that fathers spend engaging with their children affects child development. However, this type of time has been previously recognized as an important dimension of father's involvement in the child's upbringing (Russell, 1983; Wilson and Prior, 2010). Different theoretical perspectives suggest plausible mechanisms that link the amount of father-child time with children's cognitive development.

First, spending time with the father may benefit the child by exposing him/her to two involved parental figures, instead of just one. A vast majority of mothers are highly involved in the day-to-day care of their children, but this is the case for only a fraction of all fathers (Craig, 2006). Hence, to the

extent that mother and father are different in their behaviors and personalities, father's involvement may result in greater heterogeneity in the stimuli to which the child is exposed (Amato, 1998; Lamb, 2010). For example, fathers and mothers tend to spend time with their children in different ways: mothers spend a greater share of time in routine care, while fathers spend a greater share in playful and educational activities (Craig and Mullan, 2011; McBride and Mills, 1993). In addition, fathers and mothers talk differently to their children, and have different conversation topics (Pancsofar and Vernon-Feagans, 2006). Fathers' language skills are more predictive of children's vocabulary than mothers', and have been argued to afford children extra capabilities in talking to strangers and in public settings (Rowe et al., 2004).

During play, fathers are more likely than mothers to encourage their children to take risks, while mothers are more likely than fathers to encourage them to take account of others' feelings (Clarke-Stewart, 1978). Diversity in parental inputs should result in enhanced cognitive capacity in the child (Cook et al., 2011). This is because, as argued in social-learning theory, skills are acquired by observation (Bandura, 1977). Similarly, as posed by role-model theory, "*individuals influence role aspirants' achievements, motivation, and goals by acting as behavioral models, representations of the possible, and/or inspirations*" (Morgenroth et al., 2015: 4). Hence, an involved father can act both as a role model for children to reinforce, adopt and pursue goals, and as an 'observation point' for them to learn problem-solving behaviors. These interactions should promote child development in both cognitive and non-cognitive skills, and these are known to be mutually reinforcing –*skills beget skills* (Heckman, 2006).

Second, regardless of whether or not fathers exert different parenting to mothers, the time fathers spend with their children may be a substitute for time spent with other guardians. That is, spending more time with a father may mean spending less time with individuals who are less interested in, are less committed to, or are less able to enhance the child's cognitive upbringing than a father (Cooke and Baxter, 2010). For example, when fathers do not spend time with their children, relatives (e.g. grandparents), neighbors or external carers (e.g. *au pairs*, or nannies) may take responsibility for the

child. The activities and interactions that the child undertakes with these other agents may be less conducive to cognitive development than those initiated by fathers (Belsky et al., 2007). This could occur if the alternative guardians are less educated or less knowledgeable about parenting practices than that child's father (which may be the case for grandparents), or have less knowledge about the child's abilities and dispositions (which may be the case for external carers). It is also possible that paternal time acts as a substitute for time alone. Therefore, paternal time with the child may have a positive effect on child outcomes through substitution, by crowding out less productive time uses.

Third, fathers' involvement in childcare improves certain aspects of family life, which may in turn have downstream positive effects on the child (Lamb, 2010; Pleck, 2010). Increasing father-child time expenditure shifts some of the childcare burden away from mothers. In doing so, it eases maternal time pressure and work-family conflict, and 'frees' up time for mothers to increase their social and economic participation, or to spend on leisure (Kalil, Ziol-Guest and Coley, 2005). Critically, paternal involvement in childcare is a contributing factor to maternal employment, and this is associated with better child cognitive development (see e.g. Brooks-Gunn, Han and Waldfogel, 2002). In contrast, low paternal involvement in childcare can exacerbate maternal stress and mental strain, and result in suboptimal parenting practices amongst mothers through 'parenting stress' (Kalil, Ziol-Guest and Coley, 2005; Schober, 2012). Therefore, greater paternal involvement in childcare should indirectly enhance the quality of mother-child relationships and, through that channel, the child's cognitive development (Lamb, 2010). In addition, families in which fathers contribute to childcare are characterized by a range of positive outcomes (Goeke-Morey and Cummings, 2007), including positive parenting practices (Jia and Schoppe-Sullivan, 2011) and a lower propensity for family breakdown (Kalil and Rege, 2015). In these circumstances, parents may behave in richer ways towards each other and the child, creating a safe and warm environment that is conducive to children's learning and improved cognitive functioning (Lamb 2010).

Based on these postulations, we expect that:

Hypothesis 1. More father-child time should be related to better child cognitive outcomes.

As noted, empirical literature in this area is limited. Most previous studies have lacked time-use data, having to resort to poor proxies of paternal time allocations to the child (for a review, see Sarkadi et al., 2008). In these studies, the general finding is that fathers' time availability enhances children's cognitive development, particularly amongst children from disadvantaged backgrounds. Closest to our research are Hofferth (2006) and Milkie et al. (2015), two US studies that leverage time-diary data from the Panel Study of Income Dynamics Child Development Supplement (PSID-CDS). Both of these found no relationships between father-child time (measured as hours per week of time accessible to and engaged with the child) and children's academic and behavioral outcomes. Our study expands their scope by considering the content of the father-child shared activities, effect differences by parental education, and longitudinal estimation.

The importance of father-child time content

There is growing recognition that activity content is important when considering the effects of parent-child time on children. As Hsin (2009: 125) puts it: the *"simple quantity of time by itself is not sufficient for producing positive achievement outcomes in children [...] the returns to time investments depend on the amount of cognitive stimulation parents provide during that time"*. Some commentators go as far as arguing that high-*quality* parent-child time is more important to child development than high-*quantity* parent-child time (Amato, 1998).

Exposure to different types of activities has different consequences for the child's cognitive development (Hsin, 2009). Activities such as reading, playing games, doing homework, and participating in social events are argued to be associated with positive child outcomes. This is because, in undertaking these activities, children exercise their thinking skills, and this stimulates and contributes to building their brain structure (Takeuchi et al., 2015; Diamond and Lee, 2011). More importantly, when these activities are undertaken with an engaged adult and more specifically a parent, they provide opportunities for the child to improve his/her reasoning, analysis and problem-solving skills through parental role modelling, direct instruction and language exchanges (Lareau, 2011; Waldfogel, 2006). That is, these activities are more stimulating for the child if shared with the

father (or mother), which should have positive flow-on consequences on the child's cognitive development. In contrast, when the child and the father (or mother) spend their joint time in other activities, such as unstructured activities (e.g. watching television) or routine care (e.g. helping the child wash or dress), their interactions may be fewer and less intense, and consequently less conducive to children's cognitive development (Hsin and Felfe, 2014). For example, father and child may talk less and in a less engaged way when watching television, compared to when playing a board game.

Recent time-use research on how parent-child time in different activity types affects child outcomes has focused on time between the child and the mother (Hsin and Felfe, 2014) or any parent (Fiorini and Keane, 2014), but to date has neglected father-child time. These studies typically split parent-child time into two or three categories, according to the type of activity. The most common categories are: educational time (i.e. activities which have a clear learning components, e.g. reading, playing games); structured time (i.e. scheduled activities, e.g. dance lessons, organized sport); routine care time (i.e. activities aimed at covering basic child needs and which are usually time fixed, e.g. helping the child eat, bath or dress); and unstructured time (i.e. activities without a clear structure –e.g. media activities such as watching TV, and vague categories, e.g. other play, doing nothing).

Within this literature, there is consensus that educational time with the mother (Hsin and Felfe, 2014) or any parent (Fiorini and Keane, 2014) is more valuable for children's cognitive outcomes than joint time in other activities. The hierarchy across other activities is less clear. In analyses of PSID-CDS data, Hsin and Felfe (2014) found that the most productive input for children's cognitive development after educational time was structured time, followed by a 'catch-all' reference category capturing all other time uses, and finally unstructured time. In their analyses of verbal ability using LSAC data, Fiorini and Keane (2014) used a more nuanced time categorization. Their 'value added' model yielded the following hierarchy of time inputs, from most to least productive: educational time spent with parents, educational time with non-parents, media time, social time, general care with parents, general care with non-parents, bed time, and school time.

While there is no available evidence on how activity type shapes the relationships between father-child time and child outcomes, we expect the associations to be similar to those for mother-child time or parent-child time. We therefore hypothesize that:

Hypothesis 2. Father-child time in educational activities will be more conducive to child cognitive development than father-child time in other activities.

Effect heterogeneity by paternal education

Different bodies of work lead to the prediction that parental education should moderate the effect of father-child time on children's cognitive outcomes. Both the amount of time parents spend with their children and the content of such time have been shown to differ markedly by social strata (Guryan et al., 2008; Craig and Mullan, 2011; Bonke and Esping-Andersen, 2011; Kalil, Ryan and Corey, 2012). First, highly educated parents spend more time with their children than less highly educated parents –see Monna and Gauthier (2008) for a review. For instance, Australian fathers with University degrees spend about 10 more minutes per day with their children than Australian fathers without University degrees (Craig, Powell and Smyth, 2014). Second, there is evidence of heterogeneity by parental education in the content of the activities that fathers and children share when they spend time together. In particular, highly educated parents engage more in activities that stimulate children's cognitive functioning, such as educational play (Kalil et al., 2012; Altintas, 2016). In addition, highly educated parents are comparatively better in tailoring shared activities to their children's age and developmental stage (Kalil et al., 2012). Collectively, these arguments suggest that father-child time should have a stronger positive effect on child outcomes when fathers have high levels of education. Furthermore, there are reasons to expect higher returns to father-child time amongst children of more educated fathers, net of differences in the amount and content of father-child time. Highly educated fathers dispose of a wider set of skills and socio-cultural capital than lowly educated fathers, including problem-solving, information-seeking and language abilities (Mirowsky and Ross, 2003), and hold higher expectations for their children (Davis-Kean, 2005). Highly educated fathers can use their socio-cultural capital to acquire, develop and exert cognitively stimulating parenting practices that

enhance children's cognitive development. They have both 'more' to transfer to their offspring, as well as a greater predisposition to transfer (Bourdieu and Passeron, 1980). For example, children of more educated fathers will be exposed to broader, more complex and more sophisticated vocabulary and knowledge inputs from their parents during both highly productive shared activities (e.g. educational play) and not so productive shared activities (e.g. unstructured time). Therefore, children of more highly educated parents are likely to attain greater cultural capital, reaping its benefits on cognitive outcomes (Lareau, 2011; Meier and Breen, 2016; Harding et al., 2015 for a review). Altogether, we hypothesize that:

Hypothesis 3. Fathers' total time with children (as well as time on each activity type) will have a stronger positive effect on children's cognitive outcomes when parents are highly educated.

DATA AND METHODS

Dataset and sample selection

We use data from *Growing Up in Australia: The Longitudinal Study of Australian Children* (LSAC). LSAC is a biannual birth-cohort study which since 2004 collects information on Australian children and their families from the study child, his/her parents and a teacher/carer through a combination of face-to-face and self-complete questionnaires. The LSAC sample was identified using complex probabilistic methods, and is largely representative of two cohorts of Australian children: one born between March 1999 and February 2000 (n=4,983 children) and one born between March 2003 and February 2004 (n=5,107 children). For further details on the study's methodology, see AIFS (2015). LSAC is one of only two longitudinal studies in the world (with the US PSID-CDS) to collect 24-hour time-use diaries for children on multiple occasions. Parents (or the study child, depending on his/her age) provide detailed information about *what* the child was doing, as well as *where* and *with whom* the child was, splitting the day into 96 15-minute intervals. This was done for two days allocated at random, a weekend day and a weekday (Mullan, 2014). The LSAC time-diary data has some advantages over the analogous PSID-CDS data: it features a much larger analytical sample

(~10,000 children, compared to ~3,500 in the PSID), and closer observation points (two years in LSAC, compared to five years in PSID-CDS).

We restrict our analyses to children in the older LSAC cohort, and to study waves 1 (2004), 2 (2006) and 3 (2008), when these children were 4, 6 and 8 years of age, respectively. We focus on this subsample for both theoretical and pragmatic reasons. Theoretically, this age range (particularly 4-6 years) constitutes a sensitive period in children's skill acquisition, and a life-course stage in which gaps in cognitive skills between advantaged and disadvantaged children begin to widen (Ermisch et al., 2012; Cunha and Heckman, 2007). Pragmatically, the collection of the LSAC time-use diaries for the selected cohort changed drastically between study waves 1-3 and study waves 4-6 in ways that hamper comparability. In the latter waves, diaries were no longer filled by parents but by study children themselves, and there were substantial changes in the coding of the activities. In addition, our measure of cognitive ability was only collected in LSAC waves 1-3 for the selected cohort.

We restrict our analyses to children living with both biological parents. This is because the processes linking parent-child shared time-use and children's cognitive development are more complex in other family types, such as single-parent families, step families and reconstituted families (Furstenberg 1988; Hofferth 2006). We excluded observations with missing information on the day which the time diary was completed ($n=7$), in which only one of the two time diaries had been completed ($n=468$), and those who, as an error, had duplicated diaries ($n=35$). In addition, we excluded observations with missing information on the outcome variable capturing cognitive functioning ($n=276$), father's or mother's education ($n=21$) and Indigenous status ($n=55$). Our final analytical sample comprises 6,960 observations from 3,273 children. In this sample, 93% of the time-use diaries were completed by the child's mother, 6% by the father, and 1% by other family members.

Key explanatory variables: Total father-child time

LSAC includes a variable capturing who was with the child in each of the 96 15-minute blocks that

comprise a day. To derive our measure of total father-child time we first sum up each of the blocks in which the child was reportedly spending time with the father –except for those in which the mother was also present. Following previous studies (see e.g. Bianchi et al., 2006; Hofferth, 2006; Milkie et al., 2015), we undertook separate summations for the number of father-child hours in the weekday and weekend day diaries, and derived an estimate of weekly father-child hours by multiplying the weekday diary amount by 5 and the weekend-day diary amount by 2, and summing the resulting figures. Hence, our measure of total father-child time is an estimate of the *total number of hours per week that the father spends as the main carer of the child*. Similar measures were created for time with the mother alone, mother and father together, and neither father nor mother. When a 15-minute time block did not contain information on who was with the child, we allocated that time to a residual category (‘unknown’).

Key explanatory variables: Activity categories

In the study waves that we use, parents could choose one or more activities from a list of 22-24 pre-coded activities for each 15-minute interval when completing the LSAC time-use diaries. Similar to Hsin and Felfe (2014) and Fiorini and Keane (2014), we recoded these activities into eight activity categories: (i) educational, (ii) routine (iii) unstructured, (iv) social, (v) school/kindergarten, (vi) structured, (vii) sleep, and (viii) unknown. See Table S1 in the Supplementary Online Materials for further detail. Then, for each of the three time categories of key analytic interest (educational, structured and unstructured time), we derived variables capturing the amount of time the child spent on that category with (i) the father alone, (ii) the mother alone, (iii) the mother and the father together, and (iv) neither father nor mother. Again, we allocated missing data to the residual activity category ‘unknown’, with some exceptions. Following Fiorini and Keane (2014), we recoded missing data for activities occurring between 10:00pm and 6:00am as sleep time. In wave 1, we recoded missing data for activities between 8:00am and 3:00pm in ordinary weekdays as school/kindergarten time. In waves 2 and 3, when school is mandatory (ages 6-8), we recoded all time between 8:00am and 3:00pm in ordinary weekdays as school time. Where parents reported multiple activities for a single 15-

minute time slot and these activities belonged to different activity groups, we allocated a portion of those 15 minutes to each of the groups. For example, if a parent reported that the child was both doing homework and listening to music, we would allocate 7.5 minutes to educational activities and 7.5 minutes to unstructured time. After these adjustments, our time categories add up to 168 hours, or the total number of hours in a week.

Outcome variable: Children's cognitive outcomes

Children's cognitive ability is captured by their scores in a short version of the Peabody Picture Vocabulary Test, version three (PPVT-III) administered by a survey interviewer. The PPVT-III is a validated and widely used psychometric test that measures children's knowledge of the meanings of spoken words and his/her receptive vocabulary (Dunn and Dunn, 1997). Its implementation involves an examiner presenting the child with four images, together with a word that describes one of these images. The examiner then asks the child to identify the appropriate image. The complexity of the words and images varies by child's age to match the test's difficulty with developmental stages. PPVT scores range from 0 to 100, where higher scores denote higher cognitive ability. Across all children and study waves in our sample, the PPVT has a mean of 72.75 (SD=7.77) (see Table 1).

[TABLE 1 HERE]

Control variables

In our multivariate models, we adjust for a set of control variables commonly used in studies of children's cognitive development. These include (i) *study child characteristics*: sex (male/female), ethnicity (Indigenous/Not Indigenous), low birth weight (below 2.5 kg.) and age (in months); and (ii) *family characteristics*: father's and mother's weekly work hours (expressed in 10s), father's and mother's highest educational qualification (University degree/lower than University degree), parental annual income (mothers' plus fathers' weekly income times 52, adjusted for inflation using the Consumer Price Index), presence of a study child's sibling at home (yes/no), and language spoken at home (English/other language). Additionally, all models control for a set of dummy variables denoting whether the time-diary day was an ordinary day, and (ii) whether it was the mother (vs.

anyone else) who completed the diary. Table 1 shows means and standard deviations for all control variables.

Estimation approach

We examine the relationships between paternal time investments and children's cognitive functioning using two estimation techniques: (i) base ordinary-least squares (OLS) models similar to those used in previous studies (see e.g. Milkie et al., 2015; Fomby and Musick, 2017), and (ii) longitudinal 'value added' models that make better use of the panel data at hand (previously used in Fiorini and Keane, 2014). The OLS models used to test the time-quantity hypothesis (Hypothesis 1) take the form:

$$PPVT_{ct} = \beta_0 + \beta_1 T_{ct} + \beta_2 F_{ct} + \beta_3 M_{ct} + \beta_4 X_{ct} + e_{ct} \quad (1)$$

where subscripts c and t refer to child and time period, respectively; T captures all time inputs; F and M denote paternal and maternal characteristics, respectively; X is a vector of other control variables; β_0 is the model's grand intercept; β_1 to β_4 are coefficients or vectors of coefficients to be estimated; and e is the usual random error term. The standard errors are adjusted for the clustering of observations within children. We run OLS models with basic covariates (child's age and gender, diary characteristics) to establish basic associations, and more conservative models with extended covariates (adding also information on birthweight, Indigeneity, siblings, language spoken at home, parental education and work hours, and family income). The 'value added' model takes into account the correlation between current and previous outcomes, and thus considers that children's skills develop cumulatively (see Todd and Wolpin, 2007 for details). This is accomplished by including a lag of the outcome variable ($PPVT_{ct-1}$) amongst the model predictors:

$$PPVT_{ct} = \beta_0 + \beta_1 T_{ct} + \beta_2 F_{ct} + \beta_3 M_{ct} + \beta_4 X_{ct} + \beta_5 PPVT_{ct-1} + e_{ct} \quad (2)$$

These 'value added' models are better equipped to reduce the possible bias introduced by the fact that parental time investments may be endogenous to children outcomes, i.e. that parents may decide how much time they spend with their children based on their cognitive development. Value added models are estimated using the extended set of covariates.

To test the time-content hypothesis (Hypothesis 2), we substitute the time-investment variables in equations (1) and (2) by more detailed variables that also consider activity type (as described before). To test the effect heterogeneity hypothesis (Hypothesis 3), we expand all previous models by interacting the time-investment and paternal education variables.

RESULTS

Children's time use

The mean amount of weekly father-child time across all child-year observations in our pooled sample is 7.11 hours (SD=10.52), substantially lower than for mother-child time (M=26.82; SD=23.35) or time with mother and father together (M=35.39; SD=33.57) (see Table 1). When considering different activity types, weekly father-child time is 0.65 hours (SD=1.51) in educational activities, 0.78 hours (SD=1.94) in structured activities and 1.29 hours (SD=2.74) in unstructured activities. These figures are again much lower than those for mother-child time: 2.61 hours (SD=3.62) in educational activities, 1.97 hours (SD=3.03) in structured activities and 4.63 hours (SD=6.19) in unstructured activities; and time with mother and father together: 2.31 hours (SD=3.16) in educational activities, 1.43 hours (SD=2.47) in structured activities and 4.70 hours (SD=5.48) in unstructured activities. Altogether, these results are consistent with previous evidence, pointing to lower paternal than maternal involvement in childcare (Craig, 2006) and higher heterogeneity in involvement amongst mothers than fathers (Craig & Mullan, 2011). When fathers spend time with their children, the mother is typically also present.

Hypothesis 1: Father-child time quantity

Table 2 shows the results from a first set of regression models testing the effects of total father-child time on children's PPTV scores. Since time-use measures add up to 168 hours, due to collinearity, one of them must be left out of the model to serve as reference category (Fiorini and Keane, 2014). Here, we exclude the variable capturing time with neither father nor mother. Relative to one hour of time spent with neither father nor mother, one hour of father-child time is associated with improved children's PPVT scores in the OLS models with basic ($\beta=0.028$; $p<0.001$) and extended ($\beta=0.021$;

$p<0.001$) covariates, and in the value added model ($\beta=0.019$; $p<0.01$). These results are consistent with our first hypothesis. However, the magnitude of the estimated effects is very small: 5 additional weekly hours of father-child time increase PPVT scores by about 1.2-1.8% of a standard deviation. This pattern of weak results is nevertheless consistent with recent US findings for mothers (Hsin & Felfe 2014; Milkie et al., 2015). Interestingly, mother-child time and time with both father and mother are not statistically related to the child's PPVT scores in any of these models ($p>0.05$). The results on the control variables are generally consistent with expectations and will not be discussed further.

[TABLE 2 HERE]

Hypothesis 2: Father-child time content

In a second set of models (Table 3), we examine the impact on children's PPVT scores of time spent between children and parents on different types of activities. Here, following Fiorini and Keane (2014), we leave out sleep time as the reference category. Consistent with Hypothesis 2, our results yield evidence of 'productivity hierarchies' in father-child time by activity type. In the OLS models with base controls, the stronger effects on PPVT scores are found for father-child time in educational activities ($\beta=0.277$; $p<0.001$), followed by structured activities ($\beta=0.132$; $p<0.001$), and finally unstructured activities ($\beta=0.071$; $p<0.01$). In the OLS model with extended covariates, a similar hierarchy can be observed –with the effect of time spent on unstructured activities no longer being statistically significant ($p>0.05$). In the value added model, only the effect of father-child time in educational activities remains statistically significant ($\beta=0.150$; $p<0.01$), with Wald tests (not shown) revealing that this is larger than the coefficients on structured and unstructured time ($p\leq 0.05$). To get a sense of the effect size, 5 additional weekly hours of father-child time in educational activities would increase PPVT scores by 10% of a standard deviation. Whereas the same productivity ranking across time-use categories can be observed for mother-child time and time with both parents, none of the coefficients on mother-child time and only the coefficient on educational time for time with both father and mother ($\beta=0.100$; $p<0.001$) remain statistically significant in the value added model.

[TABLE 3 HERE]

We tested the robustness of the results to different methodological choices (see Tables S2 & S3 in the Supplementary Online Materials). First, we tested the sensitivity of our father-child time estimates to possible downward bias due to ‘noisy’ time-use measures derived from non-representative days (Wolfers, 2015). To accomplish this, we estimated models using only the subsample of children for whom the time-diary day was reported to be an ordinary day (66% of all observations). The estimates on total father-child time are very similar to those reported in the main models (Table S2). Those for father-child time in different types of activities are similar in the OLS model, but less so in the value added model –where the coefficient on unstructured time is the only positive, and statistically significant coefficient. Second, we tested the sensitivity of the results to using discrete rather than continuous time-use categorizations, separating fathers who do not spend any time with their child, fathers who spend some time, and more involved fathers (see Fomby & Musick, 2017; Kalil & Mayer, 2016). Results from the value added model provide evidence of gradual improvements in children’s PPVT scores with the degree of paternal involvement for total time, returns to time in educational activities only amongst highly involved fathers, and no differences by degree of involvement for time in structured or unstructured activities (Table S2). Third, we considered quadratic specifications of the father-child time variables to capture potential non-linear associations. Our results reveal little evidence of the latter –as denoted by mostly statistically insignificant parameters on the square terms (Table S2). Fourth, we replicated the models presented in the main text using alternative estimators (Table S3). The pattern of results was similar in random- and fixed-effect panel regression models, as well as in a cumulative model including lags of all time-varying covariates and the outcome variable amongst the controls (see Todd & Wolpin, 2007: 100; Fiorini & Keane, 2014: 805). As an exception, the coefficient on total father-child time becomes statistically insignificant in the fixed effects model.

Hypothesis 3: Effect heterogeneity by paternal education

In a final set of models we examine whether or not the estimated effects on children’s PPVT scores of father-child time (in general and across activity types) differ by paternal education. This is

accomplished by adding to the models variables interacting paternal highest educational qualification (degree/lower than degree) and the father-child time-use variables. Against the predictions of Hypothesis 3, all of the interaction terms were statistically insignificant ($p>0.05$), indicating that the degree to which children's cognitive functioning benefits from paternal involvement does not differ in families with highly and less highly educated fathers.

[TABLE 4 HERE]

DISCUSSION AND CONCLUSION

In this paper we have provided what, to our knowledge, constitutes the first systematic account of how father-child time is associated with children's cognitive functioning (operationalized using the PPVT) using longitudinal time-diary data. In doing so, we contribute to both the literature on the role of fathers in child development (Cabrera et al., 2007; Lamb, 2010) and an emerging body of knowledge documenting how parental time inputs and involvement in childcare are associated with child development—a body of work which has focused almost exclusively on maternal rather than paternal time with children (Milkie et al., 2015; Fomby & Musick, 2017). We accomplished this by leveraging high-quality panel survey data from the *Longitudinal Study of Australian Children* spanning from 2004 to 2010 and collecting information from children aged 4 to 8.

Using psychological, sociological and economic perspectives, we developed three testable hypotheses regarding the associations between father-child time and children's cognitive functioning. Our first hypothesis posed that higher amounts of father-child time, overall, should be associated with higher levels of cognitive development in their children. Our analyses provided some evidence in favor of this postulation, although the magnitude of association was rather small: 5 additional hours of father-child time in a given week were associated with an increase of about 0.1 in the PPVT scale, which ranges from 0 to 100, or about 2% of its standard deviation. These results are nevertheless consistent with earlier US literature focusing on motherhood. For example, Fomby & Musick (2017) found very small associations between mother-child time and children's reading scores. Similarly, Milkie et al. (2015) found no evidence of statistically significant associations between mother-child

time and several measures of children's academic and behavioral outcomes. Interestingly, while the estimated impact of total father-child time on child cognitive outcomes was small, those for mother-child time were even smaller and statistically insignificant in our sample. In fact, the estimated effects on PPVT scores of total father-child time are significantly larger than those of mother-child time (at $p < 0.01$) (results not shown). This result is perhaps surprising and might be due to two factors. First, children coming from families with an involved father might be exposed to other unobserved characteristics that enhance their development (e.g. higher levels of social capital, or less parental conflict) (Cabrera et al., 2007; Lamb, 2010). Second, compared to mothers' involvement in childcare, fathers' involvement is more infrequent and targeted, and as a result focuses on "fun" activities (Raley et al., 2012), which are more conducive to cognitive development (Fiorini and Keane, 2014).

Borrowing from another strand of work on differential 'productivity' across children's activity types (Hsin & Felfe, 2014; Fiorini & Keane, 2014), we further hypothesized that father-child time should have particularly strong effects when that time was spent in educational activities. Our subsequent analyses yielded a pattern of results that was highly consistent with this postulation (irrespective of the modelling approach used): father-child time spent in educational activities (such as reading or educational play) had larger positive effects on children's cognitive functioning than father-child time spent in structured activities (such as extracurricular activities or sports) or unstructured activities (such as watching TV or using a computer). The magnitude of these effects appeared to be moderate to large. To get a sense of the magnitude, the increase in PPVT scores associated with 5 extra weekly hours of father-child time in educational activities was equivalent to about 10% of the standard deviation in the PPVT, and comparable to the estimated effect of having a parent with University-level qualifications. The hierarchy of productivity across activity types is highly consistent with findings on maternal involvement in the US by Hsin and Felfe (2014), as well as findings for time spent with either parent in Australia by Fiorini and Keane (2014). This result is generally robust to different model specifications, and estimation approaches (see Fiorini and Keane, 2014).

Building on sociological literature on social stratification and intergenerational transfers, our third and final hypothesis posed that father-child time should have stronger positive effects on children's cognitive functioning when fathers are highly educated. Yet against this premise, we found no evidence that one-hour of father-child time yields more benefit to the child when fathers have tertiary education qualifications. Instead, our results indicate that one hour of father-child time (overall, as well as across activity types) yields the same returns to the children of highly and less highly educated fathers. This finding can be taken in a positive light: it suggests that paternal involvement in childcare *need not* be a mechanism driving social inequalities and diverging destinies amongst children, and that fathers with low educational credentials can compensate for their children's developmental deficits (see Ermisch et al., 2012) by spending more time with them –particularly if during that time they engage in educational activities. Nevertheless, this is not to say that parental education does not matter. For example, as in the broader literature, fathers with degrees in our sample spent an average of 7.75 hours per week with their children, of which 0.84 hours were in educational activities, and other fathers spent an average of 6.79 hours per week overall, 0.55 hours in educational activities.

Despite the uniqueness of our study, the data at hand and our methodological approach, some *caveats* to our findings need to be acknowledged. These point towards potential avenues for methodological refinement and further scholarly inquiry. First, an inherent problem with time-diary data, such as the LSAC data, is the relatively large incidence of 'missingness'. For example, even after making assumptions about missing data during some parts of the day as sleep or school time, we are still unable to determine which type of activity the child was doing for about 6 hours per week. This issue may have led to attenuation of our estimates on the effects of father-child time on children's PPVT scores. Second, it is possible that some (or most) parents are not fully knowledgeable (or truthful in their reporting) of who the child was with, or what the child was doing. For example, 90% of LSAC time-use diaries are filled by mothers, of which 45% work part-time (≤ 30 hours per week) and 24% work full-time (> 30 hours per week). It remains unclear how accurately reports from working mothers about the child's activities and guardians are for those parts of the diary which coincide with their

work schedules. Additionally, since public discourse places a premium on parental involvement in childcare (particularly maternal involvement) and educational activities, parents may be likely to over-report these. It remains unclear how these instances of social desirability biases would affect time-diary estimates of parental time inputs on child development. Second, reverse causality remains a looming cause of bias to estimates of how parental involvement in childcare relates to child wellbeing: parents may spend more time (particularly educational time) with their children if they perceive that their children's cognitive development is slowed or impaired. This would result in downward-biased estimates on the effects of parent-child time on child outcomes in this and other studies. Unfortunately, traditional solutions to correct for reverse causation –including pseudo-experimental approaches– are difficult, if at all possible, to implement in this context –see Fiorini and Keane (2014: 792) or Todd and Wolpin (2007) for further discussion. For instrumental-variable regression specifically, finding appropriate instruments for multiple endogenous time-investment variables remains an insurmountable challenge. Methodological developments aimed at minimizing these possible sources of bias are required to respond to this concern.

To conclude, our findings are not only novel but also relevant for policy and practice: they are indicative that enabling paternal involvement in their children's upbringing (e.g. by promoting work-family balance amongst fathers) should bring moderate-to-high gains to their children in terms of cognitive functioning. The case for investing in paternal involvement in childcare becomes even more compelling when these results are considered vis-à-vis evidence suggesting that such involvement is also a factor contributing to improved maternal mental health, maternal labor force participation, and enhanced family functioning. Future studies should also address important questions that we have not covered in this study, such as how father-child time affects other child outcomes (e.g. children's socio-emotional functioning). In addition, our results relate to a single country, Australia, which features a highly idiosyncratic constellation of institutional features concerning parental involvement in childcare. For example, Australia is characterized by high levels of intensive parenting and policies that encourage mothers dropping out of the labor market or moving into part-time work to undertake

the lion's share of the childcare. Identifying whether and how these and other features of the institutional environment contribute to the mix of parental time inputs on their children, and their outcomes, constitutes an important avenue for further research. The available evidence base is currently confined to the US and Australia, and so studies focusing on country contexts with differing institutional settings are urgently needed.

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Tables

Table 1. Descriptive statistics for analytic variables

	Mean/%	SD	Min.	Max.
<i>Outcome variable</i>				
Peabody Picture Vocabulary Test	72.75	7.77	34.18	96.98
<i>Weekly time spent...</i>				
Alone with father	7.11	10.52	0	142.5
Alone with mother	26.82	23.35	0	168
With mother and father together	35.39	33.57	0	168
With neither mother nor father	95.75	40.28	0	168
Unknown	2.92	3.22	0	21
<i>Weekly time in different activity types</i>				
<i>With father</i>				
Educational activities	0.65	1.51	0	21.12
Structured activities	0.78	1.94	0	38.25
Unstructured activities	1.29	2.74	0	33.62
<i>With mother</i>				
Educational activities	2.61	3.62	0	33.56
Structured activities	1.97	3.03	0	37.35
Unstructured activities	4.63	6.19	0	56.25
<i>With mother and father together</i>				
Educational activities	2.31	3.16	0	35.12
Structured activities	1.43	2.47	0	30.88
Unstructured activities	4.70	5.48	0	55.46
<i>With neither mother nor father</i>				
Educational activities	2.40	3.57	0	42.50
Structured activities	5.03	6.78	0	59.50
Unstructured activities	4.84	6.92	0	42.50
<i>Time in other activities</i>				
Attending school/kindergarten	29.20	13.39	0	70.25
Social activities	4.23	6.43	0	99.12
Routine care	17.71	6.23	0	61.42
Sleeping	78.11	6.69	20.75	121.17
Unknown	6.12	7.09	0	40.87
<i>Control variables</i>				
Child's age (in months)	80.16	19.74	51	114
Child is female	49%		0	1
At least one other child in household	44%		0	1
Child speaks English at home	89%		0	1
Child is Indigenous	2%		0	1
Child had low birth weight	5%		0	1
Child's father has a University degree	31%		0	1
Child's mother has a University degree	32%		0	1
Family income, in \$10,000	9.98	6.54	0	71.28
Child's father weekly work hours, in 10s	4.49	1.57	0	10
Child's mother weekly work hours, in 10s	1.64	1.62	0	10
Diary completed in an ordinary day	66%		0	1
Child's mother completed the diary	91%		0	1

Notes: Longitudinal Study of Australian Children. K Cohort, waves 1-3. Observations are pooled across waves. n(observations)=6,960; n(children)=3,273).

Table 2. Regression models of children's Peabody Picture Vocabulary Test scores, time quantity

	OLS		OLS		VA	
	β	SE	β	SE	β	SE
<i>Weekly time spent with...</i>						
<i>(ref. cat. With neither mother nor father)</i>						
Alone with father	0.028***	0.006	0.021***	0.006	0.019**	0.007
Alone with mother	-0.002	0.003	-0.002	0.003	-0.000	0.003
Together with mother and father	-0.004	0.002	-0.002	0.002	0.001	0.002
Unknown	-0.047*	0.021	-0.032	0.020	-0.008	0.022
<i>Basic controls</i>						
Child's age (in months)	0.294***	0.003	0.291***	0.003	0.046***	0.008
Child is female	0.094	0.156	-0.001	0.148	-0.451**	0.137
Diary completed in an ordinary day	0.130	0.142	0.249	0.137	0.126	0.148
Child's mother completed the diary	0.151	0.257	-0.001	0.244	0.030	0.243
<i>Extended controls</i>						
At least one other child in household			-0.829***	0.148	-0.418**	0.142
Child speaks English at home			2.572***	0.274	0.571*	0.259
Child is Indigenous			-0.593	0.496	0.220	0.425
Low weight at birth			-1.430***	0.346	-0.398	0.306
Child's father has a University degree			1.242***	0.171	0.970***	0.160
Child's mother has a University degree			1.120***	0.168	0.480**	0.160
Family income, in \$10,000			0.056***	0.011	0.025*	0.011
Father's weekly work hours, in 10s			0.037	0.048	-0.021	0.052
Mother's weekly work hours, in 10s			-0.090*	0.046	-0.054	0.045
<i>Lag of PPVT score</i>					0.386***	0.015
Intercept	48.912***	0.438	45.825***	0.523	44.743***	0.837
R ²	0.548		0.581		0.390	
AIC / BIC	42,790 / 42,852		42,285 / 42,408		20,654 / 20,772	
n (children) / n (observations)	3,273 / 6,960		3,273 / 6,960		2,215 / 3,628	

Notes: Longitudinal Study of Australian Children. K Cohort, waves 1-3. OLS: Ordinary Least Squares; VA: Value added. Significance levels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Ref. cat. stands for Reference category.

Table 3. Regression models of children's Peabody Picture Vocabulary Test scores, time content

	OLS		OLS		VA	
	β	SE	β	SE	β	SE
<i>Weekly time in activity types</i>						
<i>(reference category: Time sleeping)</i>						
<i>With father</i>						
Educational activities	0.277***	0.046	0.210***	0.044	0.150**	0.051
Structured activities	0.132***	0.034	0.106**	0.033	0.035	0.039
Unstructured activities	0.071**	0.025	0.047	0.025	0.053	0.034
<i>With mother</i>						
Educational activities	0.152***	0.022	0.113***	0.022	0.045	0.027
Structured activities	0.113***	0.024	0.085***	0.023	0.035	0.027
Unstructured activities	0.017	0.017	0.011	0.017	-0.013	0.024
<i>With mother and father together</i>						
Educational activities	0.162***	0.025	0.133***	0.024	0.100***	0.029
Structured activities	0.065*	0.031	0.054	0.030	0.033	0.030
Unstructured activities	-0.017	0.016	-0.007	0.015	0.003	0.020
<i>With neither mother nor father</i>						
Educational activities	0.111***	0.022	0.093***	0.021	0.072**	0.023
Structured activities	0.001	0.015	0.007	0.015	0.022	0.019
Unstructured activities	0.062***	0.014	0.045***	0.014	0.014	0.016
<i>Time in other activities</i>						
Attending school/kindergarten	0.043***	0.013	0.031**	0.012	-0.008	0.013
Social activities	0.063***	0.012	0.059***	0.012	0.005	0.015
Routine care	-0.009	0.015	0.001	0.014	0.004	0.016
Unknown	0.089***	0.014	0.076***	0.013	0.024	0.015
<i>Basic controls</i>	Yes		Yes		Yes	
<i>Extended controls</i>	No		Yes		Yes	
<i>Lag of PPVT score</i>	No		No		Yes	
R ²	0.565		0.590		0.397	
AIC / BIC	42,557 / 42,701		42,149 / 42,355		20,638 / 20,830	
n (children) / n (observations)	3,273 / 6,960		3,273 / 6,960		2,215 / 3,628	

Notes: Longitudinal Study of Australian Children. K Cohort, waves 1-3. OLS: Ordinary Least Squares; VA: Value added. Full set of estimates available from the authors upon request. Significance levels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 4. Regression models of children's Peabody Picture Vocabulary Test scores, interactions with paternal education

	OLS		OLS		VA	
	β	SE	β	SE	β	SE
<i>Total time</i>						
Child's father has University degree	1.936***	0.187	1.298***	0.196	0.987***	0.189
Total time with father	0.029***	0.007	0.023***	0.007	0.020*	0.008
University degree *						
Total time with father	-0.013	0.012	-0.008	0.012	-0.002	0.015
R ²	0.561		0.581		0.390	
AIC / BIC	42,599 / 42,675		42,287 / 42,417		20,656 / 20,780	
n (children) / n (observations)	3,273 / 6,960		3,273 / 6,960		2,215 / 3,628	
<i>Time content</i>						
Child's father has a University degree	1.633***	0.184	1.173***	0.192	0.868***	0.188
Educational time with father	0.240***	0.058	0.205***	0.058	0.157*	0.064
Structured activities with father	0.127**	0.043	0.108**	0.042	0.026	0.049
Unstructured activities with father	0.079**	0.029	0.062*	0.028	0.042	0.041
University degree *						
Educational activities with father	0.003	0.088	0.016	0.084	-0.018	0.099
University degree *						
Structured activities with father	-0.011	0.064	-0.006	0.062	0.030	0.078
University degree *						
Unstructured activities with father	-0.046	0.050	-0.051	0.048	0.028	0.067
<i>Basic controls</i>	Yes		Yes		Yes	
<i>Extended controls</i>	No		Yes		Yes	
<i>Lag of PPVT score</i>	No		No		Yes	
R ²	0.573		0.590		0.397	
AIC / BIC	42,424 / 42,595		42,154 / 42,380		20,643 / 20,854	
n (children) / n (observations)	3,273 / 6,960		3,273 / 6,960		2,215 / 3,628	

Notes: Longitudinal Study of Australian Children. K Cohort, waves 1-3. OLS: Ordinary Least Squares; VA: Value added. Full set of estimates available from the authors upon request. Significance levels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Supplementary online materials

Table S1. Correspondence between activities and time categories

Category	Activities
Educational	Reading, being read to, playing educational games, being taught to do chores
Structured	Lessons, structured physical exercise
Unstructured	Watching TV, computer, listening to music, doing nothing, other activity, other play
School	School, day care
Social	Visiting people, special event, party
Routine	Eating, drinking, being fed, bathe, dress, hair care, crying, upset, arguing, fighting, destroying things, held, cuddled, being reprimanded, corrected, walk for travel or for fun, riding bicycle, scooter, rollers
Sleep	Sleep, bed
Unknown	Not sure what child was doing, missing

Notes: Longitudinal Study of Australian Children. K Cohort, waves 1-3.

Table S2. Alternative specifications

	OLS		VA	
	β	SE	β	SE
<i>Sensitivity analysis 1: Subsample of ordinary days</i>				
<i>Total time model</i>				
Total time with father	0.022**	0.008	0.023*	0.010
n (children/ observations)	2,823 / 4,566		1,642 / 2,097	
<i>Time-content model</i>				
Educational activities with father	0.187***	0.056	0.128	0.069
Structured activities with father	0.134**	0.041	0.034	0.050
Unstructured activities with father	0.055	0.031	0.113*	0.051
n (children/ observations)	2,823 / 4,566		1,642 / 2,097	
<i>Sensitivity analysis 2: Categorical specifications</i>				
<i>Total time model</i>				
Father not involved (0 hours)	Ref.	Ref.	Ref.	Ref.
0-6 hours per week	0.588***	0.156	0.370*	0.178
>6 hours per week	0.823***	0.156	0.504**	0.182
n (children/ observations)	3,273 / 6,960		2,215 / 3,628	
<i>Time-content model</i>				
<i>Educational activities</i>				
Father not involved (0 hours)	Ref.	Ref.	Ref.	Ref.
0-2 hours per week	0.343	0.178	0.262	0.204
>2 hours per week	0.890***	0.210	0.507*	0.243
<i>Structured activities</i>				
Father not involved (0 hours)	Ref.	Ref.	Ref.	Ref.
0-2 hours per week	0.393*	0.173	0.261	0.190
>2 hours per week	0.804***	0.195	0.352	0.213
<i>Unstructured activities</i>				
Father not involved (0 hours)	Ref.	Ref.	Ref.	Ref.
0-2 hours per week	0.310	0.164	-0.054	0.189
>2 hours per week	0.148	0.175	0.186	0.207
n (children/ observations)	3,273 / 6,960		2,215 / 3,628	
<i>Sensitivity analysis 3: Quadratic specifications</i>				
<i>Total time model</i>				
Total time with father	0.034**	0.011	0.027*	0.012
Total time with father, squared	-0.000	0.000	-0.000	0.000
n (children/ observations)	3,273 / 6,960		2,215 / 3,628	
<i>Time-content model</i>				
Educational activities with father	0.339***	0.074	0.177*	0.090
Educational activities with father, squared	-0.016*	0.008	-0.004	0.010
Structured activities with father	0.162**	0.052	0.094	0.075
Structured activities with father, squared	-0.005	0.004	-0.007	0.008
Unstructured activities with father	0.023	0.045	0.039	0.067
Unstructured activities with father, squared	0.001	0.003	0.001	0.006
n (children/ observations)	3,273 / 6,960		2,215 / 3,628	

Notes: Longitudinal Study of Australian Children. K Cohort, waves 1-3. OLS: Ordinary Least Squares; VA: Value added. The time thresholds used to define categorical measures of time are chosen so that sample members with non-zero variables are split into two similarly sized groups. For total time, 33.9% of fathers spent 0-6 weekly hours with the child, and 37.8% more than 6 hours. For educational time, 18.4% of fathers spent 0-2 hours, and 11.4% more than 2 hours. For structured time, 15.8% of fathers spent 0-2 hours, and 20.2% more than 2 hours. All models control for basic and extended covariates. Full set of estimates available from the authors upon request. Significance levels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table S3. Alternative estimation approaches

	Fixed effects		Random effects		Cumulative + lagged PPVT	
	β	SE	β	SE	β	SE
<i>Total time model</i>						
<i>(ref. Total time with neither father nor mother)</i>						
Total time with father	0.008	0.007	0.015**	0.006	0.017*	0.008
Total time with mother	-0.006	0.003	-0.003	0.003	-0.001	0.004
Total time with father & mother together	-0.001	0.002	-0.001	0.002	0.001	0.002
R ²	0.746		0.465		0.387	
AIC / BIC	34,462 / 34,558		42,287 / 42,417		20,096 / 20,238	
n (children) / n (observations)	3,273 / 6,960		3,273 / 6,960		2,215 / 3,523	
<i>Time-content model</i>						
<i>(ref. Sleep time)</i>						
Educational activities with father	0.134**	0.047	0.172***	0.039	0.141**	0.053
Structured activities with father	0.092*	0.036	0.107***	0.030	0.025	0.039
Unstructured activities with father	-0.017	0.029	0.024	0.024	0.040	0.036
R ²	0.756		0.472		0.393	
AIC / BIC	34,205 / 34,383		42,151 / 42,363		20,086 / 20,376	
n (children) / n (observations)	3,273 / 6,960		3,273 / 6,960		2,215 / 3,523	

Notes: Longitudinal Study of Australian Children. K Cohort, waves 1-3. All models control for a set of basic and extended controls. The total time model controls for unknown time & the time-content model controls for other time uses (as in Table 3). The ‘cumulative + lagged PPVT’ model is specified as in Fiorini & Keane (2014: 805): predictors include lags of all time-changing time-use and control variables, as well as the lag of the outcome variable (i.e. the PPVT). Random-effect models are estimated using maximum likelihood estimation. The R² statistics for the fixed-effect models refer to the *within* R². Full set of estimates available from the authors upon request. Significance levels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.